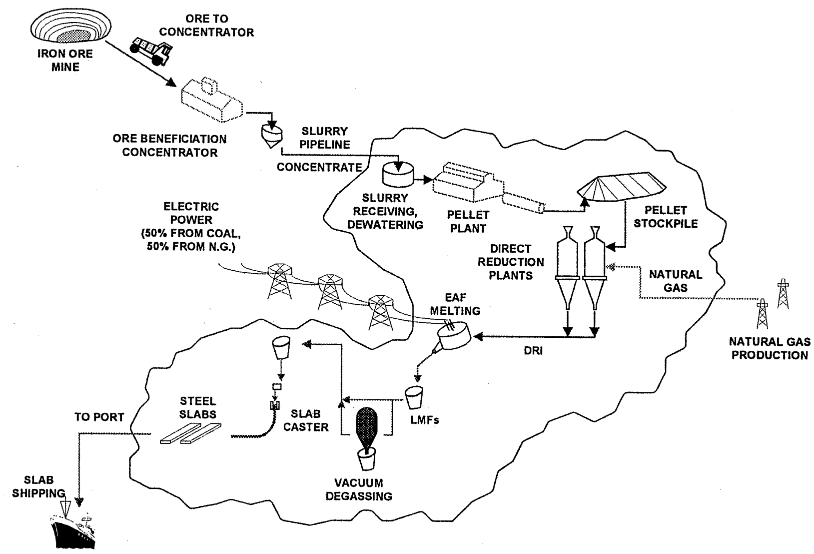
Energy Systems
LOCKHEED MARTIN

Ironmaking Process Alternatives Screening Study

Volume II: Appendix



August 2000

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IRONMAKING PROCESS ALTERNATIVES SCREENING STUDY

VOLUME II: APPENDIX

AUGUST 2000

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PROCESS DESCRIPTIONS

SHAFT FURNACE PROCESSES

IRONMAKING PROCESS DESCRIPTION

MIDREX® SHAFT FURNACE

PROCESS BACKGROUND:

The Midrex ™ Direct Reduction process is based upon a low pressure, moving bed shaft furnace where the reducing gas moves counter-current to the lump iron oxide ore or iron oxide pellet solids in the bed. The reducing gas (from 10-20% CO and 80-90% H_2) is produced from natural gas using Midrex's CO_2 reforming process and their proprietary catalyst (instead of steam reforming).

A single reformer is utilized instead of a reformer/heater combination. The reformed gas does not need to be cooled before introduction to the process. There is also no need for a separate CO_2 removal system.

The process can produce cold or hot DRI as well as HBI for subsequent use as a scrap substitute feed to a steelmaking melting furnace (SAF, EAF or oxygen steelmaking process).

Over 50 Midrex™ Modules have been built worldwide since 1969. They have supplied over 60% of the worlds DRI since 1989.

Standard sizes:

MIDREX™ MINIMOD Plant	(0.25-0.5 MM mt/year)
MIDREX™ Series 500 Module	(0.5-0.8 MM mt/year)
MIDREX™ Series 750 Module	(0.8-1.0 MM mt/year)
MIDREX MEGAMOD™	(1.0-1.6 MM mt/year)
MIDREX SUPER MEGAMOD™	(1.6-2.7 MM mt/year)

PROCESS DESCRIPTION:

The iron oxide feed to a Midrex ® shaft furnace can be in the form of pellets, lump ore or a mixture of the two (in 0 to 100% proportions). The solid feed is discharged into a feed hopper on top of a proportioning hopper that evenly distributes the solids into the shaft furnace.

A dynamic seal leg keeps the reducing gas inside the furnace. The shaft furnace operates at low pressure, under 1 bar gauge, which allows dynamic seals to be used on the furnace inlet and discharge. The iron ore burden in the shaft furnace is first heated, then reduced by the upward flowing, counter-current reducing gas that is injected through tuyeres located in a bustle distributor at the bottom of the cylindrical section of the shaft. The ore is reduced to a metallization typically in the range of 93% to 94% by the time it reaches the bustle area.

Below the bustle area, it goes through a transition zone (with design to reduce agglomeration or lumping) and then reaches the lower conical section of the furnace. Lower carbon reduced iron (<1.5% C) is cooled using a circulating stream of cooled exhaust gas that is introduced in the conical section for cold DRI discharge. Higher carbon DRI (up to 4.0% C) can be produced by introduction of natural gas into this cooling gas. It readily reacts (and cracks) with the highly reactive metallic DRI.

For hot discharge of DRI to be used for hot charging of EAF's (i.e. Midrex's Hotlink™ Process) or for feed to hot briquetting presses (to produce HBI), the lower part of the furnace is modified to allow handling of hot burden.

The Midrex gas generation system consists of a CO_2 reformer using their own catalyst. The feed to the reformer is a mixture of process gas recycled from the furnace and makeup natural gas. The top gas leaving the shaft furnace at a temperature of 400 to 450C is cooled and dust is removed in a top gas scrubber. About two-thirds of the gas is recycled back to the process (process gas) and the rest is used as a fuel. The process gas is compressed, mixed with natural gas and is preheated in the reformer recuperator before entering the tubes of the reformer.

The reformed gas comprising of mostly CO and H_2 exits the reformer at about 850 °C and passes through collection headers to the reformed gas line. The ratio of H_2 to CO is controlled at about 1.5 to 1.8, and reducing quality at 11 to 12 for best operation.

PROCESS ADVANTAGES:

World-wide commercial use
Proven performance
"Relatively-forgiving" operation
Raw material flexibility
CO_2 reformer eliminates need for steam system, reformed gas quench, reducing gas heating and CO_2 removal system.

HYLSA PROCESS (HYL III)

PROCESS BACKGROUND:

The HYL process uses reducing gases within a moving bed shaft furnace reactor to remove the oxygen from iron ore pellets and lump ore. In comparison to other similar technologies, it operates at slightly higher reduction temperatures (about 50 °C higher) and intermediate reduction pressures (up to 6 bars). The process can produce cold/hot DRI as well as HBI.

The HYL process can utilize higher-sulfur ore and gas feeds since it is equipped with a sulfur removal step (prior to the conventional steam reformer). A more-positive control is obtained for the reducing gas (CO to H_2 ratio) is obtained by utilizing a selective CO_2 removal circuit (typically PSA) in the circulating gas systems. This allows a wide range of CO to H_2 ratios (from 0.1 to 0.3) to be utilized depending on the required degree of metallization and/or carbon content of the final product.

PROCESS DESCRIPTION:

The iron oxide feed to a HYL shaft furnace can be pellets, lump, or a mixture of the two. The solids are fed to the top of the shaft furnace by conveyor. An automatic system of bins and pressure locks receives the ore at atmospheric pressure in an open bin, pressurizes in intermediate bins and charges it continuously to the reactor.

Hylsa divides the process into two independent sections: reducing gas generation and iron ore reduction. The natural gas (makeup to the reducing gas stream) is mixed with reducing gases recycled from the CO_2 removal system. The pressurized reducing gas is passed through a gas heater (where it is heated up to 930 °C) and is introduced to the reactor at up to 6 bar gauge. The higher gas pressure system reduces the tendency for bed fluidization, permits higher capacity from a given-diameter shaft furnace and reduces the effective volumetric flow rates or circulating gases. Higher mole ratios of reducing gas to iron oxide solids can be obtained (as compared to other shaft furnace processes).

The exhaust reducing gas from the reactor (at about 400 °C) is cooled in a quenching/scrubbing system that removes most of the water produced during the reduction process from the gas stream. Also most of the dust in the exhaust gas is also removed. The scrubbed gas is compressed, fed to the CO_2 removal system (and optionally to a SO_2 removal system) before being fed back to the lower part of the shaft furnace.

In the reducing gas generation system, natural gas is passed through a section of the reformer recuperator to preheat it, and is then desulfurized to reduce the sulfur content to less than 1 ppm. This is to prevent poisoning of the reformer catalyst with sulfur compounds. The natural gas is mixed with superheated steam from the reformer steam circuit in a steam to carbon ratio of around 2.4 to 1 by volume, and the mixture is further superheated to 620C in the reformer recuperator.

The gas mixture is heated in the tubes by gas-fired burners to a temperature of about 830 °C where the reforming reactions take place. The reformed gas passes through a waste heat boiler and through a boiler feed water preheater to recover heat. It is then quenched to remove water remaining in the gas. The product gas contains around 72% H2 and 16% H2. The reactor has a cylindrical upper section with reducing gas inlets and outlets for top gas and cooling gas. The lower part is conical and has inlets for the cooling gas when cold DRI is produced.

The use of a reformer that does not process gas from the reduction section isolates it from any gas-side changes which might occur in the reactor.

As the solid feed moves down the reactor by gravity flow, it is heated and reduced by reducing gas flowing upwards. The major reductant is H_2 due to its higher concentration in the reducing gas. In the conical lower part of the reactor, the burden is cooled and carburized by a circulating cooling gas that is enriched with natural gas. The product is reduced to a metallization up to 95% and carbon can be controlled in a range of 1.5% to 4.5%. For hot discharge of DRI, Hylsa's HYTEMP™ system is used which links the reactor discharge to the melt shop by way of a pneumatic conveying system.

PROCESS ADVANTAGES

Proven performance
Raw material flexibility (high S ore and natural gas)
Conventional Steam reforming
Selective elimination of H_2O and CO_2 from the reducing gas circuit allows maximum recycle of reducing gases to the reduction reactor.
Higher pressure operation reducing circulating gas volumetric flow at high molar
Flexibility to generate electric power by high pressure steam produced in the reformer.

HYLSA 4M PROCESS

PROCESS BACKGROUND:

The Hylsa 4M process is based on a moving bed shaft furnace (similar to HYL III process but without a reformer) which reduces iron ore pellets and lump ore, and operates at typical reduction temperatures and intermediate reduction pressures. This process requires no reformer to generate the reducing gas as the reforming of the natural gas takes place inside the reduction reactor using the metallic iron of the DRI product as the catalyst. The process can produce cold/hot DRI as well as HBI.

PROCESS DESCRIPTION:

As before, the iron oxide feed to a Hylsa 4M furnace can be pellets, lump, or a mixture of the two (from 0 to 100% of either).

HYL divides the process into three primary units: Reduction system, DRI handling system and External cooling system.

The HYL 4Mreactor operates at similar conditions to the other Hylsa reactors (e.g. HYL III, etc.). The reactor has a cylindrical upper section where reduction and reforming reactions take place. The lower part is conical with a rotary valve at the end to control the flow of solids discharging the reactor.

The starting point of the reduction circuit is the fresh stream of natural gas that is used as a makeup for the process. This natural gas (desulfurization is not necessary, but is optional) is mixed with recycled gas and fed to a humidifier, where the humidity of the total stream of reducing gas is controlled to adjust the carbon deposition rate on the DRI at the bottom of the reactor.

The reducing gas goes to the top gas heat recuperator, where sensible heat is recovered from the reactor top gas. Then the preheated gas goes to a gas heater where its temperature is increased to above 900 °C. In the transfer line to the reactor, O_2 is injected in order to have some partial combustion of the reducing gas to increase its temperature to above 1020 °C. This gas, upon introduction into the bottom of the HYL reactor, flows upward into the reduction zone countercurrent to the moving bed of solids.

In the lower part of the reduction zone, insitu reforming reactions are carried when this hot gas contacts the metallic DRI product. The metallic iron in the DRI acts as a catalyst for the reforming reactions. In addition, this occurs in parallel with the final stage of reduction of the iron ore. As a result some of the DRI reacts with the carbon and is carburized (to FeC_3) and there is some excess free carbon.

PROCESS ADVANTAGES:

Proven equipment performance (uses HYL II and HYL III reactor technology)
Raw material flexibility
Not sensitive to S in natural gas or ore
No reformer - lower Capital costs
High energy efficiency (87% in comparision to 70% for most efficient other DRI plant).
Hylsa claims lower overall operating costs (to be confirmed)

BLAST FURNACE PROCESS

PROCESS BACKGROUND:
The blast furnace process is based upon a moving bed reduction furnace which reduces iron ore with coke and limestone. Reduction is carried out at typical reduction temperatures. The process produces liquid pig iron.

PROCESS DESCRIPTION:
The blast furnace process consists of weighing of the burden, charging of the blast furnace, hot product dispersal from the blast furnace and offgas cleanup system. The blast furnace is a tall shaft-type furnace with a vertical stack superimposed over a crucible-like hearth. Iron bearing materials (iron ore, sinter, pellets, mill scale, steelmaking slag, scrap, etc.), coke and flux (limestone and dolomite) are charged into the top of the shaft. A blast of heated air and also, in most cases, a gaseous, liquid or powdered fuel are introduced through openings at the bottom of the shaft just above the hearth crucible. The heated air burns the injected fuel and most of the coke charged in from the top to produce the heat required by the process and to provide reducing gas that removes oxygen from the ore. The reduced iron melts and runs down to the bottom of the hearth. The flux combines with the impurities in the ore to produce a slag which also melts and accumulates on top of the liquid iron in the hearth. The total furnace residence time is about 6 to 8 hours. The hot metal produced is sent to a steelmaking shop or a pig-casting machine. The slag goes to a water-spray granulator, a cry slag pit or a slag dump. The gas from the top of the furnace goes through the gas cleaning system, and then a portion goes to fire the hot blast stoves with the balance being used in other parts of the plant. The dust is removed from the gas in the cleaning system and goes to the sinter plant to be agglomerated for recycling back into the blast furnace.

PROCESS ADVANTAGES
Proven performance
Raw material flexibility

TECNORED PROCESS

PROCESS BACKGROUND:

The Tecnored process is based upon a low pressure moving bed reduction furnace which reduces pellets made out of iron ore fines with cement and coke fines. Reduction is carried out at typical reduction temperatures. The process produces liquid pig iron.

PROCESS DESCRIPTION:

The Technored process consists of pelletizing of the iron ore fines with cement and coke fines. The pellet size is controlled for the optimum reaction in the reduction furnace. The pellets are cured and dried at 200C and fed to the top of the furnace. The furnace internal pressure is about 3.5 to 5.2 psig. The total furnace residence time is 30 to 40 minutes against 6 to 8 hours in blast furnace.

Lump coke is fed into side feeders in the furnace below the hot pellet area. Hot blast air at about 1550C is blown in through tuyeres located in the side of the furnace to provide combustion air for the coke. A small amount of furnace gas is allowed to flow through the side feeders to use for pet coke drying and preheating. Cold blast air is blown in at a higher point to promote post combustion of CO in the upper shaft. The use of coke with sulfur (pet coke) necessitates an elaborate furnace clean-up system in order to meet environmental regulations.

The pig iron produced is tapped into a ladle on a ladle car, which can tilt the ladle for deslagging. The liquid iron is desulfurized in the ladle, and slag raked into a slag pot.

PROCESS ADVANTAGES

Low cost raw materials

Low metling costs using low cost fuels to reduce electric power and electrode cost.

High productivity and energy efficiency in the furnace

Full metallization (upto 99%)

COREX PROCESS

PROCESS BACKGROUND:
The Corex process is based upon a reduction shaft for iron ore reduction and a melter gasifier for the coal gasification and iron melting. Comparing the Corex process with the blast furnace, if a blast furnace is cut into half along the cohesive zone, the same reactions that take place in the upper part of the blast furnace take place in the Corex reduction shaft. Similarly, the reduced iron is melted in the melter gasifier like the region along or underneath the cohesive zone in a blast furnace.

PROCESS DESCRIPTION:
The iron oxide feed to a Corex reduction shaft is in the form of lump ore or pellets. Non-coking coal is used in the Corex process as the strength of coke needed in the cohesive zone of the blast furnace to provide sufficient permeability to the bed is not required. All other coke functions such as fuel supply, basis for the reduction gas generation and carborization of the hot metal can be fulfilled as well by non-coking coal. Similar to the blast furnace process, the reduction gas moves in counterflow to the descending burden in the reduction shaft. Then, the reduced iron is discharged from the reduction shaft by screw conveyors and transported via feed legs into the melter gasifier. The gas containing mainly of CO and H2, which is produced by the gasification of coal with pure O2 leaves the melter gasifier at temperatures between 1000 and 1050C. Undesirable products of the coal gasification such as tar, phenols, etc. are destroyed and not released to the atmosphere. The gas is cooled to 800-850C and cleaned from dust particles. After reduction of the iron ore in the reduction shaft, the top gas is cooled and cleaned to obtain high caloric export gas. The main product, the hot metal can be further treated in either EAF or BOF or can be cast and sold as pig iron.

PROCESS ADVANTAGES
Use of low cost non-coking coal

ROTARY KILN PROCESSES

SL/RN PROCESS

PROCESS BACKGROUND:
The SL/RN process is a kiln based process that uses lump ore, pellets, beach sand or ilmenite ore and solid carbon to produce hot or cold DRI. The process operates at high temperature and atmospheric pressure. This is the most widely used coal based direct reduction process.

PROCESS DESCRIPTION:
The iron oxide feed to a SL/RN kiln is in the form of lump or pellet iron ore, reductant (low-cost non-coking coal) and limestone or dolomite (to absorb sulfur from high sulfur reductant). The rotary kiln is inclined downward from the feed (elevated end) to the discharge end. The discharge end is provided with a burner to be used for startup or to inject reductant. Typical retention times are around 10 hours. The kiln is divided into two process regions; preheat and reduction. In the preheat section, the charge is heated to about 1000C, free moisture is first driven off and reduction to FeO occurs. As the reductant is heated, volatile components are released and part of the gases are burned in the freeboard above the bed by the air injected into the kiln. This combustion transfers heat to the charge directly by radiation, and also by conductive heat transfer from the kiln lining, which is first exposed to the flame and heated before contacting the charge. The charge then passes into the metallization or reduction zone where the temperature is maintained at about 1000C to 1100C, depending upon the type of charge used. The final metallization is about 93% and carbon content about 0.1 to 0.2%. The product DRI can be discharged hot or cold.

The combustion off-gases from the kiln contain char particles and combustible gases. These are burned off in a afterburner and the offgas then passes through an evaporative cooler and an electrostatic precipitator and vented to the atmosphere.

PROCESS ADVANTAGES
Use of any iron bearing material
Wide variety of reductants
Proven DRI technology
Economic production of DRI

ROTARY HEARTH PROCESSES

REDSMELT PROCESS

PROCESS BACKGROUND:
The Redsmelt process is based upon a rotary hearth furnace which reduces green pellets made out of iron ore, reductant fines and binders to produce hot, metallized DRI (similar to blast furnace pig iron) that is directly charged to an electric melter or HBI. The process operates at high temperature and atmospheric pressure.

PROCESS DESCRIPTION:
The iron oxide feed to a Redsmelt furnace is in the form of green pellets made of fine iron ore, reductant and binders. Binders are to give to the green pellets sufficient mechanical strength to support the handling shocks downstream. Pellets are screened on a roller-type screen to a size between 8 to 16 mm. Under and oversize materials are recirculated to feed the pelletizing disks. Pellets are then distributed onto the RHF in a layer up to 30 kg/m2. While travelling throughout the furnace in 12 to 18 minutes, pellets are heated up to 1200-1300C. Drying of the pellets, coal devotalitization and iron oxide reduction takes place during the heating process. The intimate contact between iron oxide and carbon at a very high temperature results in a very fast reaction rate. To prevent reoxidation of metallized iron the final zones of the furnace are operated in sub-stoichiometric atmosphere. The hot DRI product is then fed to the submerged arc furnace (SAF) for smelting into Hot metal and slag.

PROCESS ADVANTAGES
Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time (12 to 18 minutes)
Proven equipment usage

FASTMET/ FASTMELT PROCESS

PROCESS BACKGROUND:
The FastMet process is based upon a rotary hearth furnace which reduces briquettes made out of iron ore fines, waste iron bearing materials and pulverized coal to produce hot, metallized DRI that can be directly charged to a specially designed electric melter (FASTMELT) or HBI.

PROCESS DESCRIPTION:
The iron oxide feed to a FastMet furnace is in the form of dried greenballs made of iron ore and coal. They are continuously fed to the RHF by means of a loss-in-weight vibrating pan feed system. After introduction, the greenballs are heated in 3 burner/ reaction zones; all fired by side-wall mounted burners. Zone 1 has three burners, Zone 2 has five burners and Zone 3 has two burners. All burners are designed for air/natural gas or oxygen enriched air/natural gas combustion. A water cooled chill plate is positioned after Zone 3 for cooling of the hot DRI product to 1000-1200C prior to discharge from the RHF. The hot DRI product can either be collected in N2 purged transfer cans, or directly fed to the electric furnace for melting. Thr RHF operates under a slight negative pressure, and sealed by a water seal trough.

The DRI melter is a custom design single phase AC eletric arc furnace type melter that has a stationary hearth and a water cooling roof. It produces carbon containing molten iron (FASTIRON) from a charge of 100% hot DRI continuously fed from the RHF.

PROCESS ADVANTAGES
Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time (6-12 minutes)
Lower capital investment costs than NG based DR processes
Proven equipment usage

IRON DYNAMICS PROCESS

PROCESS BACKGROUND:
The Iron Dynamics process is based upon a rotary hearth furnace which reduces a carbonaceous iron oxide charge to metallic iron solids that are charged to a SAF to complete the reduction and to melt and desulfurize the reduced iron. Melting the DRI also allows for a phase separation of the resulting liquid slag and iron.

PROCESS DESCRIPTION:
The IDI process is composed of five process areas: raw material receiving, ore and reductant (coal) grinding and preparation, pelletizing, rotary hearth reduction and submerged arc furnace smelting. After the ore is received, it is dried to the moisture content less than 0.5% using offgas from the rotary hearth furnace. Ore is also beneficiated using magnetic separators and screens to reduce the amount of silica. It is then ground to 50% minus 200 mesh. Coal is conveyed to a coal/fluxstone pulverizer for sizing to 80% minus 200 mesh. Ground ore and coal are intensively mixed with binders and water in a mixer and fed onto disc pelletizers. Wet pellets are dried to less than 1% moisture and preheated to 150C in a circular grate dryer. The pellet charger receives the dried green balls and layers them onto the furnace hearth in 11/2 - 1 in. thick layers. The natural gas fired rotary hearth furnace has eight reaction zones. Temperature, gas flow ans gas composition are controlled to provide the required conditions in each zone to properly heat, reduce and protect the pellets. The DRI at the discharge of the furnace has about 85% metallization. An additive facility introduces flux, coke, silica or other materials to the DRI transport bottles to control slag chemistry in the submerged arc furnace. The offgas system removes heat, dust, sulfur dioxide and nitrous dioxides from the flue gas. An afterburner combusts any remaining CO in the offgas water-cooled duct. The gas is cooled and the Nox removed in the primary cooler. Offgas is used to preheat combustion air and supply heat to the ore, coal and pellet dryers. After the pellet dryer, the gas is filtered and Sox removed prior to discharge from the stack. The DRI and the additives fall into the slag layer of the Submerged Arc Furnace by gravity where smelting takes place. Average metallization here is about 95.8%. Slag is tapped from the furnace into slag pots and transferred to a slag processing facility.

PROCESS ADVANTAGES
Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time
Lower capital investment costs than NG based DR processes
Proven equipment usage

INMETCO PROCESS

PROCESS BACKGROUND:
The InMetCo process is based upon a rotary hearth furnace which reduces briquettes made out of iron ore fines, waste iron bearing materials and pulverized coal to produce hot, metallized DRI that can be directly charged to an electric melter or HBI. The process operates at high temperature and atmospheric pressure.

PROCESS DESCRIPTION:
The iron oxide feed to a Inmetco furnace is in the form of disk pellets made of fine iron ore under 250um in size and fine coal or coke or char with less than 25% volatiles. They are distributed onto the RHF in a layer about 3 pellets deep by means of a pivoting belt conveyor. The process uses a quick acting binder which allows the pellets to be transported to the hearth without significant degradation. The hearth rotates continuously and the pellets are heated by burners located around the periphery of the hearth to 1250C to 1300C during a period of 10 to 15 minutes. The burners are arranged in groups, and form heating and reduction zones. The heating zone makes about 1/3 of the hearth area and the reduction zone about 2/3. The burners are located on the inner and outer circumference
The hot DRI product can either be collected in N2 purged transfer cans, or directly fed to the electric furnace for melting. The RHF operates under a slight negative pressure, and sealed by a water seal trough.

PROCESS ADVANTAGES
Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time (6-12 minutes)
Proven equipment usage

MAUMEE PROCESS

PROCESS BACKGROUND:
The Maumee process is based upon a rotary hearth furnace which reduces green pellets made out of waste iron oxide materials and pulverized non-metallurgical coal to produce hot, metallized (>90%) DRI. The process operates at high temperature and atmospheric pressure, features a short residence time and can be used to recycle revert materials.

PROCESS DESCRIPTION:
The iron oxide feed to a Maumee furnace is in the form of green pellets/ briquettes made of fine iron oxides and coal or coke that eliminates the pre-drying of the pellets. Under ideal high-temperature (2350°F) theoretical conditions, iron oxide will react with fixed carbon to form metallic iron in the briquette with the release of CO2. The theoretical ratio of fixed carbon to iron oxide is 1.5:1. Maumee process has been formulated to produce metallic iron using a carbon-to-oxide ratio of 6:1, which results in the evolution of both CO and CO2 and leaves a residual carbon level of about 4%. The key to this process is controlling the CO-to-CO2 ratio to minimize reoxidation, carbon consumption and furnace residence time. While travelling throughout the furnace, pellets are heated up to 2350F. Drying of the pellets, coal devotalitization and iron oxide reduction takes place during the heating process. The intimate contact between iron oxide and carbon at a very high temperature results in a very fast reaction rate. The hot DRI product can then be supplied to the steel mill by a number of different options.

PROCESS ADVANTAGES
Iron ore fines or waste iron units as raw material
Wide variety of solid reductants
Less reduction time
Proven equipment usage

ITmk3 PROCESS

PROCESS BACKGROUND:
The ITmk3 process is based upon a rotary hearth furnace similar to a FASTMET furnace which reduces dried green pellets made out of iron ore, reductant fines and binders to produce hot, metallized DRI that is charged to a Melter which separates liquid metal from liquid slag in a short time. The process operates at high temperature and atmospheric pressure.

PROCESS DESCRIPTION:
The iron oxide feed to a ITmk3 furnace is in the form of dried green pellets made of fine iron ore, reductant and binders. Binders are to give to the pellets sufficient mechanical strength to support the handling shocks downstream. Pellets are dried and screened for 17 to 19 mm greenball diameter. Undersize and oversize materials are recirculated to feed the pelletizing disks. Pellets are then distributed onto the RHF. While travelling throughout the furnace, pellets are heated up to 1350C. Drying of the pellets, coal devotalitization and iron oxide reduction takes place during the heating process. The intimate contact between iron oxide and carbon at a very high temperature results in a very fast reaction rate. Heating of the gangue and ash components also occurs and leads to softening and subsequent initiation of slag droplet coalesence. Often a hollow, highly metallized iron shell is formed, and at the bottom of the hollow is a bead of melted slag. The hot product is then fed to the Melter for complete separation of Hot metal or the cold iron shots (iron nuggets) from slag. Further heating in the melter results in the formation of molten iron droplets, collapse of the iron shell structure followed by coalescence of iron droplets into a nugget of molten iron which is completely separated from the slag.

PROCESS ADVANTAGES
Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time
Complete separation of hot metal from slag

FLUIDIZED BED PROCESSES

FINMET PROCESS

PROCESS BACKGROUND:
The Finmet process is a multiple fluidized bed process which utilizes a H2 rich reducing gas produced by steam reforming. Reduction is carried out at intermediate reduction temperatures, but at a higher operating pressure than most DR processes. The process produces hot briquetted iron, HBI.

PROCESS DESCRIPTION:
The iron oxide feed to the Finmet process is in the form of iron fines under 12 mm in size. The fines are first dried to 0.2% moisture in a fluid bed drier at about 100C and stored in a hopper close to the reactors. In the first reactor, the oxide fines are preheated to about 550C. Then they pass through the other reducing reactors in series, where they are heated and reduced by the reducing gas. The reactor system operates at high pressure, about 11-13 bars gauge, in order to increase the productivity.

The fresh reducing gas required for the process is produced in a steam reformer with a steam to natural gas ratio of 3 to 4. The reformed gas consisting of CO and H2 passes through a waste heat boiler to produce steam required for the reforming reaction. The reducing gas entering the bottommost reactor is distributed by the grid, passes through the fluid bed where reduction occurs, then exits the reactor via the cyclones, located inside the reactor vessel. Reduction temperatures range from 550C in the top reactor to about 800C in the lower one. The reduced ore exits the last reactor with a metallization of 93% and carbon in the range of 1 to 3%. The reduced fines are compacted to a density of 5 g/cc in a briquetting press.

PROCESS ADVANTAGES
Direct use of low cost iron ore fines
Proven fluid bed technology
High process and plant flexibility through separate gas production, fines reduction and briquetting.

CIRCORED PROCESS

PROCESS BACKGROUND:
The Circored process is a two stage fluidized bed process that operates at low reducing temperatures and uses natural gas to produce reducing gas by means of reforming. The process uses ore fines that have a particle size between 1mm and 0.03mm and produces HBI.

PROCESS DESCRIPTION:
The iron ore fines are first dried and heated to about 800C in a fluid bed preheater system. The dried fines are then charged to a circulating fluidized bed (CFB). The heat required is generated by the combustion of natural gas and air that is introduced into the CFB. The fines are reduced to about 70% metallization in CFB. The process reactions are endothermic and the required energy is introduced in the form of preheated iron ore fines and process gases. The pressure in the CFB is about 4 bars and the reaction temperature is about 630C. This temperature is lower than that used for other reduction processes, and hence avoids the sticking problems that occur with high temperature fines-based processes. The fluidizing gas in the CFB is a mixture of heated process gas which enters the lower part of the CFB, and the off-gas from the second stage conventional fluidized bed reactor, Stage II Reactor, FB. The retention time in the CFB is relatively short, of the order of 15 to 20 minutes.

A portion of the partially metallized fines are withdrawn from CFB and enter the FB reactor. The FB reactor is compartmentalized into several sections, and has gas velocities in the range of 0.5 to 0.6 m/s. The fines reach a final metallization of 92 to 93% in the FB reactor. The off-gas leaving the top of the FB passes on to the CFB. The product leaves the FB reactor at about 630C, is then heated to about 680C, and briquetted.

PROCESS ADVANTAGES
Ability to process directly low cost fine ore
Excellent heat and mass transfer conditions in CFB
Low investment costs
Low operating cost

CIRCOFER PROCESS

PROCESS BACKGROUND:
The Circofer process is a two stage fluidized bed process that uses iron ore fines and a solid carbon source such as coal to produce reducing gas. Reduction is carried out at highreduction temperatures. The process produces hot briquetted iron, HBI.

PROCESS DESCRIPTION:
The iron oxide feed to the Circofer process is in the form of iron fines between 1mm and 0.03mm in size. The coal to be used as the energy source and reductant must have an ash softening temperature above 1500C due to operating temperature of the gasifying process. The fines, lime and char are first preheated by the hot exhaust gases. These then enter the gasifier, where O2 is injected and coal is fed in from the charge hopper. The gasifier operates at about 1000C and at these conditions, the O2 partially combusts the carbon contained in the coal, producing heat and a CO/CO2 gas mixture. The heat produced in the gasifier heats the ore and char to process temperatues. In the CFB, the ore fines are reduced to about 70% metallization. The fluidizing gas in the CFB is a mixture of heated recycle gas which enters the lower part of the CFB, and the offgas from the second reducer (FB) which enters further up in the CFB. The fines and char are carried out of the CFB due to the high gas velocity in the reactor, are captured by the cyclone, and returned to the CFB via the gasifier. Thus a virculation pattern is set up which allows the heat to be transferred to the CFB reactor.

Reduced solids from the CFB enter the FB reactor, which is a conventional bubbling bed. In this second reduction stage, the fines reach a final metallization of 92 to 93%. The gas leaving the top of the FB passes on to the CFB. The product from the second reducer is partially cooled, the char and ash are removred by magnetic separation, and the product is briquetted and cooled.

PROCESS ADVANTAGES
Direct use of low cost iron ore fines
Proven fluid bed technology
High quality product

IRON CARBIDE PROCESS

PROCESS BACKGROUND:
Iron carbide (Fe3C) is a chemical compound of 93% iron and 7% carbon in pure form. It can be used as the only feed for BOFs and EAFs. In that role it eliminates the need for coke ovens and the blast furnace, and all the ancilliary equipment for coal and lime. The Iron Carbide process is a two stage fluidized bed process that operates at a lower temperature than other DR processes. It operates at low pressures and uses steam reforming to produce the H2 which is mixed with CH4 tomake the carburizing gas. It produces Fe3C powder which contains about 6% carbon.

PROCESS DESCRIPTION:
The iron oxide feed to the iron carbide process is in the form of iron ore fines in the range of 1mm to 0.1 mm. Iron ore fines are preheated in a series of cyclones and then pressurized to reactor pressure in lockhoppers, and fed to the reactor by a screw feeder.

The fluidized bed reactors have the upward moving stream of 600C gas composed of CO, CO2, H2, CH4 and H2O. The hydrogen reacts with the iron ore, combing with its oxygen to form water (the only process by-product). Carbon from the carbonaceous gases combines with the elemental iron to form iron carbide. The methane provides the gas system equilibrium. After the reactions in the fluid bed reactors, the off gases are condensed to get rid of water vapor, reconstituted with H2 and carbonaceous gases, raised to reactor working pressure to 1.8 atm, heated to 600C, and reintroduced in the windbox of the reactor.

An indication of the inherent thermal efficiency of the process is gained from the fact that the temperature of formation of iron carbide in the fluid bed reactor is only 600C as against around 1000C for reduction of iron in DRI processes and 1500C to produce hot metal in the blast furnace.

PROCESS ADVANTAGES
Lower operating temperature
Lower production costs
No storage costs as the product does not oxidise
Steelmaking cheaper with Fe3C

OTHER PROCESSES

HISMELT PROCESS

PROCESS BACKGROUND:
The HIsmelt process was initially developed as an air-blown, bottom-injected, refractory-lined process. But due to excessive refractory wear, the initial horizontal design was abandoned and a new Vertical smelt reduction vessel (SRV) was proposed.

PROCESS DESCRIPTION:
In this process, the iron ore is preheated (and optionally prereduced as far as magnetite) in a lean-phase cyclone preheat system similar to that on many cement kilns. It is then injected into the SRV, along with coal and flux materials through two water-cooled solids injection lances such that the mixture is carried predominantly into the metal phase. Rapid dissolution and smelting occur in the metal and the resulting product gases (mainly hydrogen and carbon monoxide) rise under buoyancy to generate the large liquid fountain, a characterstic of HIsmelt. The result is strong mixing within the metal and slag phases with effective elimination of any significant thermal gradients.

Hot offgas from the SRV is enriched with a small quantity of natural gas, the resulting mixture being roughly equivalent to blast furnace gas. This gas is cooled to around 1000C and split into roughly equal proportions. One portion is used (hot) in the preheater, whilst the other is scrubbed and subsequently burned as fuel in the hot blast stoves.

PROCESS ADVANTAGES
Direct smelting

ROMELT PROCESS

PROCESS BACKGROUND:
The Romelt process is a bath smelting technology for converting iron oxides (either virgin iron ores or iron bearing waste materials) to blast furnace – grade pig iron using non-coking grades of coal as a fuel and reductant. Liquid, granulated, or cast pig iron have the highest "value-in-use" of all scrap substitutes, as they contain no gangue, have low residuals, and a high carbon content, and hence enable the EAF to produce high quality steel grades while simultaneously increasing furnace productivity.

PROCESS DESCRIPTION:
The iron oxide feed to a Romelt furnace can be any iron containing material, e.g. iron ore fines and concentrates, blast furnace and BOF dusts and sludges, mill scale, iron bearing slags from non-ferrous smelting operations, swarfs and turnings, iron dusts, etc. The non-coking coals of 15-20% votatile matter and approx. 8% ash have been used in past. The solid feeds (coal, iron oxides, and fluxes) are charged by gravity in the furnace. A row of lower blast tuyeres on each side of the furnace introduce oxygen to agitate the bath and gasify some coal, while upper tuyeres blow oxygen for postcombustion. The furnace operates under a slight pressure, with an induced draft fan drawing the waste gases out of the furnace and through the off-gas system. Hot metal and slag are removed periodically through separate tapholes in either end of the furnace. The hearth and lower walls of the furnace are refractory lined, and the upper walls of the furnace are made up of a series of water-cooled panels. The furnace consists of four zones: Quiescent metal zone, Quiescent slag zone, Agitated slag zone and Gas combustion zone. The bulk of the reduction process takes place in the agitated slag zone. Interaction between the metal and slag in both the agitated and quiescent zones allows partitioning of minor elements between these two phases to take place. Gases generated in the bath (predominantly CO and H2, with some N2) enter the combustion zone where they react with the oxygen from the upper blast, liberating energy.

PROCESS ADVANTAGES
Wide variety of raw material
Solid waste disposal

DIOS PROCESS

PROCESS BACKGROUND:
The Dios process is a bath smelting process, intensively investigated in Japan. For testing program, 100t smelters are constructed from remodelled BOF converters. Successful operational procedures have been established and an output rate of 40t/hr of hot metal is reported.

PROCESS DESCRIPTION:
Lump iron ore, coal and fluxes are charged from overhead storage hoppers, and ore and coal fines have been injected into the smelter through tuyures. The oxygen required is introduced through the BOF top lance and a side tuyure provides oxygen for post-combustion. Dios also introduces a prereduction operation which reuses its own energy. It is claimed that the high thermal efficiency has the potential for using less expensive coal and lower consumption compared with BF route.

PROCESS ADVANTAGES
Direct smelting process

AISI PROCESS

PROCESS BACKGROUND:
The AISI direct steelmaking project was a collaborative research programme heavily supported by the US DOE, by the Steel industry and by academic institutions. But now it has been discontinued largely. Hoogovens has continued some work in this area as a source of semi-reduced feedstock for their other project, the cyclone converter furnace.

PROCESS DESCRIPTION:
The AISI process directly uses fine ores and coals to produce molten iron in a two stage process. In the first stage, ore is prereduced and melted in a melting cyclone. Directly connected to the melting cyclone is a converter type vessel where prereduced and melted ore undergoes final reduction. Post-combustion of gases takes place which improves energy efficiency, and the waste gases are used for prereduction of the pellets. A vertical smelter was used initially, but a change to a horizontal reactor has been made which is expected to improve productivity and flexibility.

PROCESS ADVANTAGES
Direct smelting process

GRIDSMELTER PROCESS

PROCESS BACKGROUND:

The Gridsmelter process is based upon a melter gasifier which melts efficiently prereduced fine ore (60% to 80%) with some coke and coal in a grid smelter. Reduction is carried out at typical reduction temperatures. The process produces liquid pig iron.

PROCESS DESCRIPTION:

The Gridsmelter process consists of a melter gasifier for using iron containing fines as feed stock. It is a pressure vessel with internal refractory lining of walls. The high temperature wall area and roof, where fine coal, natural gas or oil burns with preheated air or oxygen are water cooled. The grid that supports a coke/refractory filter bed is also water cooled. The region above the grid (high temperature zone) is very similar to the raceway of a Blast furnace. In this high temperature zone, the final reduction and liquification take place. The liquified materials pass through the filter bed in cocurrent with the gases. FeO droplets formed are reduced, carburized and separated from the leaving gases, falling down into the furnace hearth. The furnace hearth contains liquid pig iron, slag and a bubbling fluidized coal/coke bed. The offgas leaves the vessel in the middle of the vessel height. The gas is hot cleaned by cyclone and used for prereduction and preheating of the feedstock and blast preheating.

PROCESS ADVANTAGES

Wide variety of raw materials like sponge iron, iron ore fines, mill scale, etc.

Takes advantage of 'sticking effect'

COMET PROCESS

PROCESS BACKGROUND:
The Comet process, developed by the Centre de Recherches Metallurgiques (CRM), is a coal-based system that produces sponge iron from ore fines and limestone in a rotary hearth furnace.7 A laboratory, 100-kg/hr installation was brought on-stream in Nov. 1996. (Cockerill Sambre, Profil Arbed, Sidmar and Hoogovens have acquired the CRM license for the process.) Based on the successful results obtained, a pilot 1.5-tonne/hour plant has been built at Sidmar, Ghent, Belgium. Metallization results confirm those obtained from the laboratory unit. Productivity, cost, price, energy consumption and environmental impact are being established.

PROCESS DESCRIPTION:

PROCESS ADVANTAGES
Direct use of low cost iron ore fines
Low cost reductant

FINEX PROCESS

PROCESS BACKGROUND:
The FINEX process produces liquid iron (hot metal) using fine iron ore and non-coking coal directly without any pre-treatment process for raw materials and fuel such as sintering process for raw materials and coking process for coal in the blast furnace ironmaking process.

PROCESS DESCRIPTION:
FINEX Development Project in POSCO in Sanghoon Joo RIST, Republic of Korea The detailed objectives are as follows:
Finex, a coal-based smelting reduction process, continues to be jointly developed by Posco, RIST and Voest-Alpine. This process is reported to be a more advanced smelting reduction technology than Corex. A 150-tonne/day pilot plant is under construction at the Posco Pohang Works based on the success achieved with a smaller 15-tonne/day unit: completion is scheduled for March 1999. It is reported that advantages include the use of fine ore and noncoking coal together with lower construction costs, reduced emissions and lower manpower and production costs than the Corex process.

PROCESS ADVANTAGES:
Direct use of ore fines (-8 mm) without sintering
Direct use of non-coking coal without the coke oven for ironmaking
Reduced hot metal production cost
An environment-friendly ironmaking process
Operational flexibility in ironmaking process.
<u>Contact : Ernst Worrell</u>

PLASMA PROCESS

PROCESS BACKGROUND:
In plasma smelting for direct reduction, gases and solids are passed through an arc, much like a welding arc, and are heated. This electric heating replaces oxygen in conventional systems that use oxy-fuel burners.
The Plasmasmelt process produces molten iron from prereduced iron ore. A plasma torch consisting of a pair of tubular, water-cooled copper eletrodes discharges an electric arc which is magnetically rotated at very high speeds. The electrodes are spaced closely together and during operation, a process gas is injected through the narrow gap between the electrodes. The arc current can be varied independent of gas flow rate and thus, process temperatures can be controlled.

PROCESS DESCRIPTION:
In this process, the shaft is completely filled with coke. The reactions take place in the shaft furnace with tuyeres spaced symmetrically around the lower part of the furnace. Plasma generators and equipment for injection of metal oxides mixed with slagforming material and possibly reductants are attached to the tuyeres. In front of each tuyere a cavity is formed inside the coke column where reduction and smelting take place. At regular intervals the produced slag and metal are tapped from the bottom of the shaft furnace. During iron ore smelting, the off-gas from the furnace, consisting mainly of carbon-monoxide and hydrogen, are used for prereduction of the ore.
In case the ore contains metals with high vapor pressures, for example zinc and lead, these metals leave the furnace with the off-gas which is then passed through a condenser where the metals are recovered from the gas.

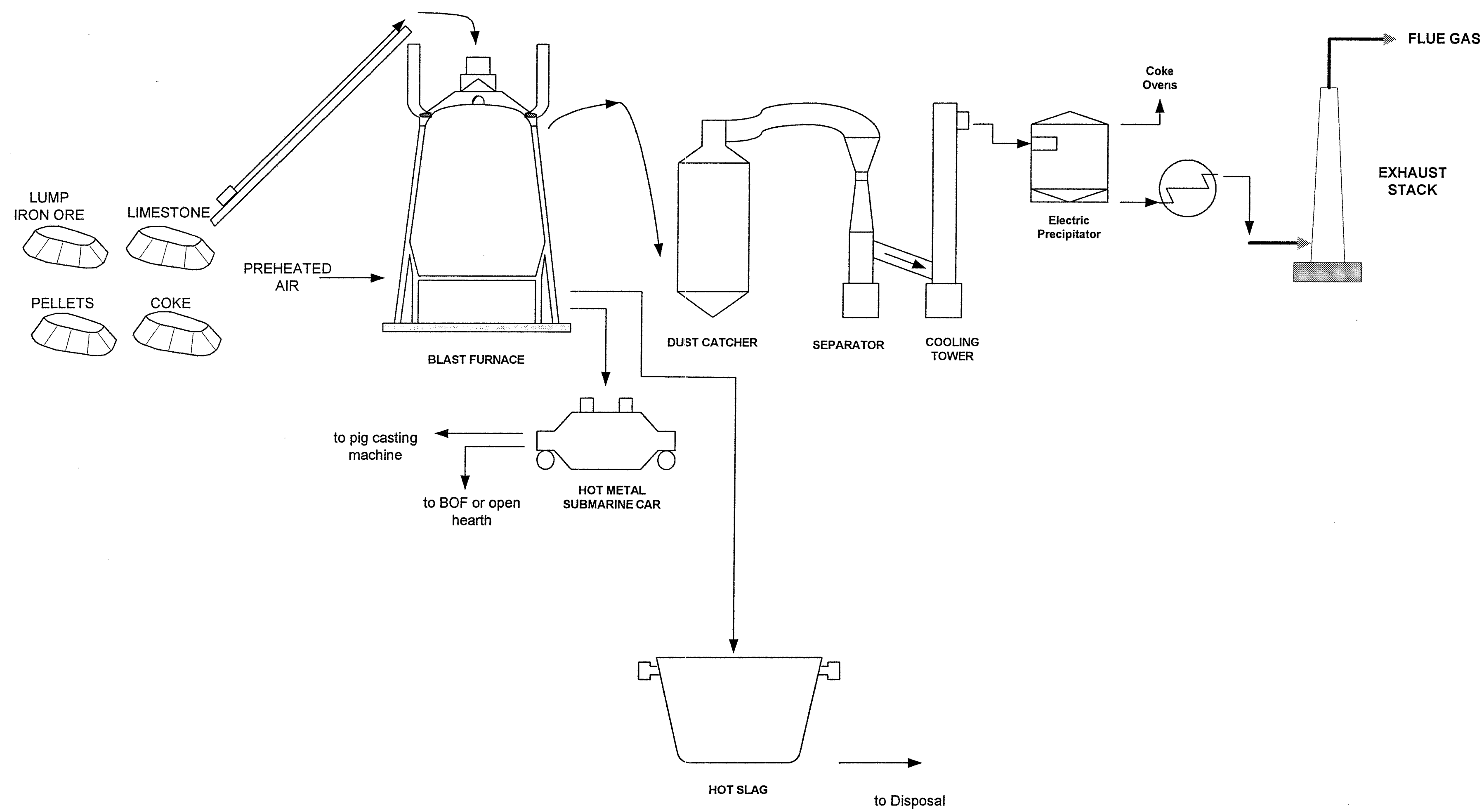
PROCESS ADVANTAGES:

APPENDIX A-2:

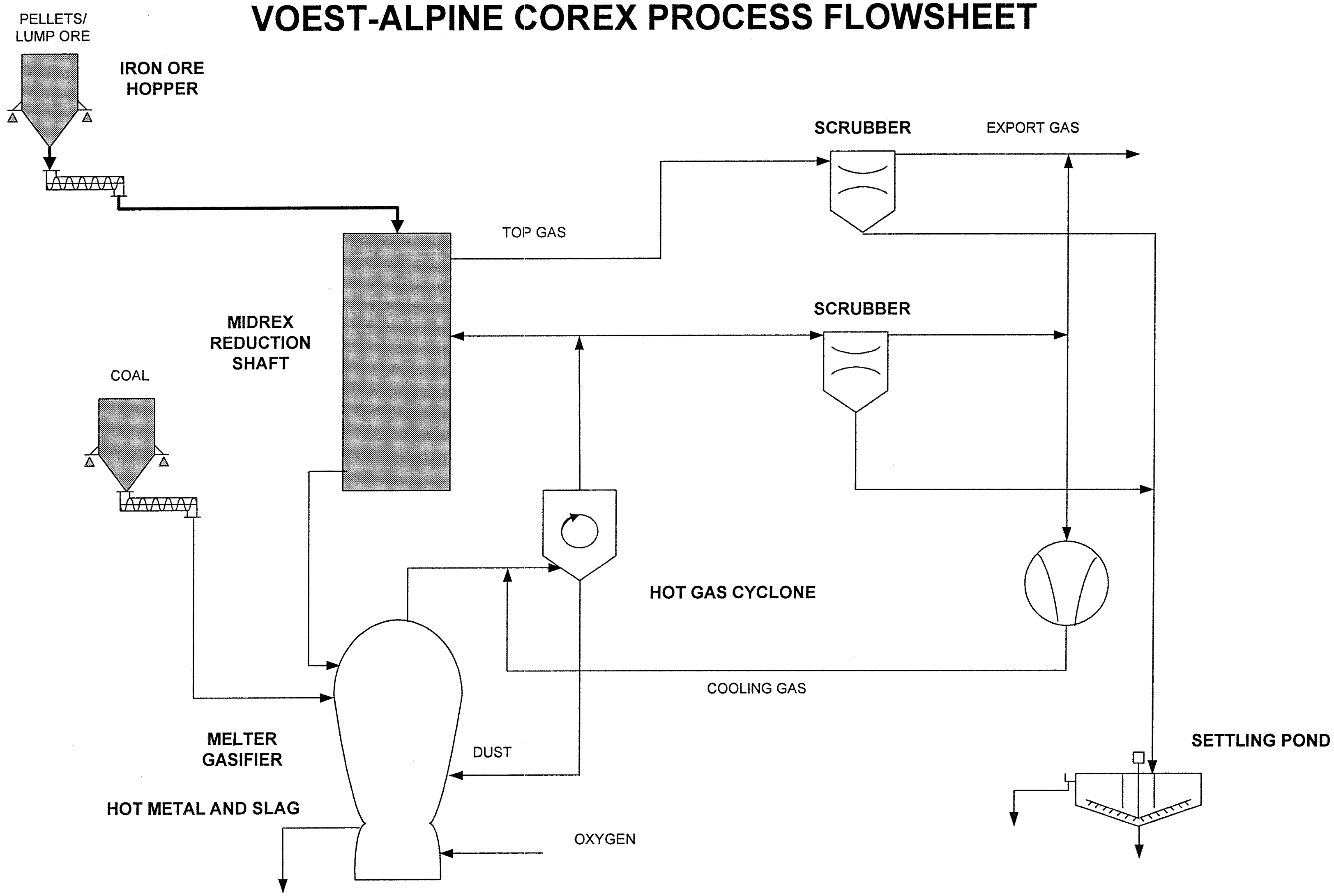
IRONMAKING PROCESS FLOW DIAGRAMS

SHAFT FURNACE PROCESSES

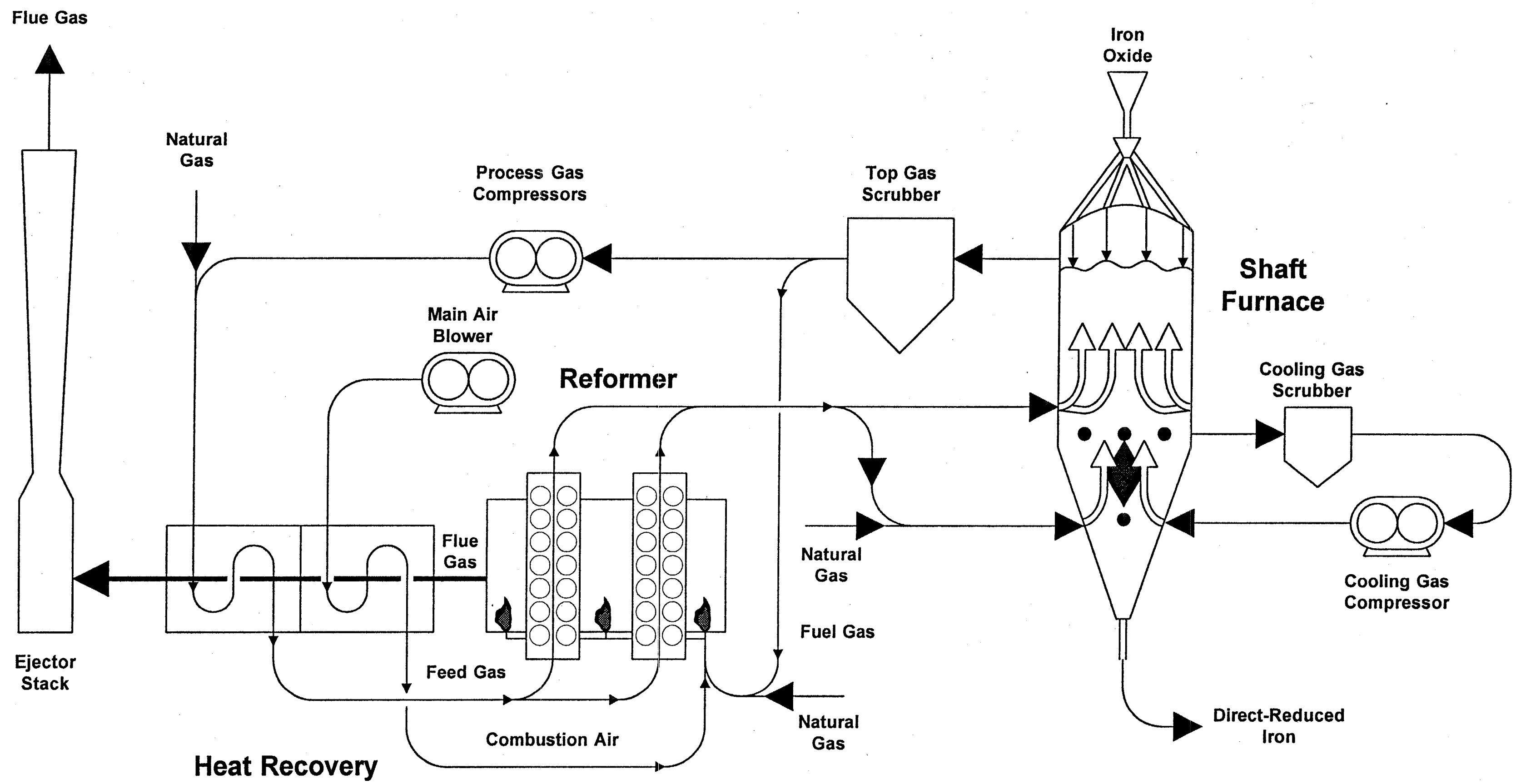
BLAST FURNACE PLANT FLOWSHEET



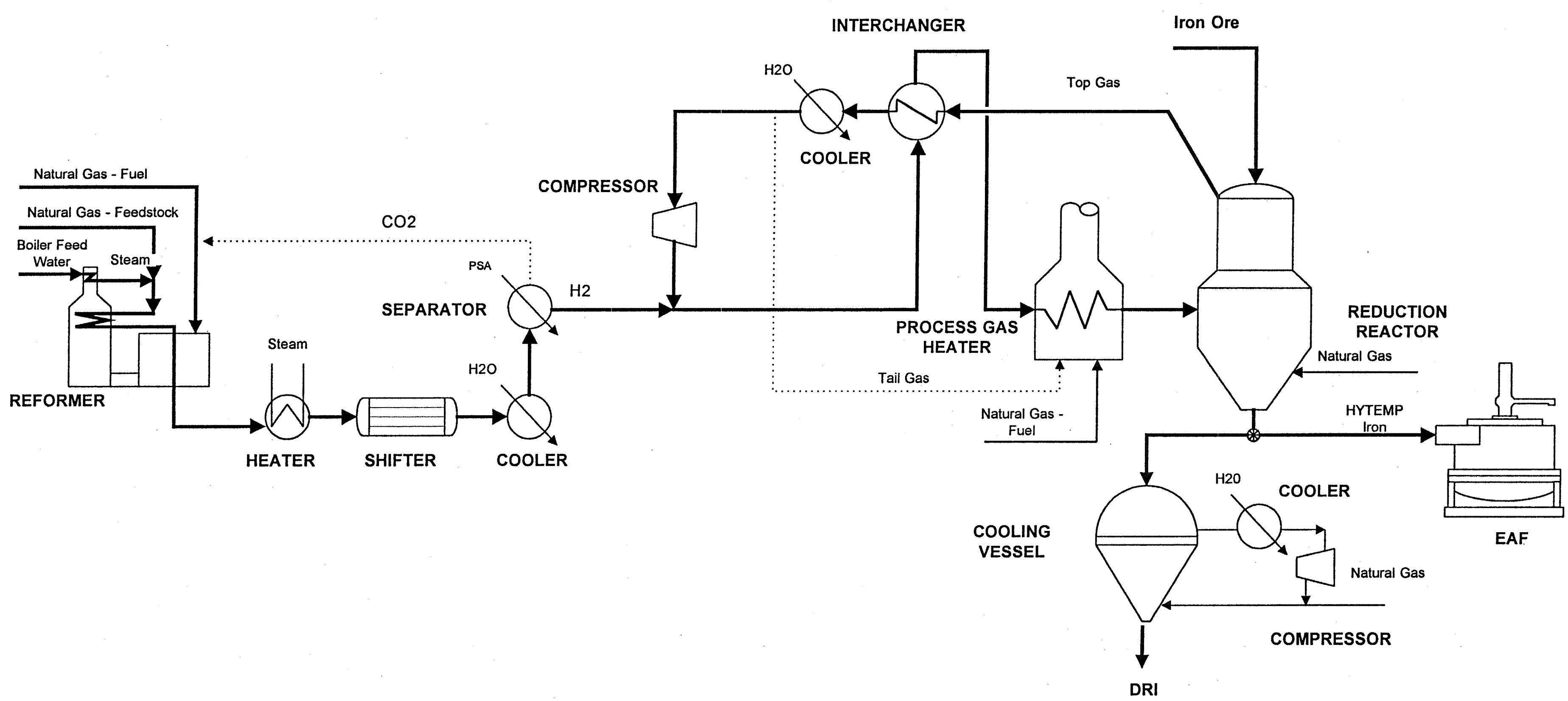
VOEST-ALPINE COREX PROCESS FLOWSHEET



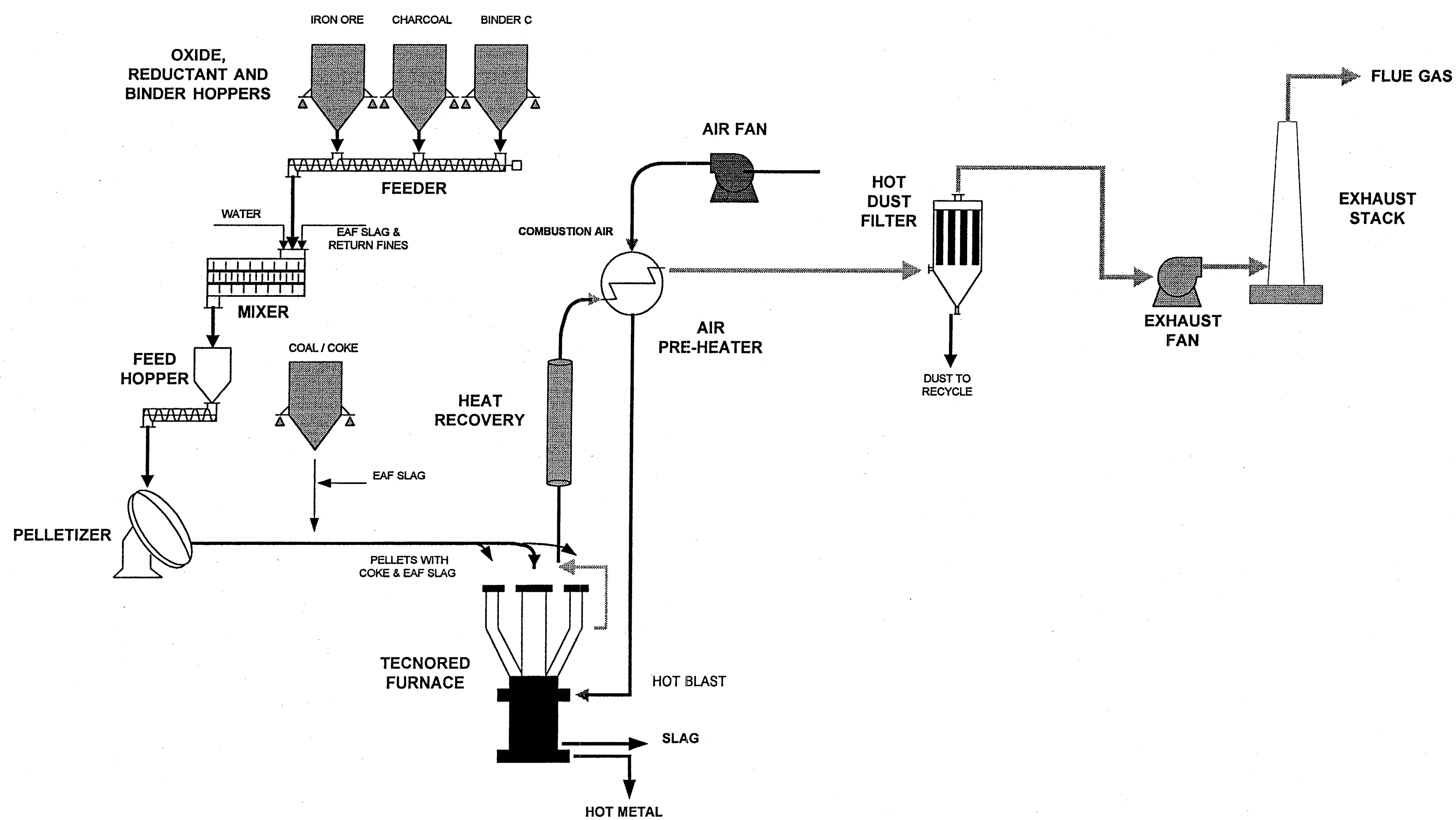
MIDREX PROCESS FLOWSHEET



HYLSA PROCESS FLOWSHEET

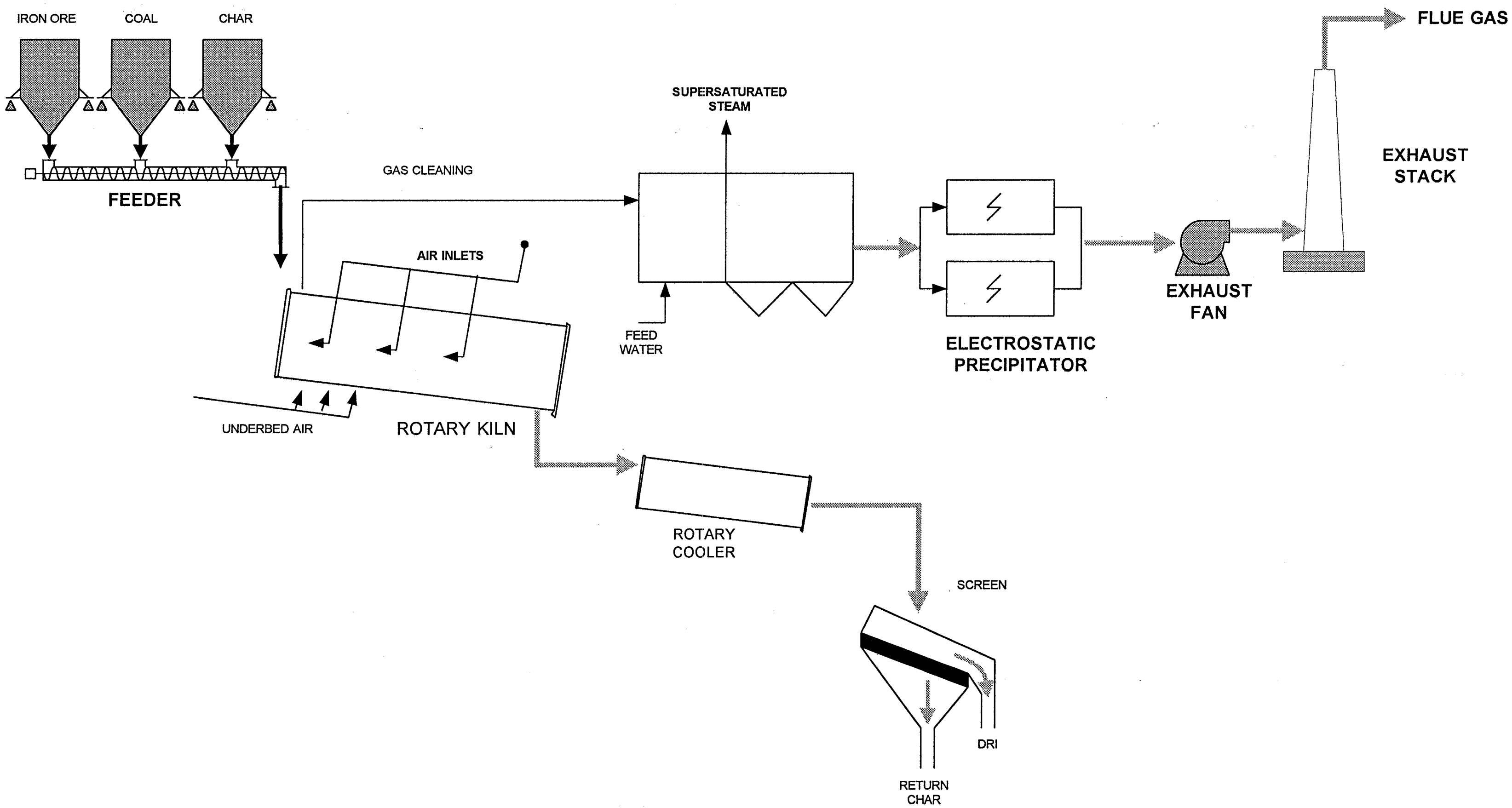


TECNORED PROCESS FLOWSHEET



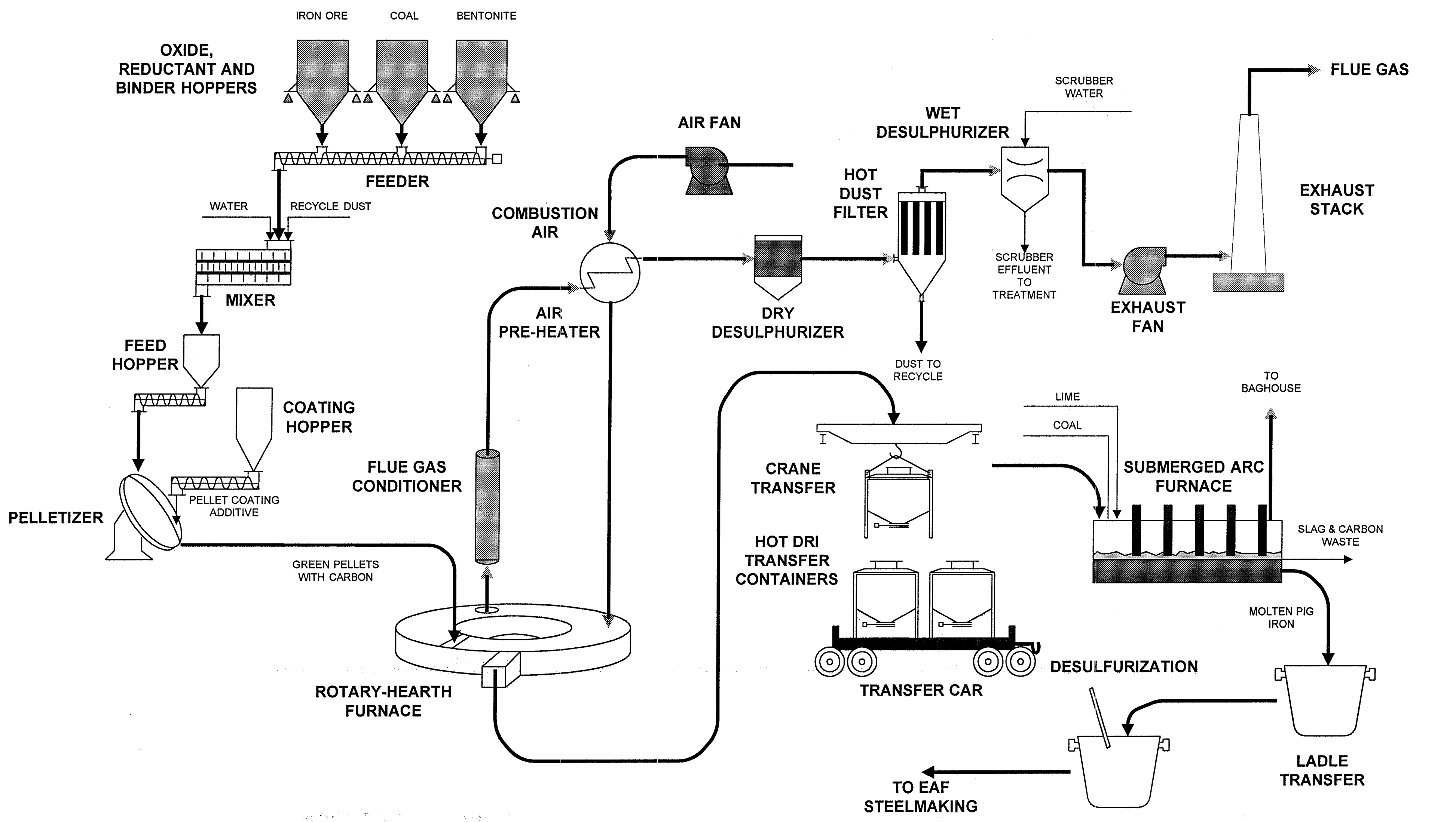
ROTARY KILN PROCESSES

SL/RN PROCESS FLOWSHEET

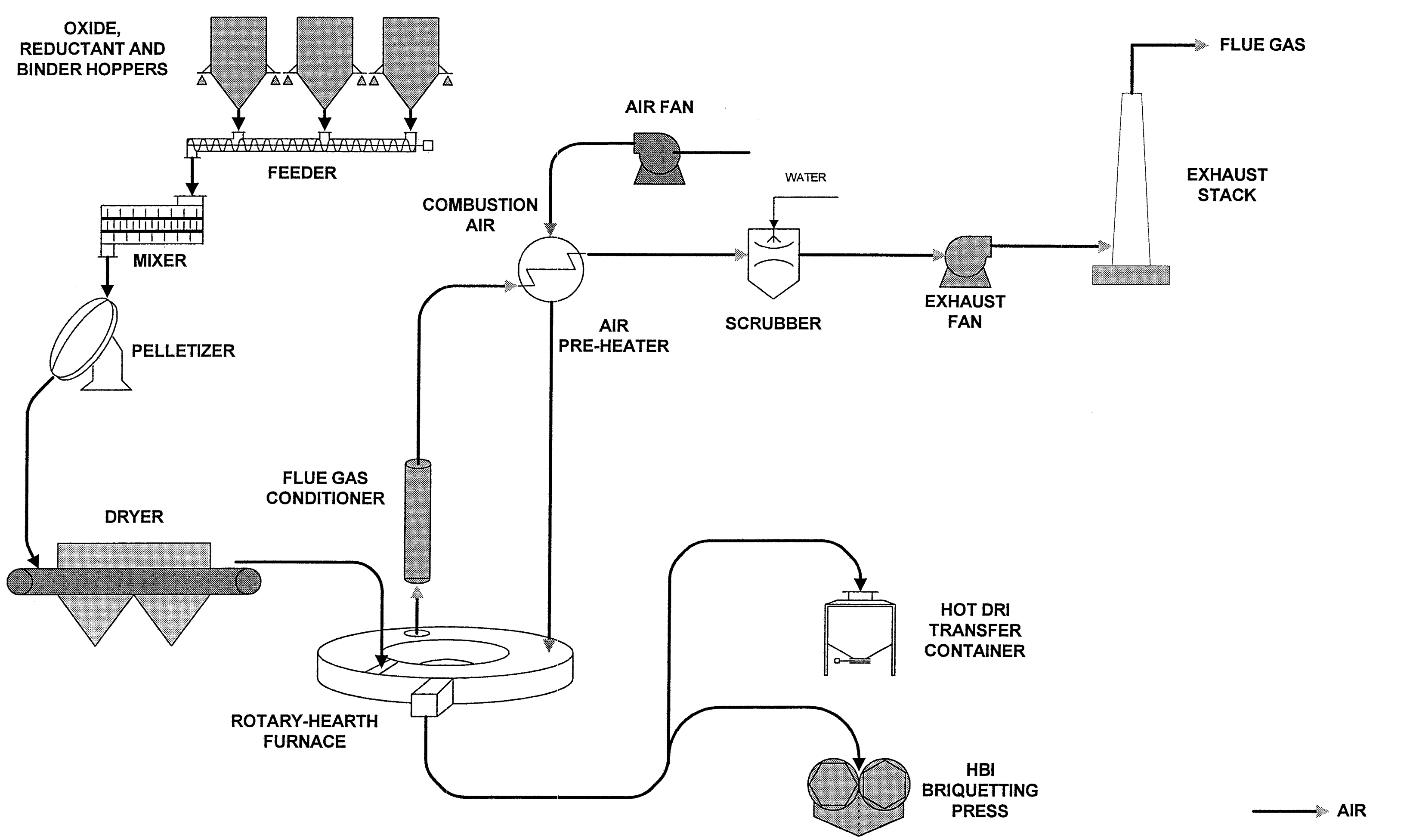


ROTARY HEARTH PROCESSES

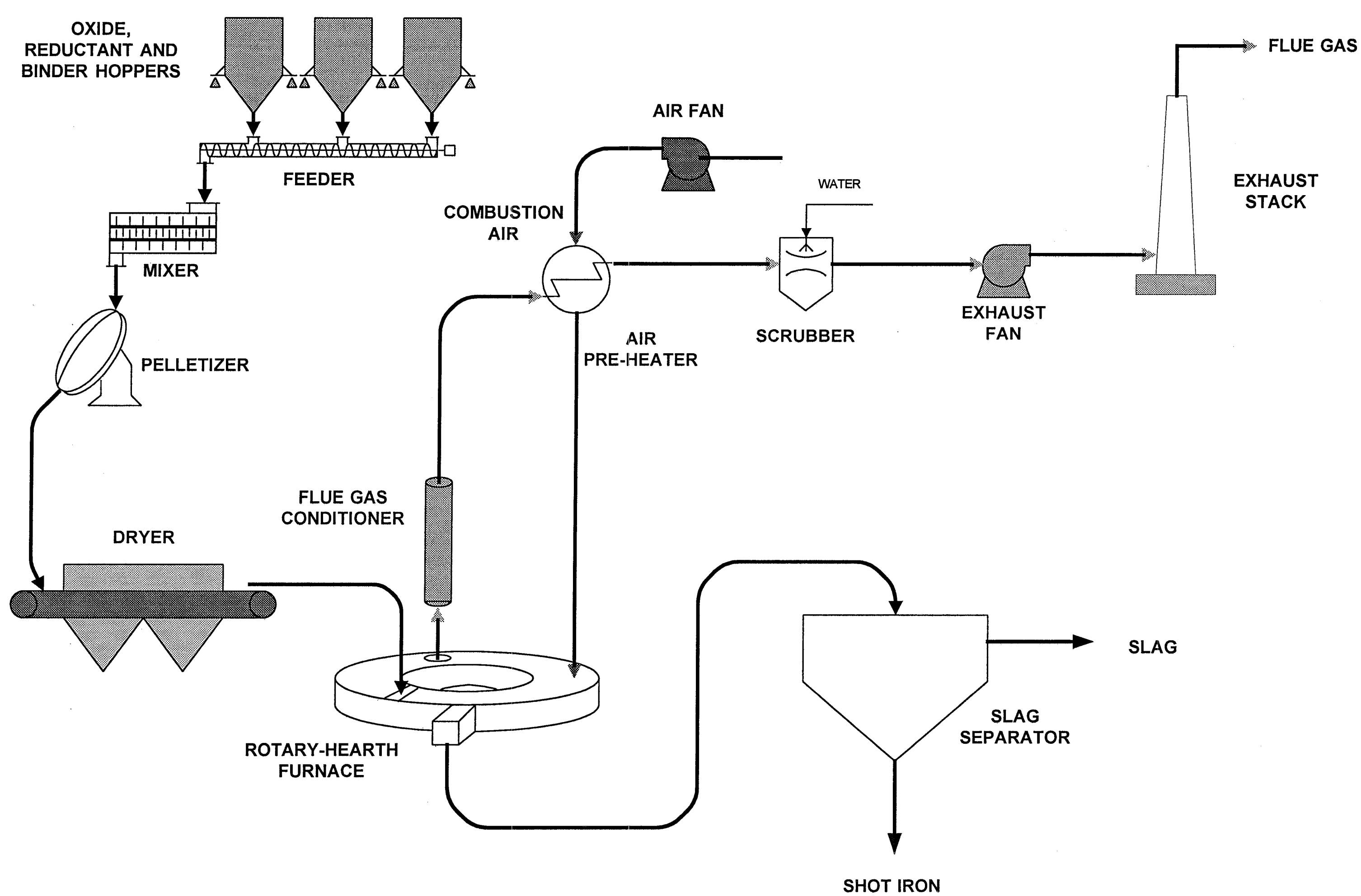
MANNESMANN DEMAG REDSMELT PROCESS FLOWSHEET



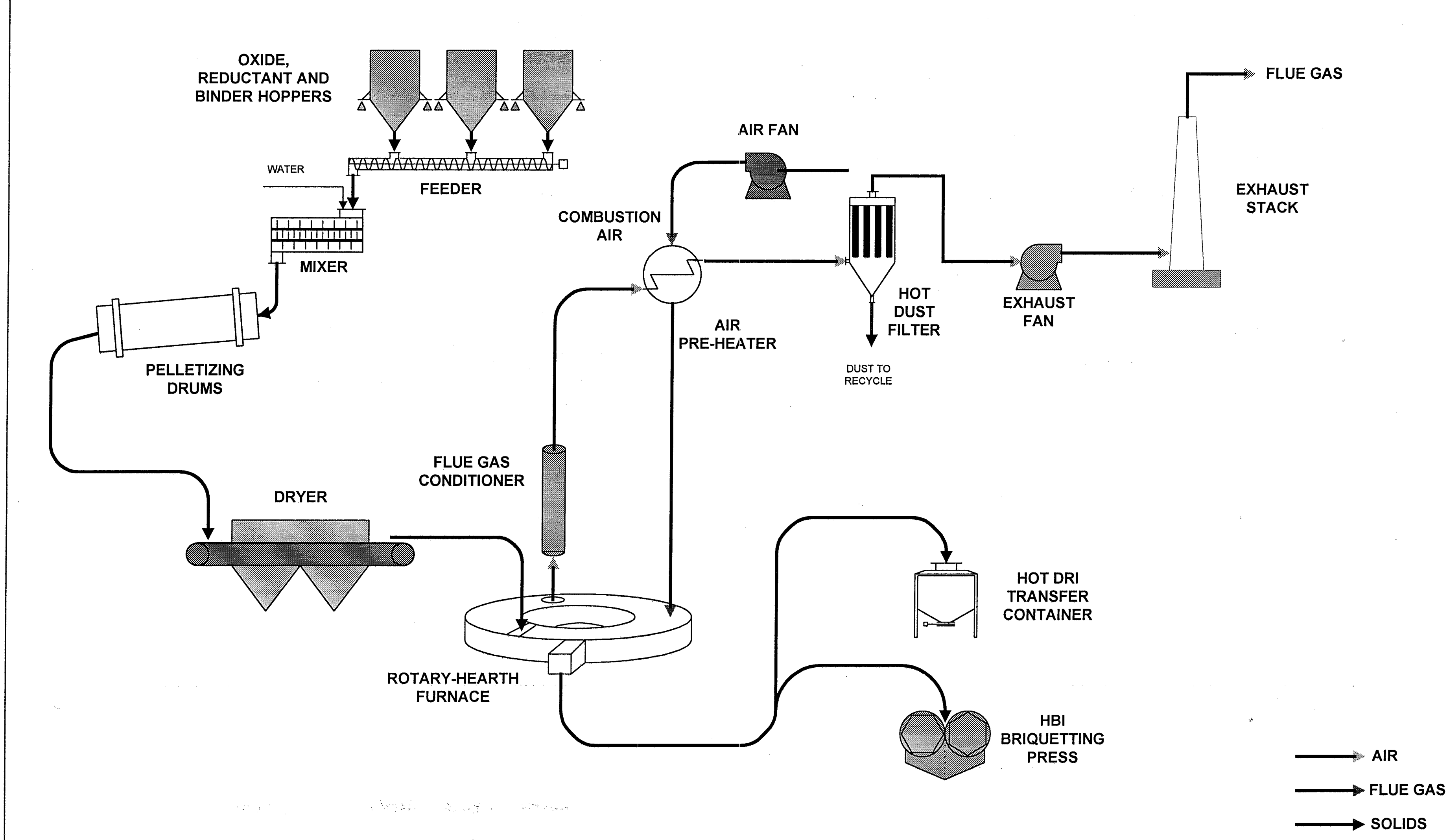
FASTMET PROCESS FLOWSHEET



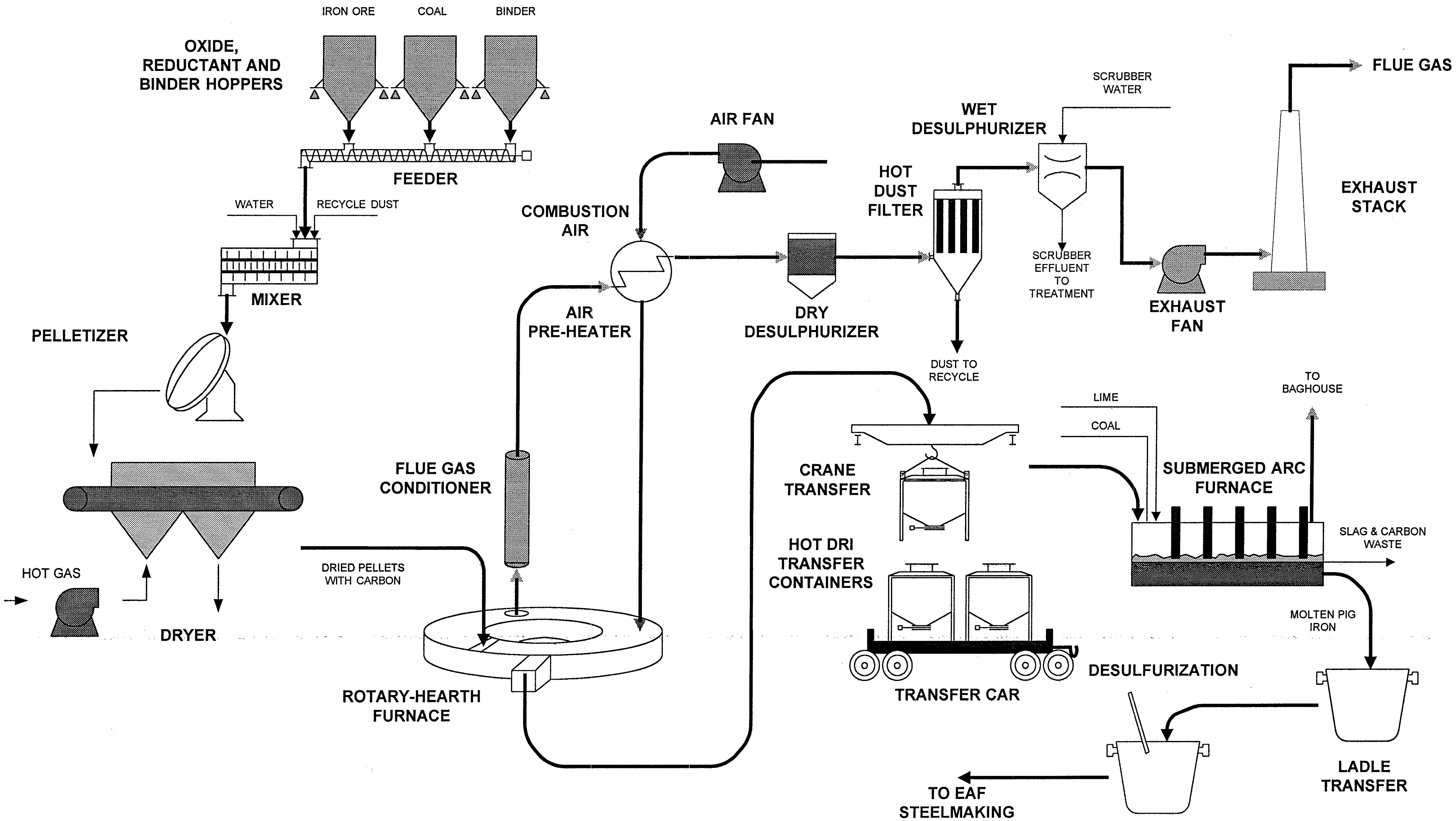
ITmk3 PROCESS FLOWSHEET



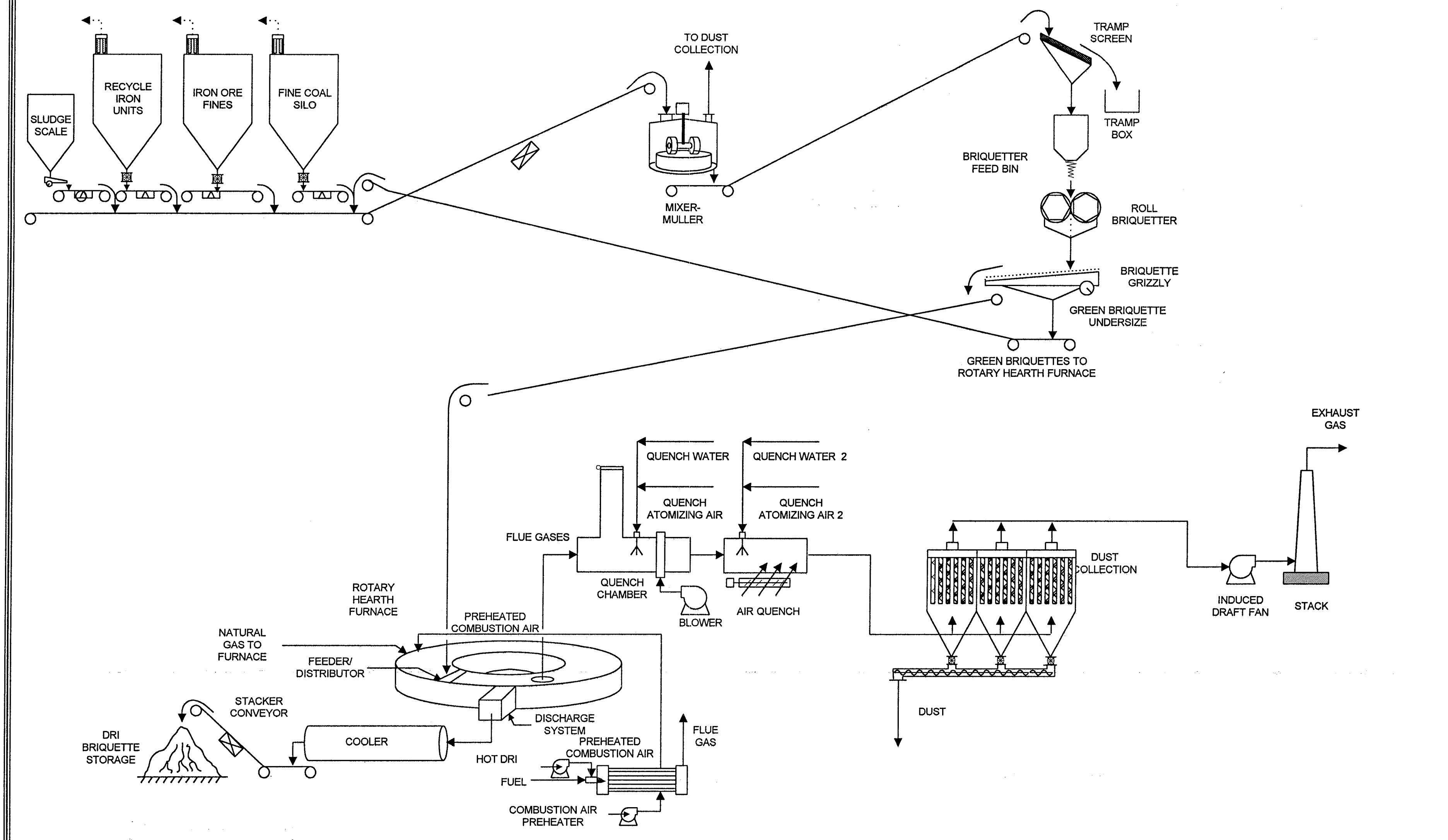
INMETCO PROCESS FLOWSHEET



IRON DYNAMICS PROCESS FLOWSHEET

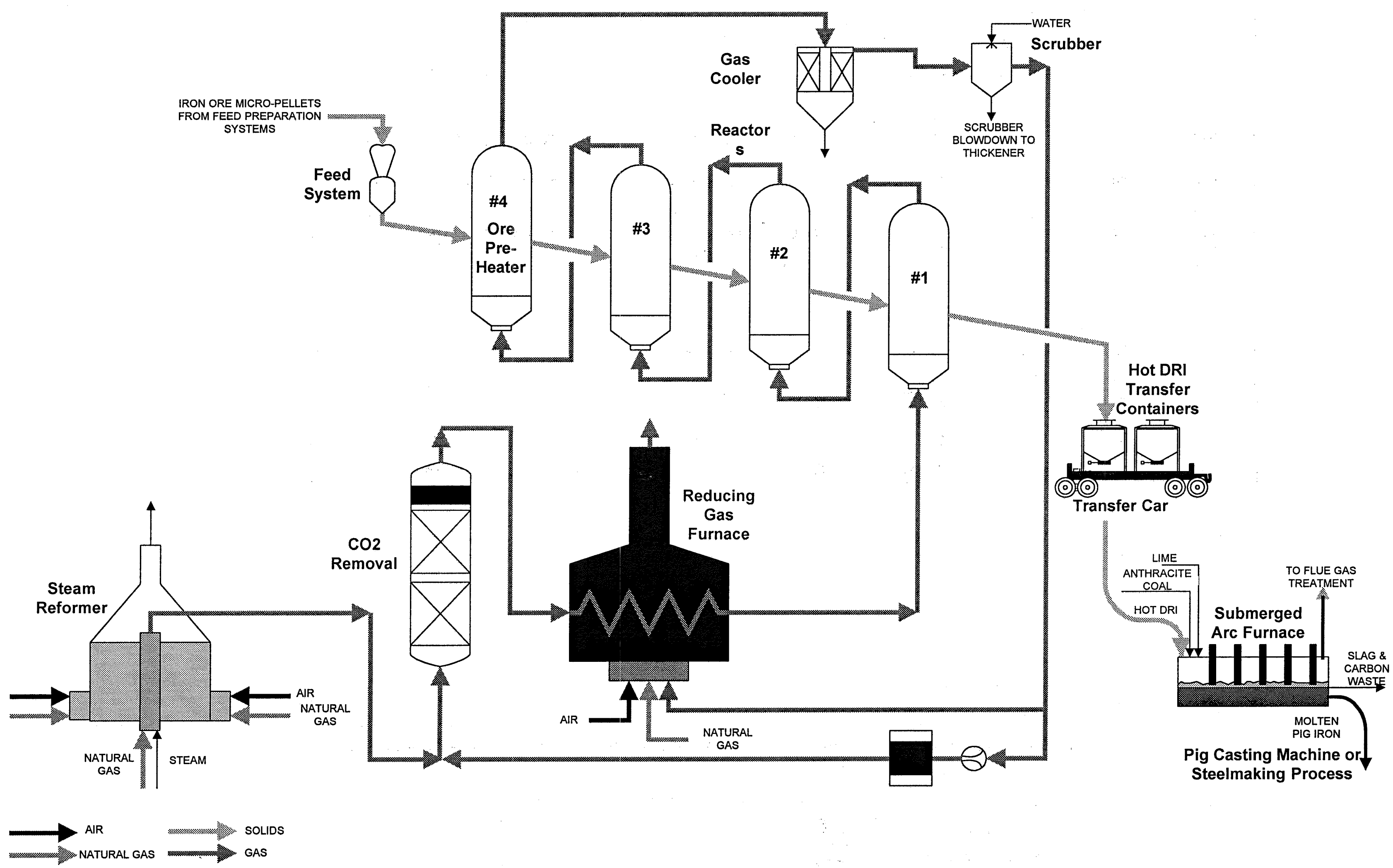


MAUMEE PROCESS FLOWSHEET

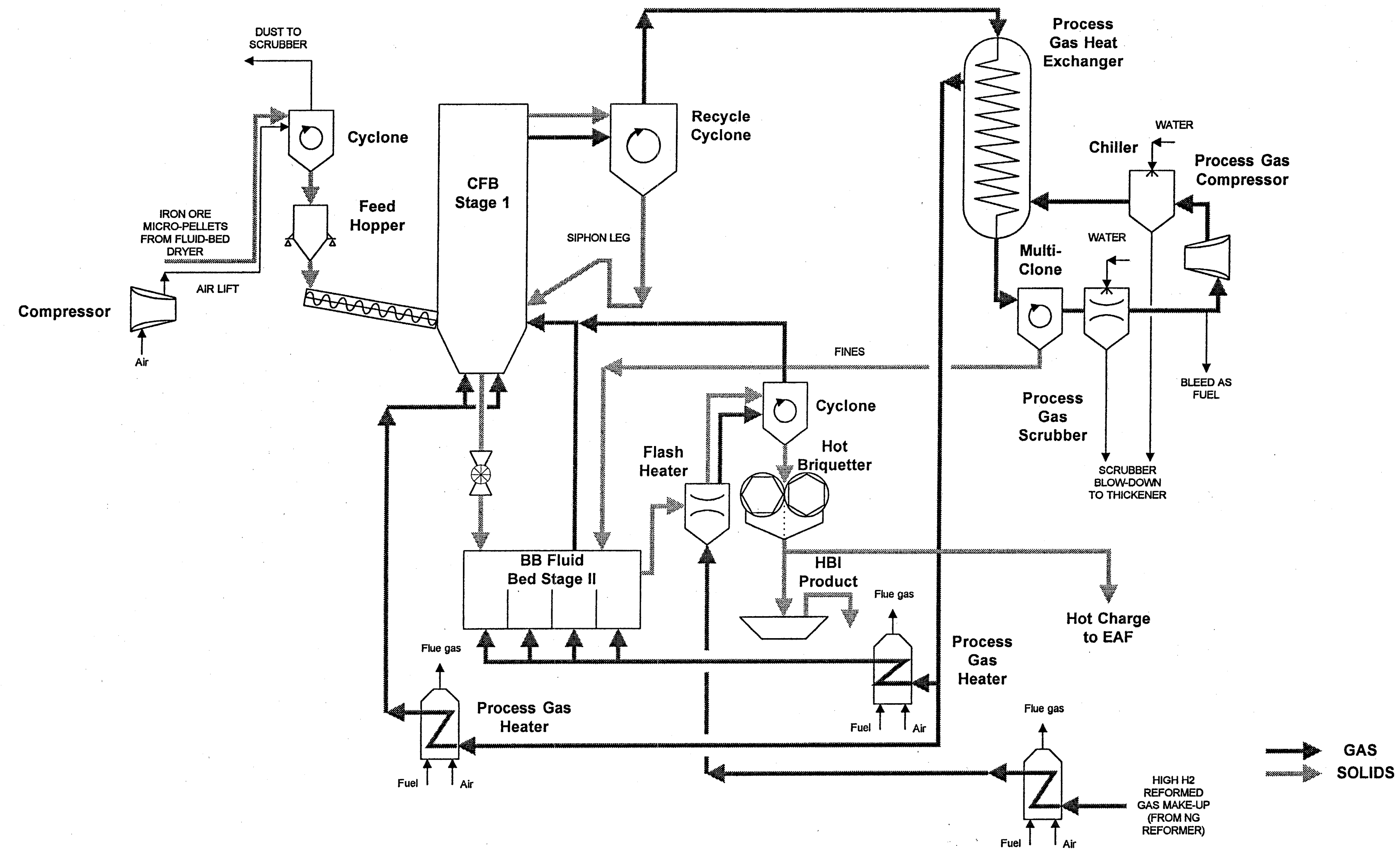


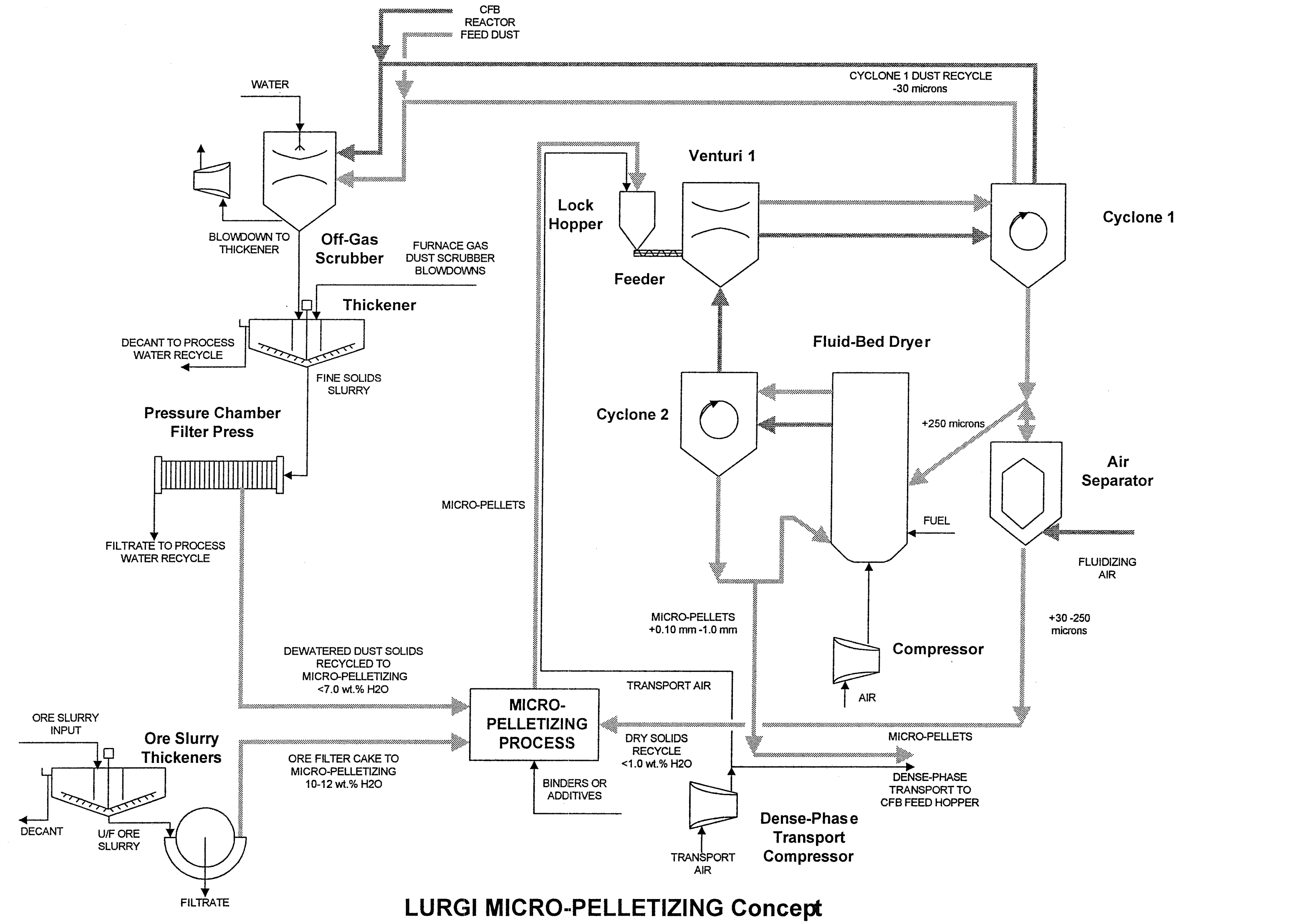
FLUIDIZED BED PROCESSES

VOEST-ALPINE FINMET PROCESS FLOWSHEET



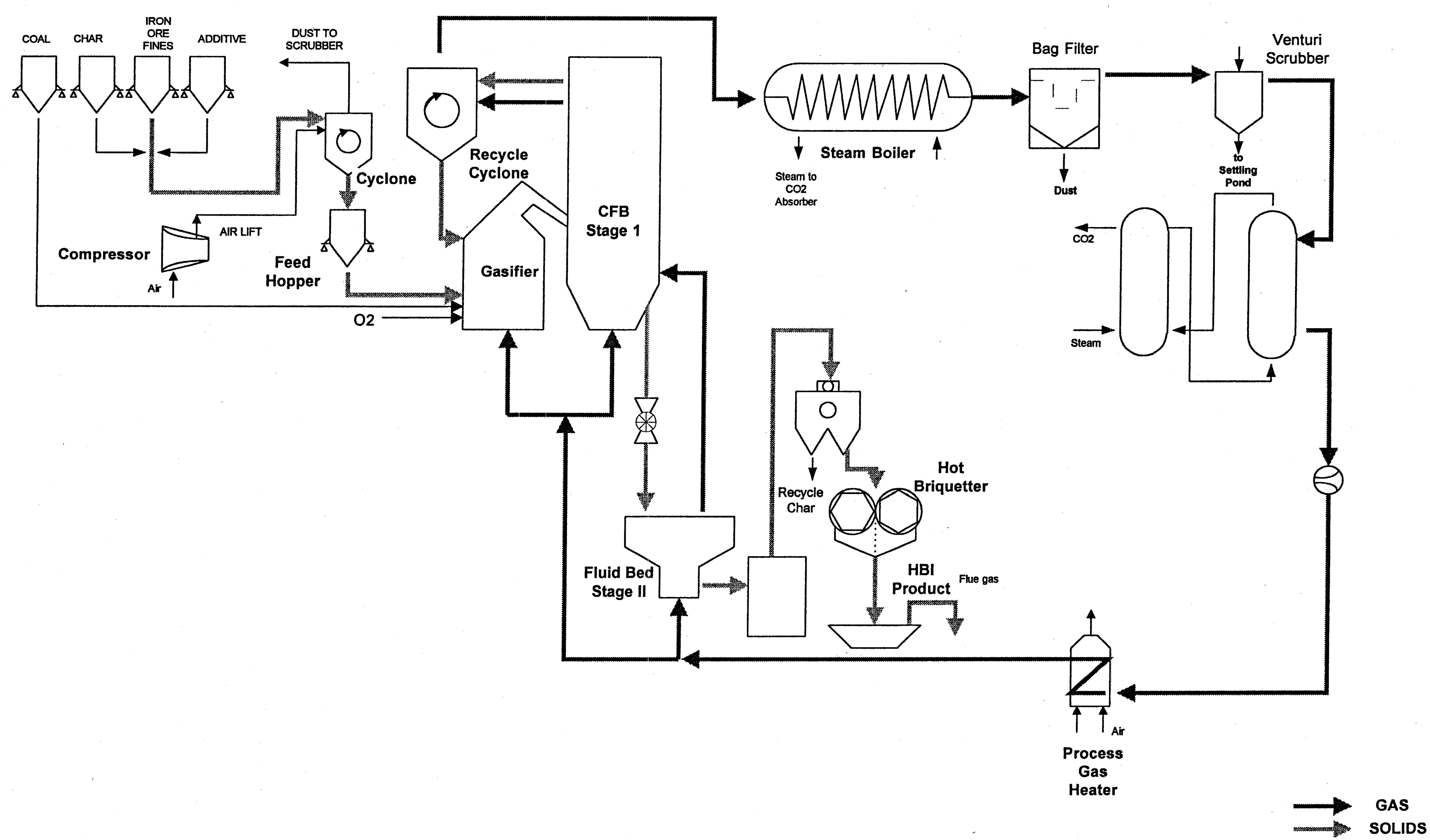
LURGI CIRCORED PROCESS FLOWSHEET

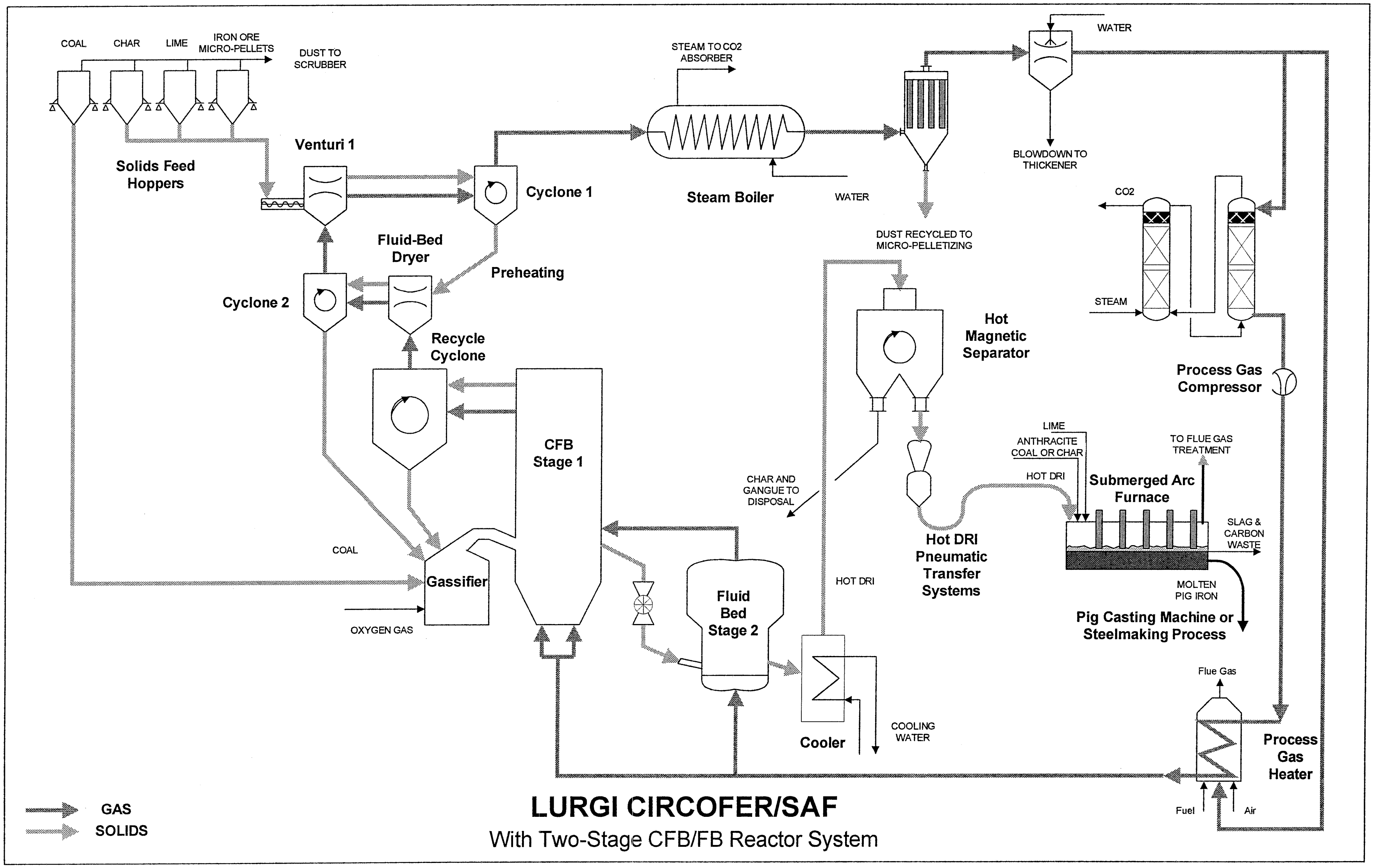




LURGI MICRO-PELLETIZING Concept

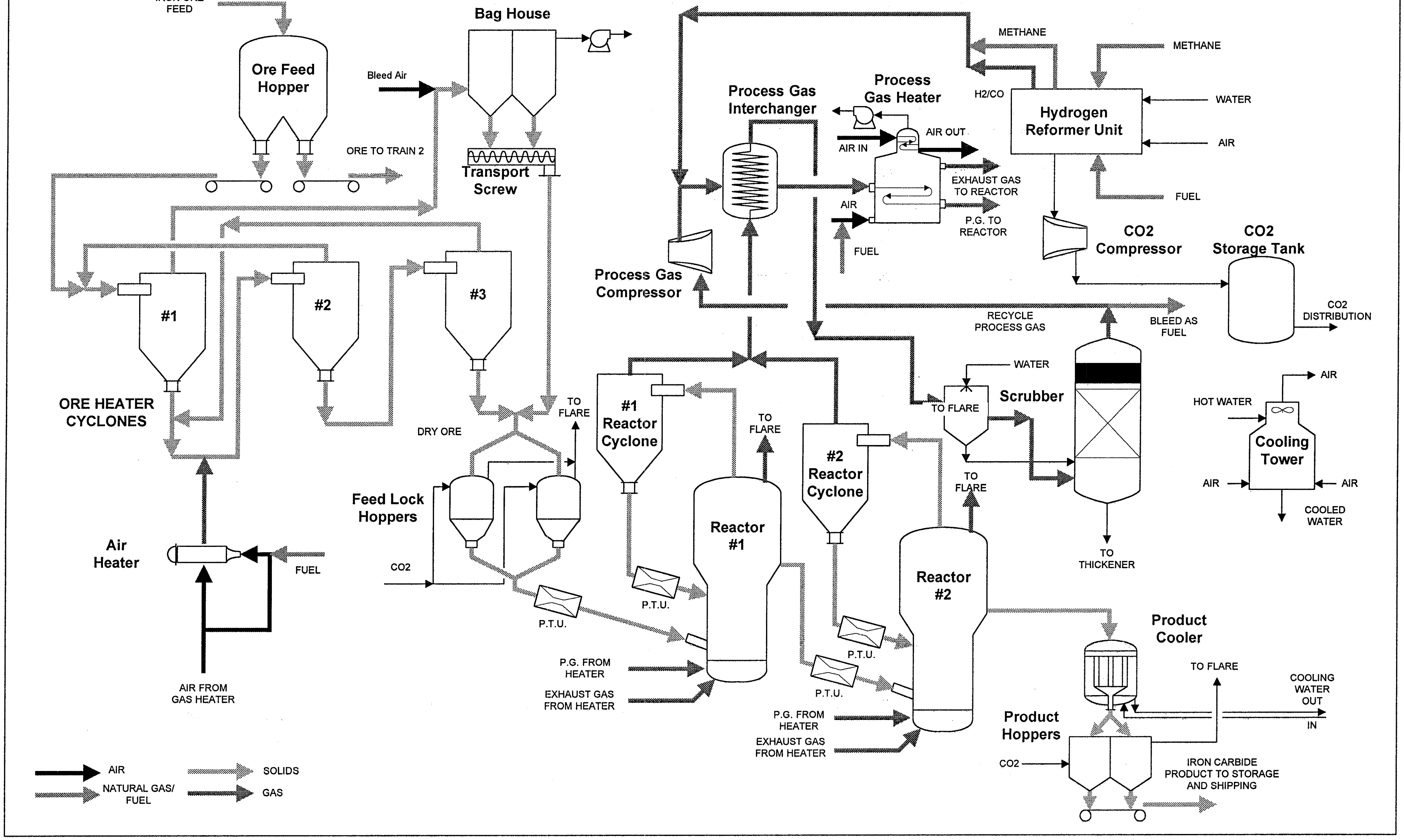
LURGI CIRCOFER PROCESS FLOWSHEET



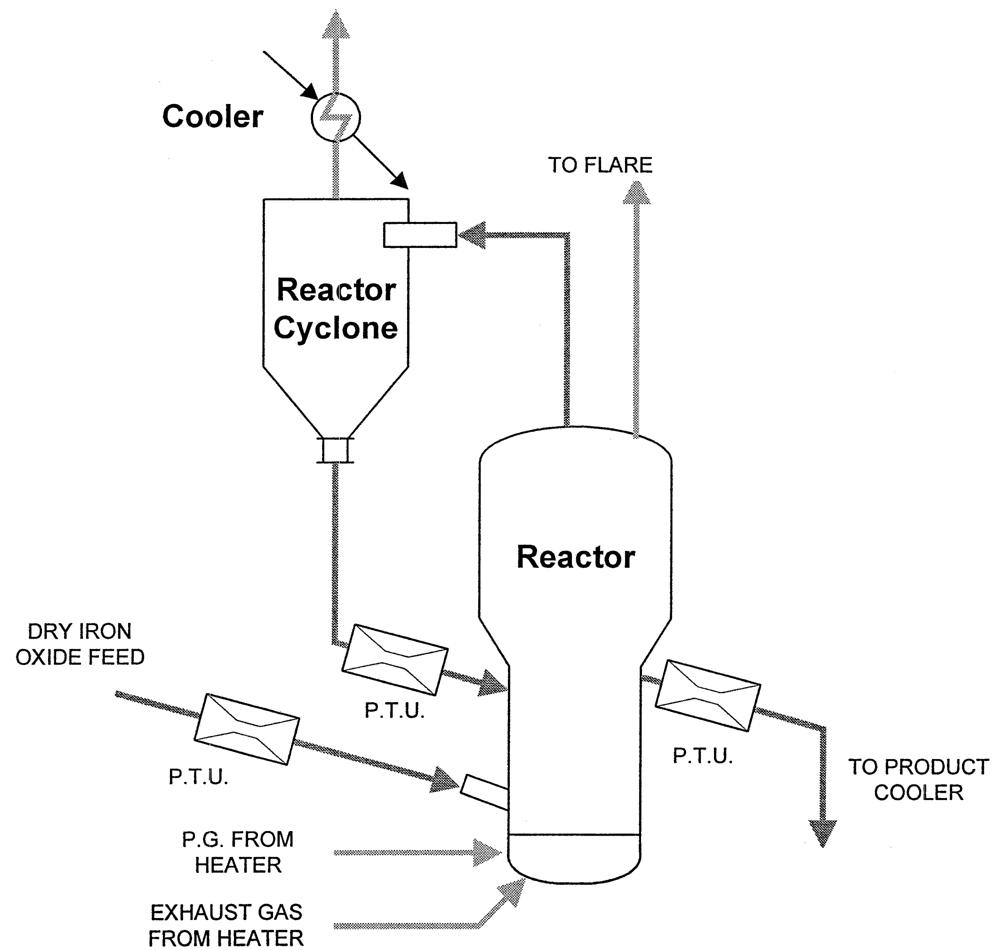


LURGI CIRCOFER/SAF
With Two-Stage CFB/FB Reactor System

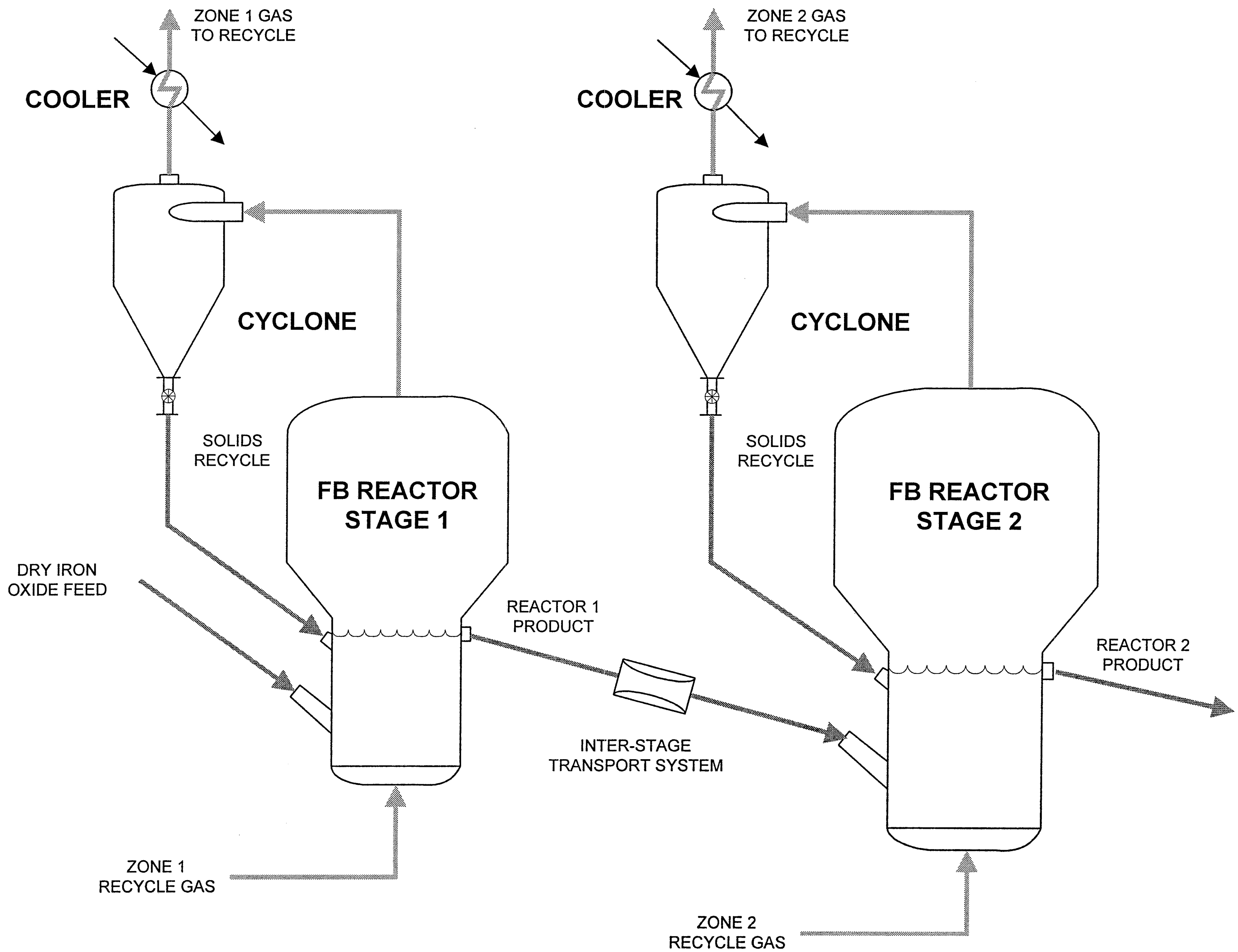
IRON CARBIDE PROCESS FLOWSHEET



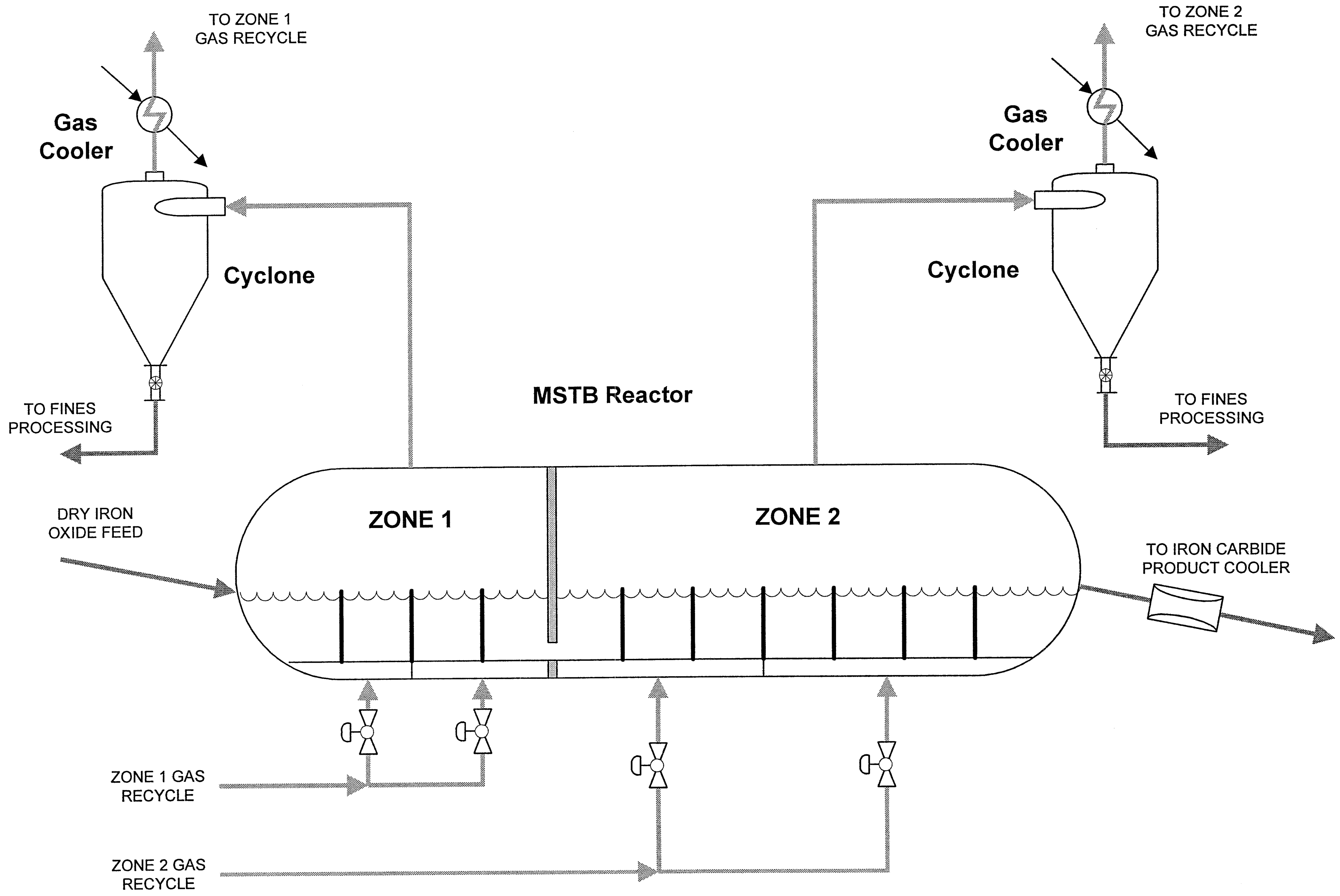
SINGLE-STAGE IRON CARBIDE REACTOR SYSTEM



TWO-STAGE IRON CARBIDE REACTOR SYSTEM

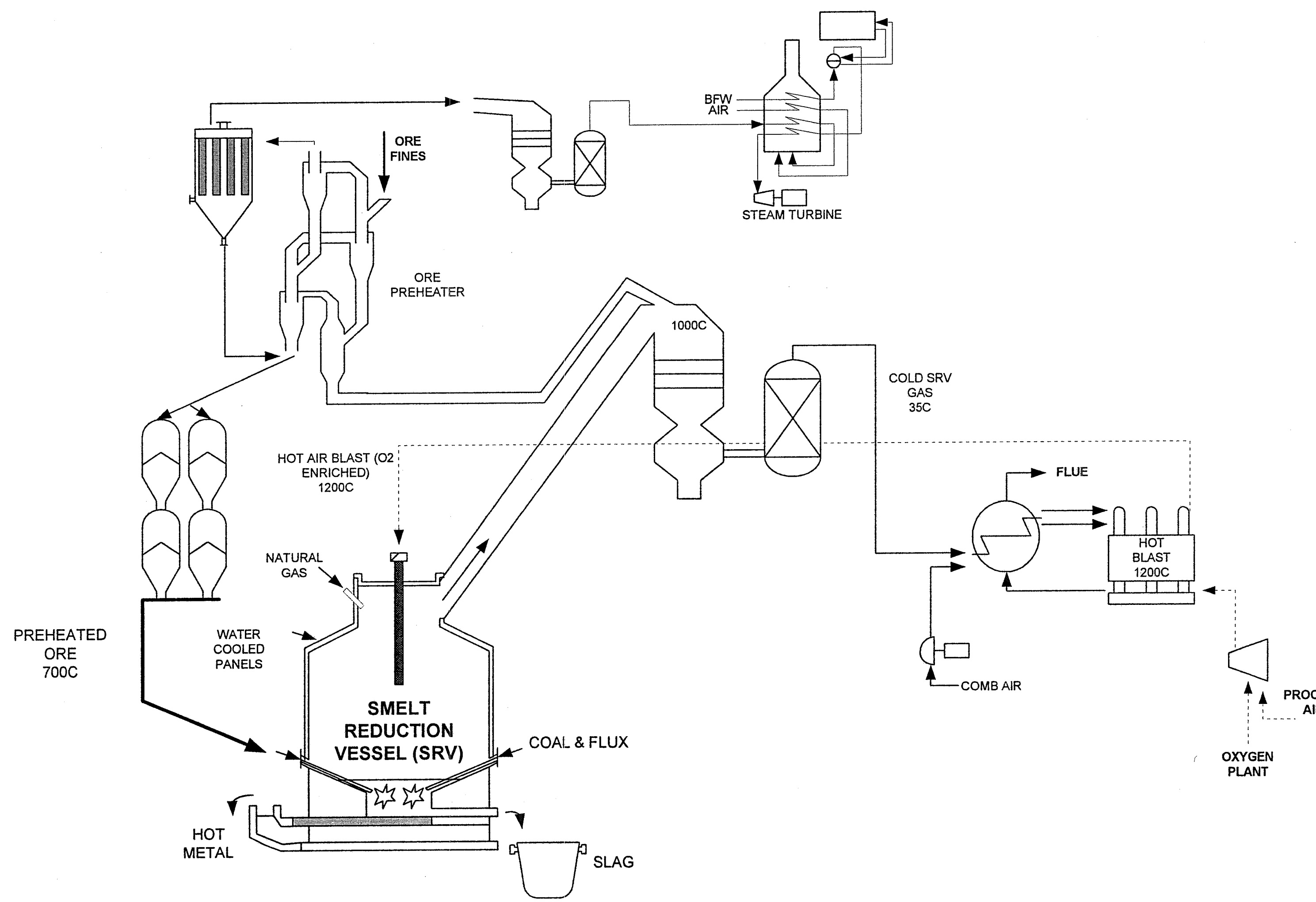


PROCEDYNE MSTB IRON CARBIDE REACTOR SYSTEM

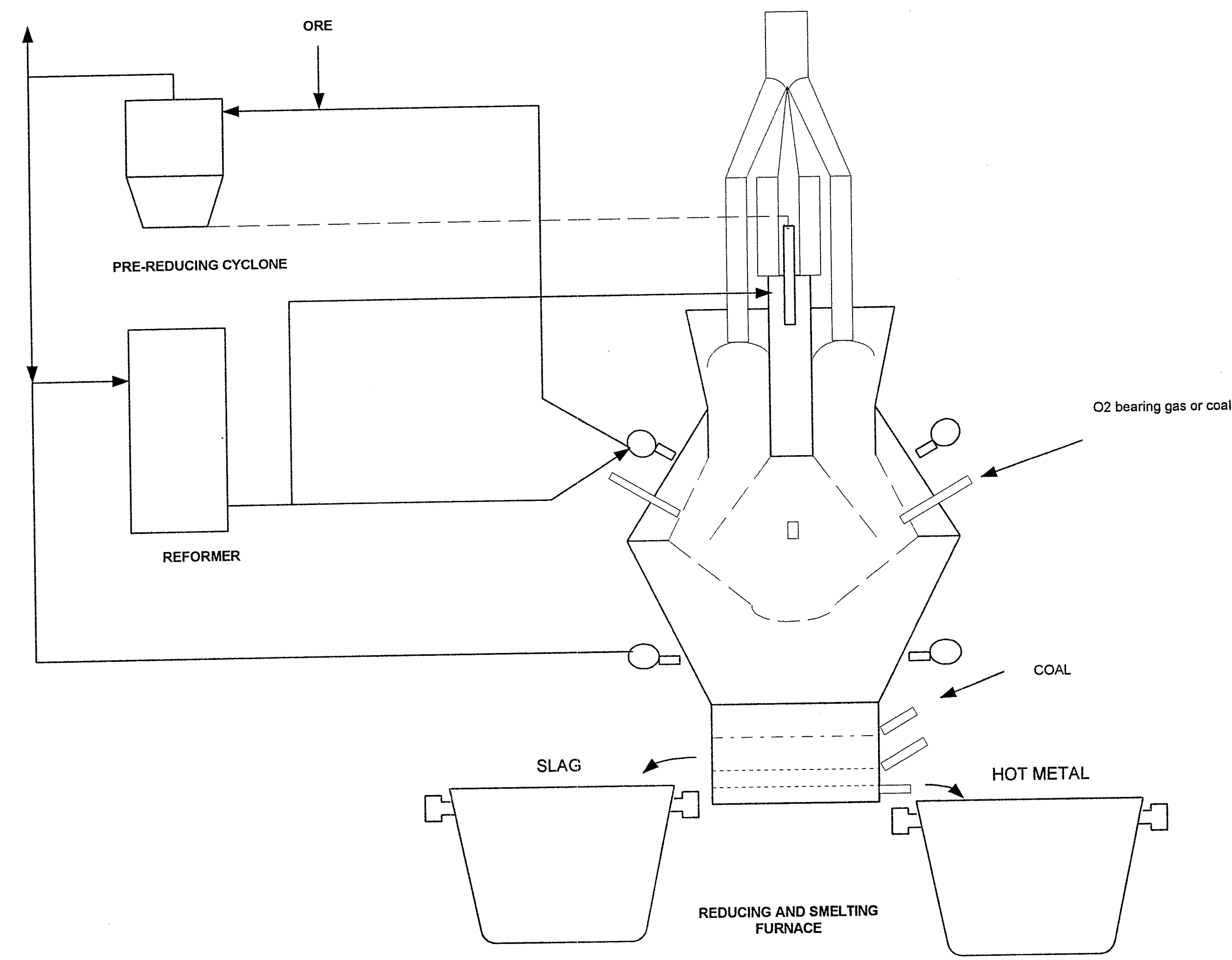


OTHER PROCESSES

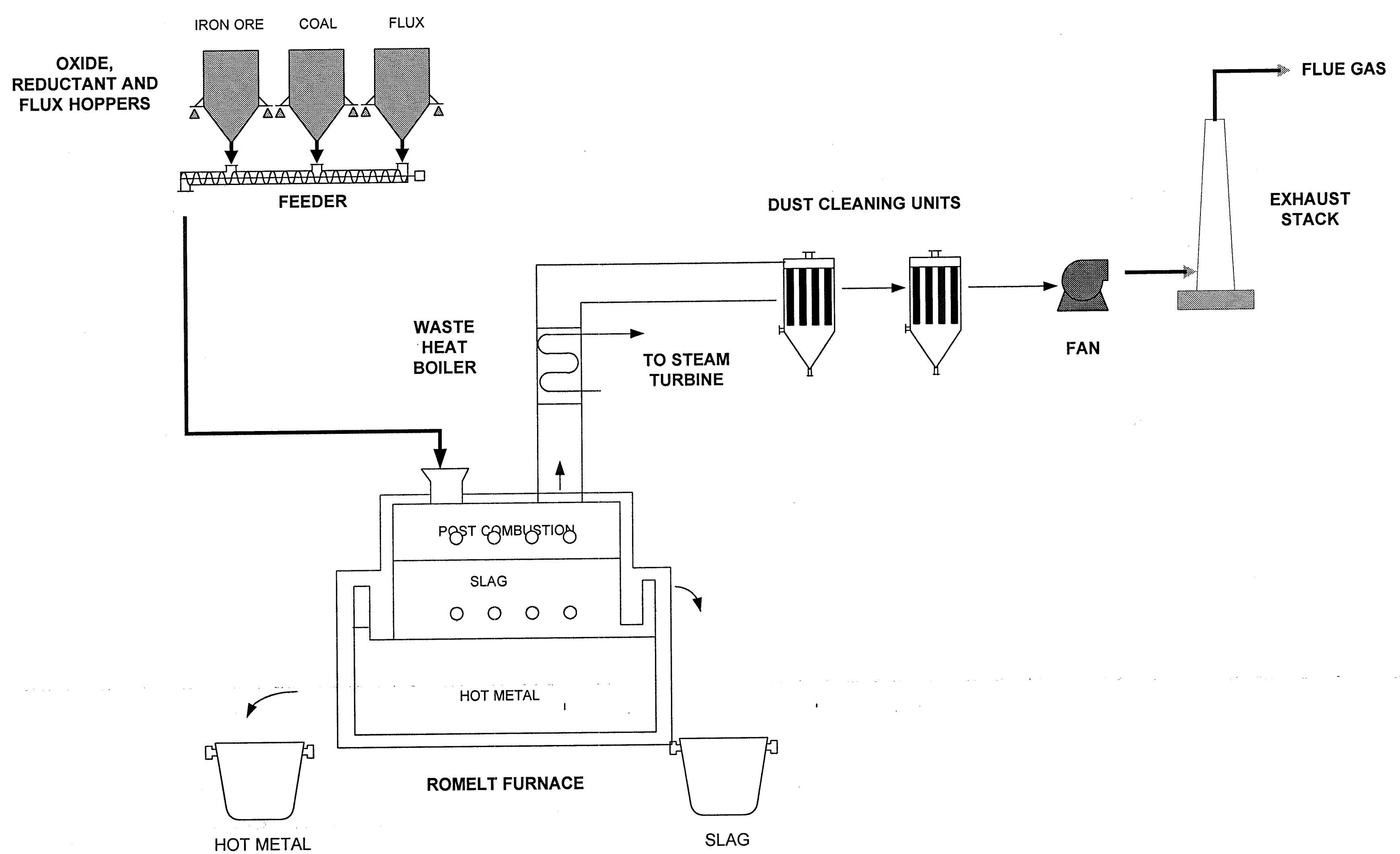
HISMELT PROCESS FLOWSHEET



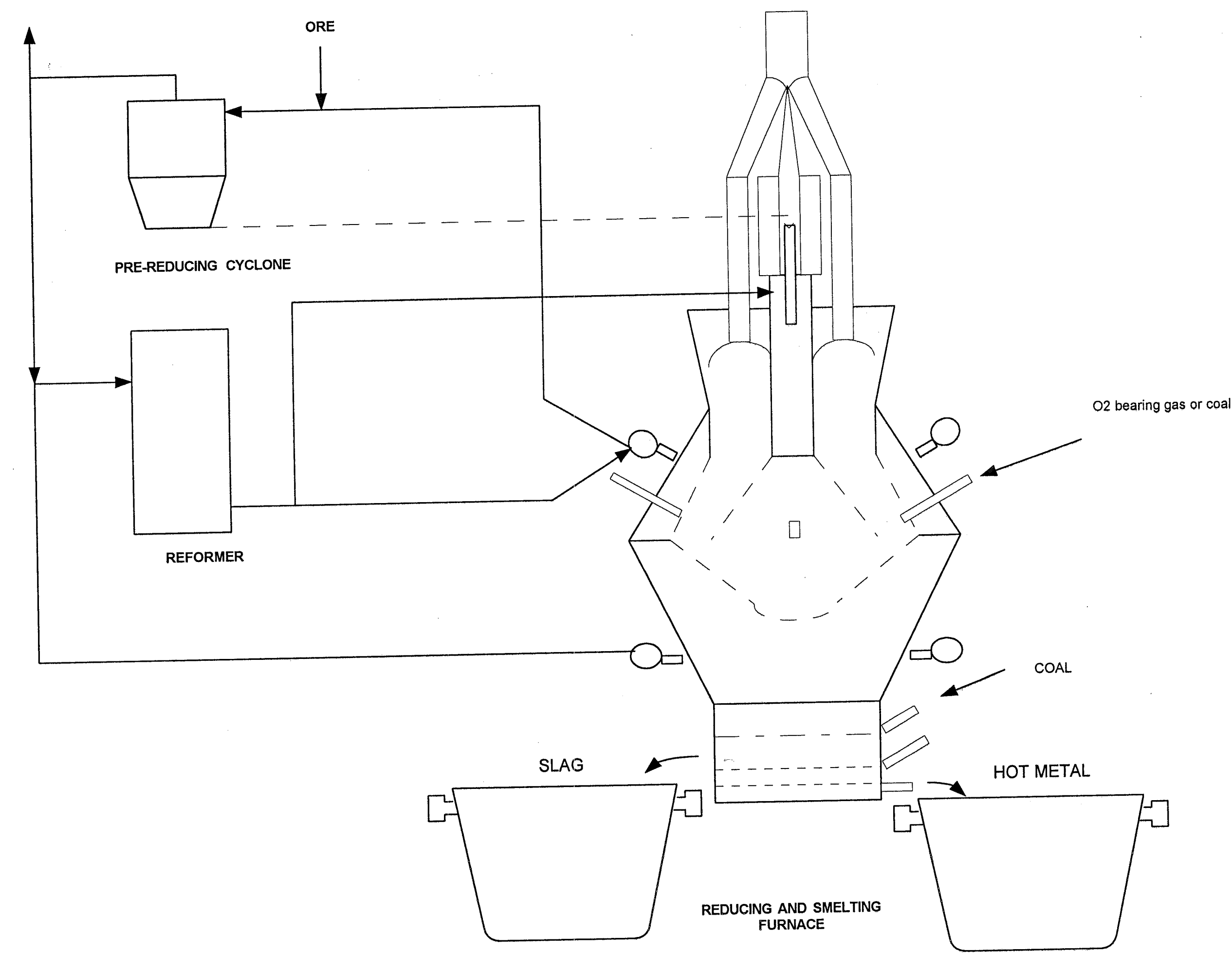
ISCON GRIDSMELTER PROCESS FLOWSHEET



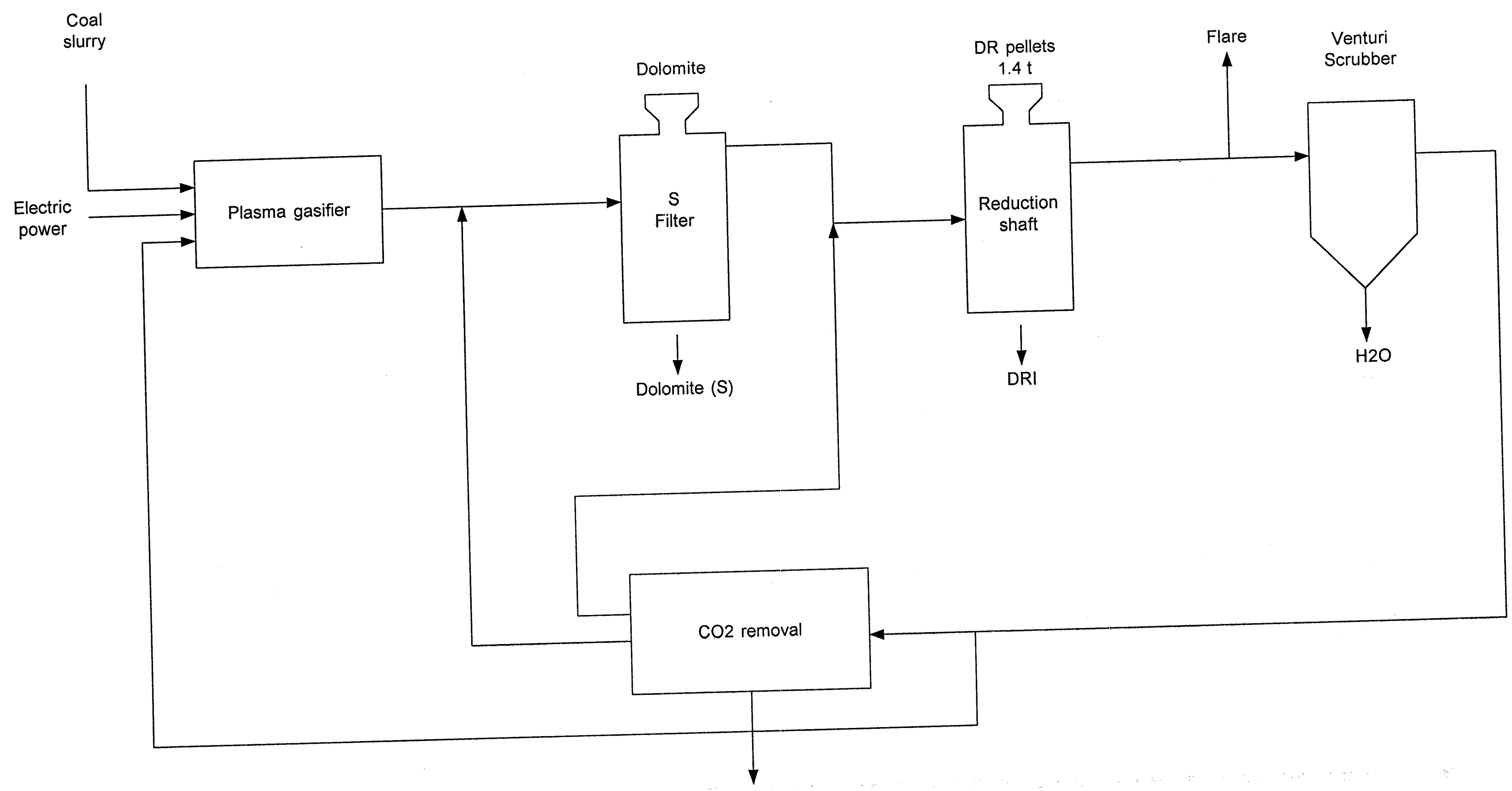
ICF KAISER / MISA ROMELT PROCESS FLOWSHEET



ISCON GRIDSMELTER PROCESS FLOWSHEET



PLASMARED PROCESS FLOWSHEET



APPENDIX A-3:

COMPONENT AND PROCESS BLOCK FLOW DIAGRAMS

APPENDIX A-3.1

ELECTRIC POWER GENERATION - COAL & NATURAL GAS

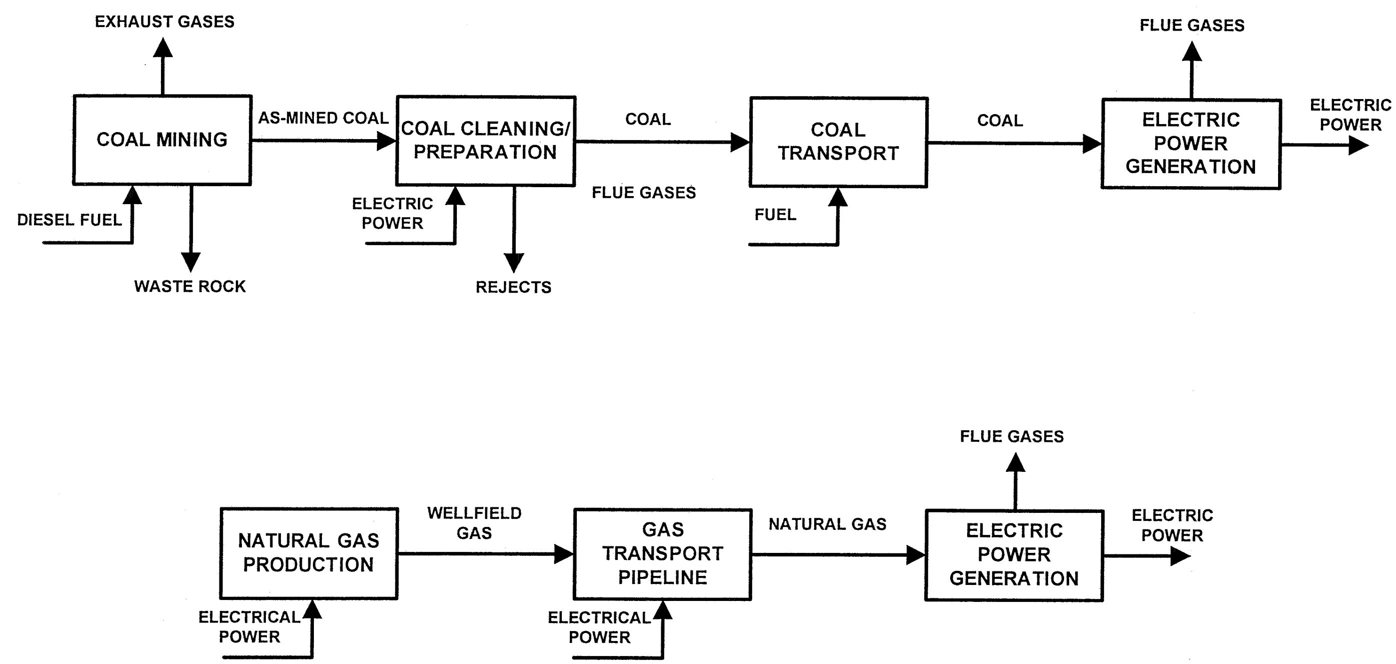


FIGURE A-1
ELECTRICAL POWER GENERATION - COAL AND NATURAL GAS

APPENDIX A-3.2

OXYGEN AND CARBON ELECTRODES

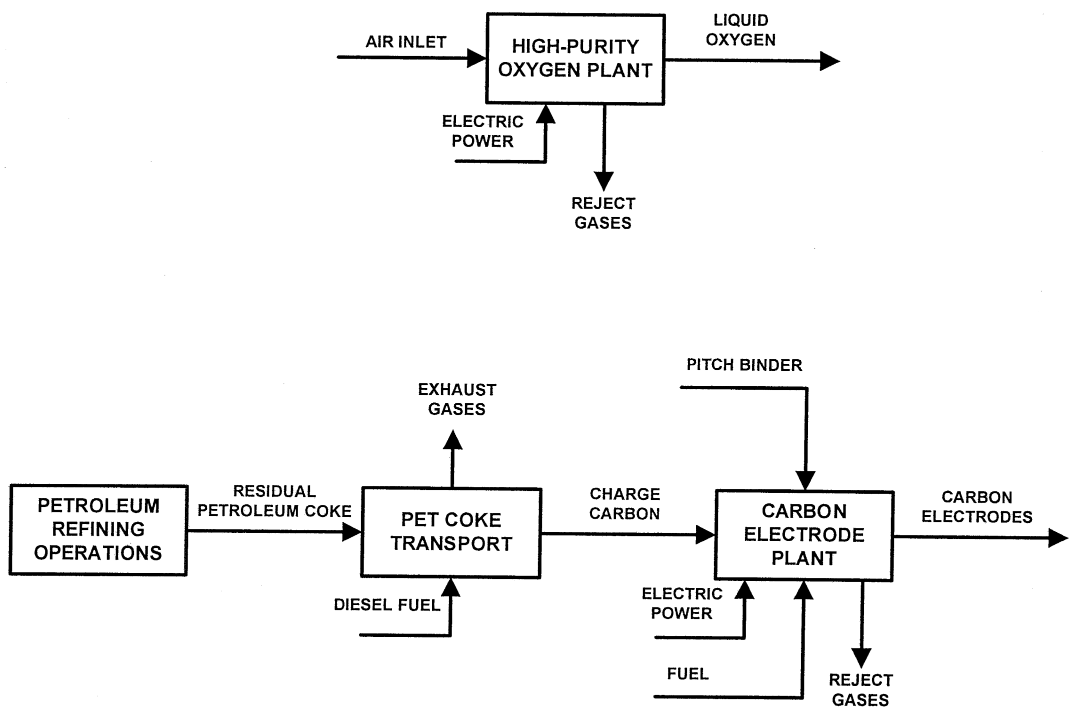


FIGURE A-2
COMPONENT BALANCES -
LIQUID OXYGEN AND CARBON ELECTRODES

APPENDIX A-3.3

BURNT LIME AND PELLETIZING BINDER

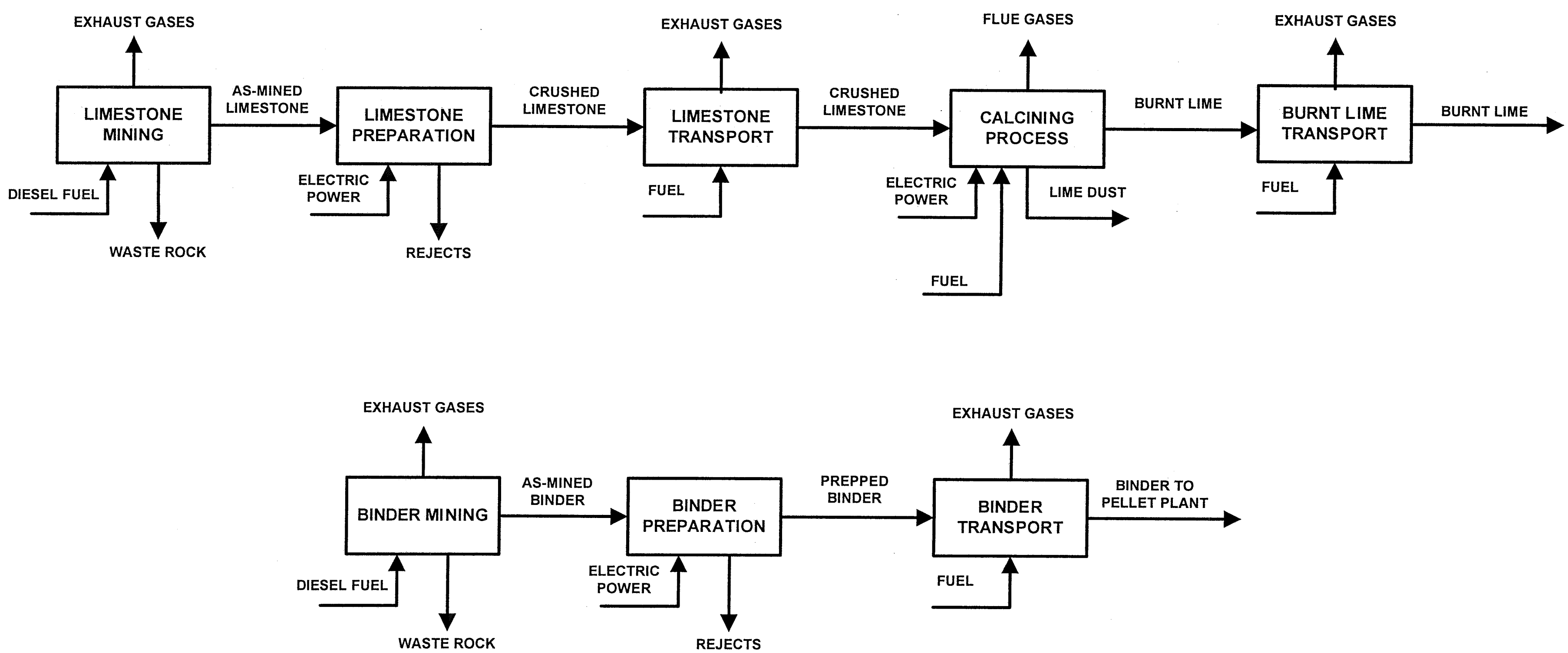


FIGURE A-3
COMPONENT BALANCES -
BURNT LIME AND PELLETIZING BINDER

APPENDIX A-3.4

NON-RECOVERY COKE PROCESS WITH CO-GENERATION

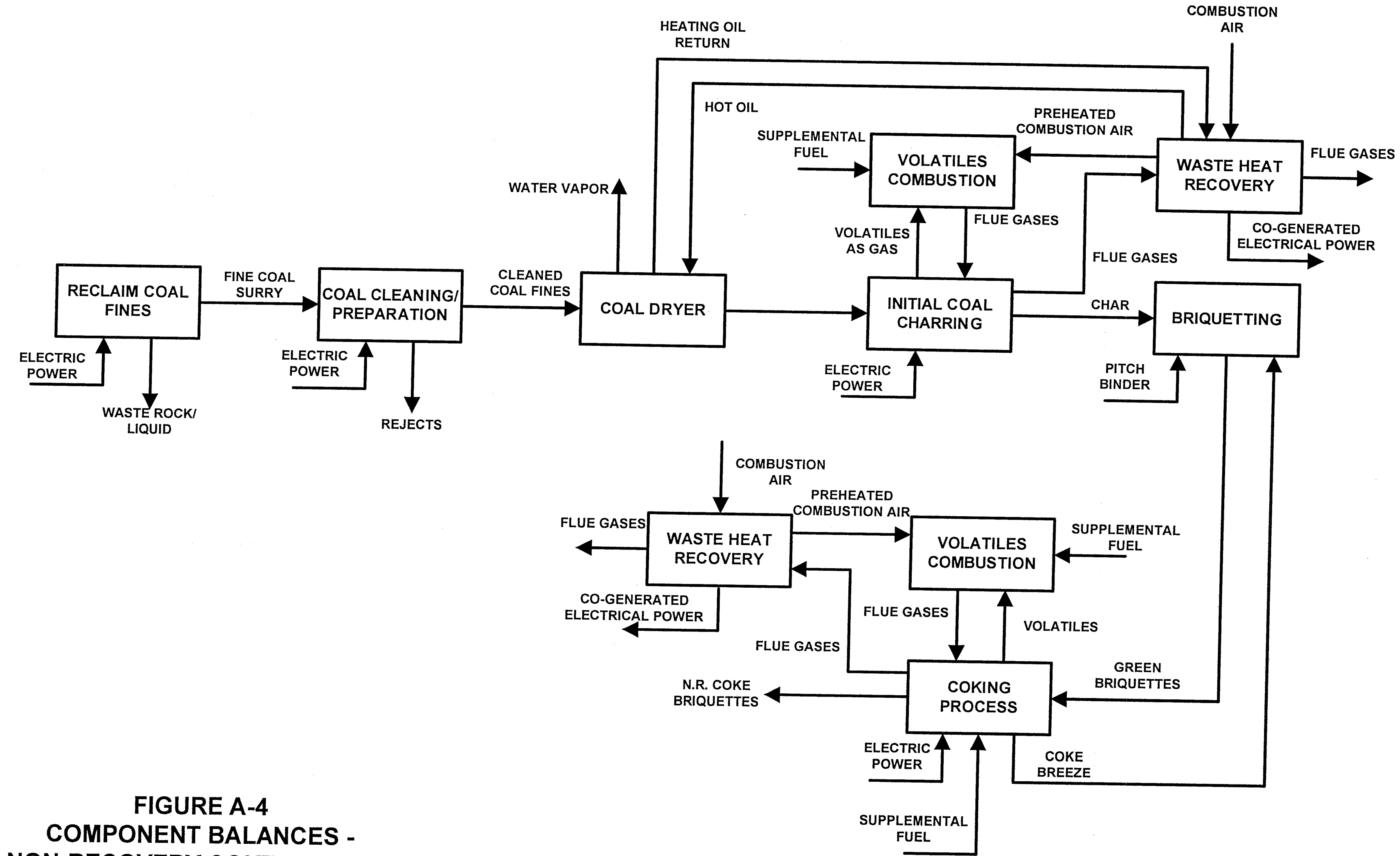


FIGURE A-4
COMPONENT BALANCES -
NON-RECOVERY COKE PROCESS

APPENDIX A-3.5

BASE PROCESS – DRI/EAF

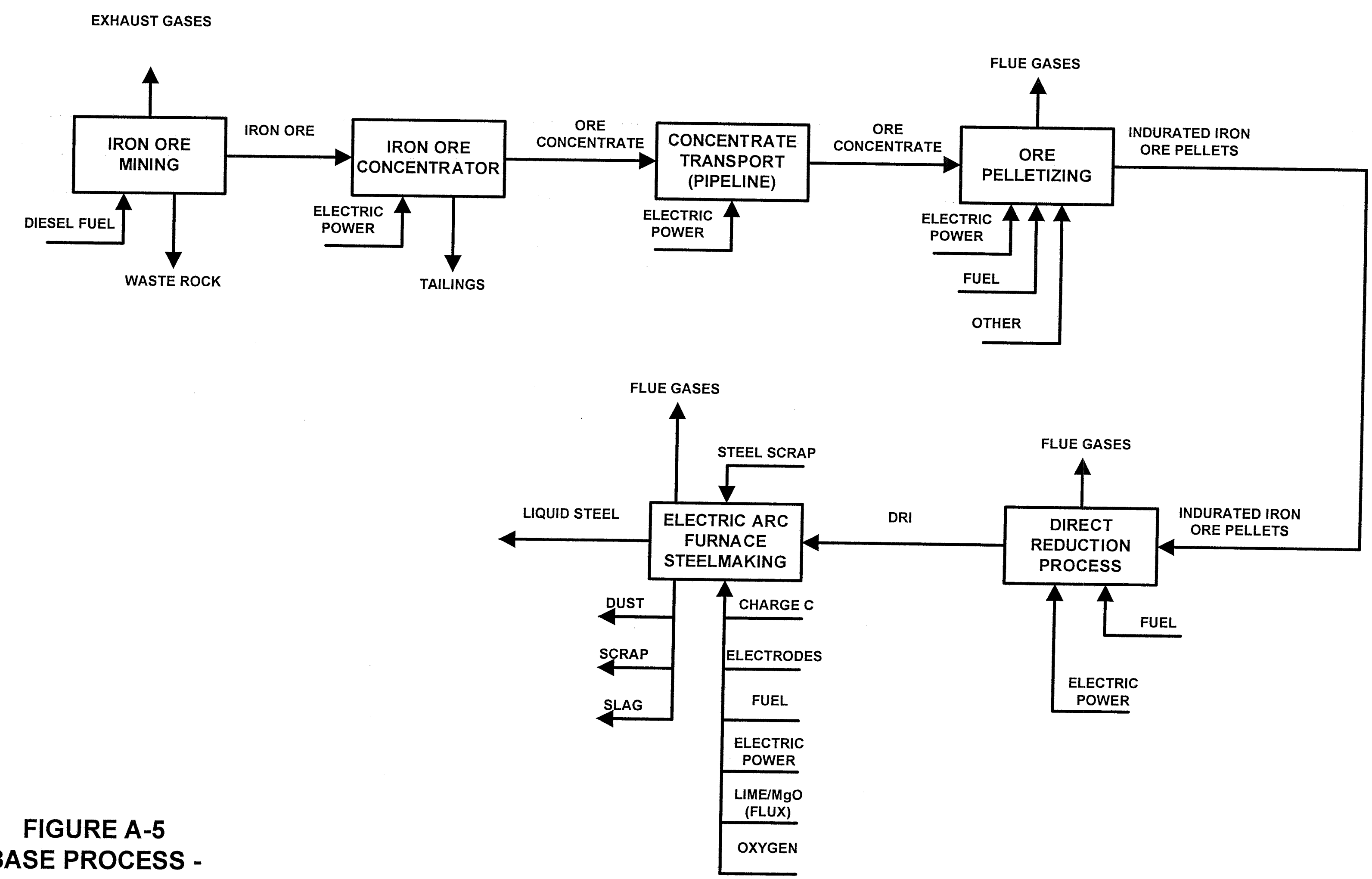


FIGURE A-5
BASE PROCESS -
DRI/EAF

APPENDIX A-3.6

BLAST FURNACE/EAF

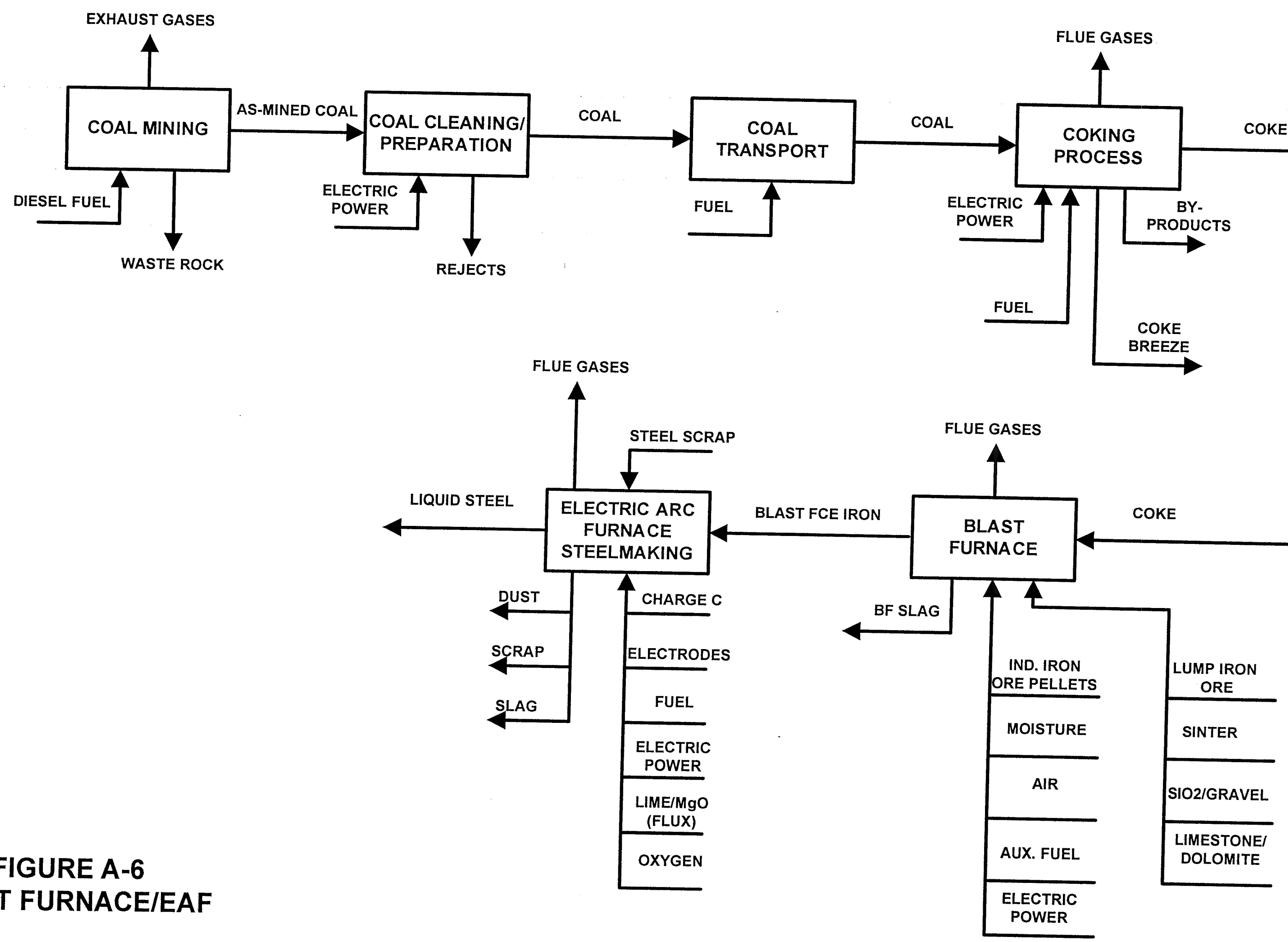


FIGURE A-6
BLAST FURNACE/EAF

APPENDIX A-3.7

TECNORED/EAF

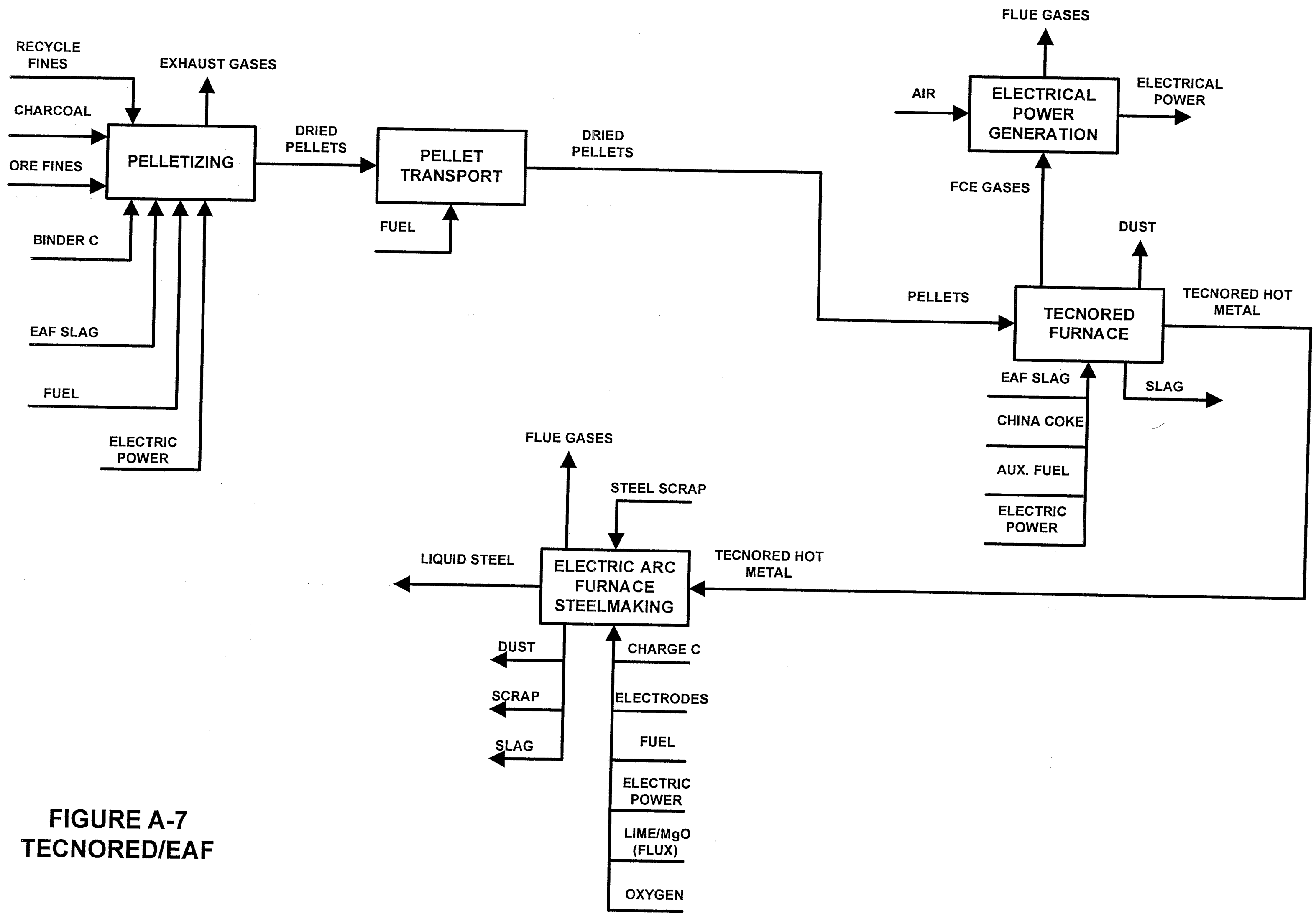


FIGURE A-7
TECNORED/EAF

APPENDIX A-3.8

HISMELT/EAF

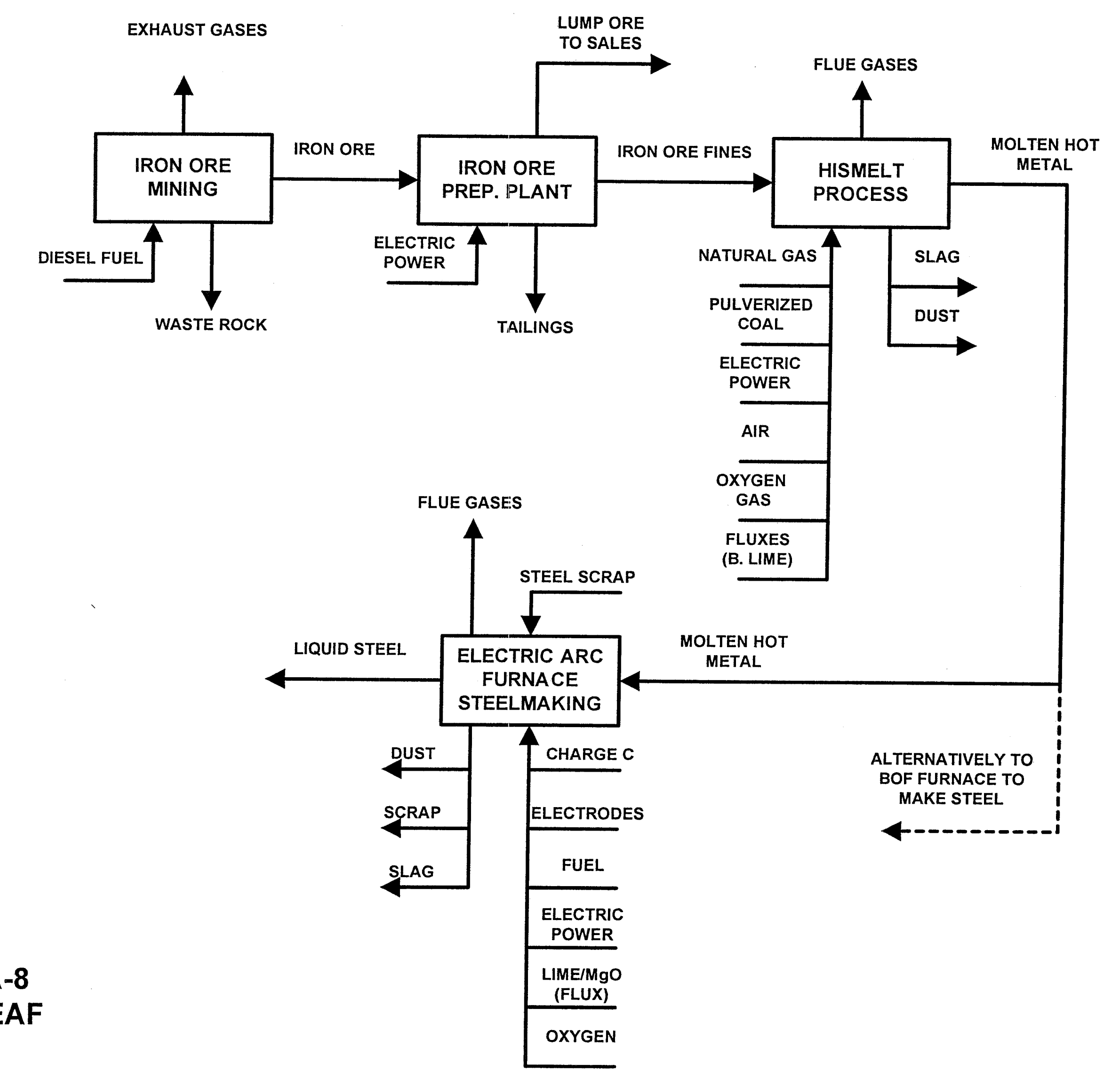


FIGURE A-8
HISMELT/EAF

APPENDIX A-3.9

CIRCORED/EAF

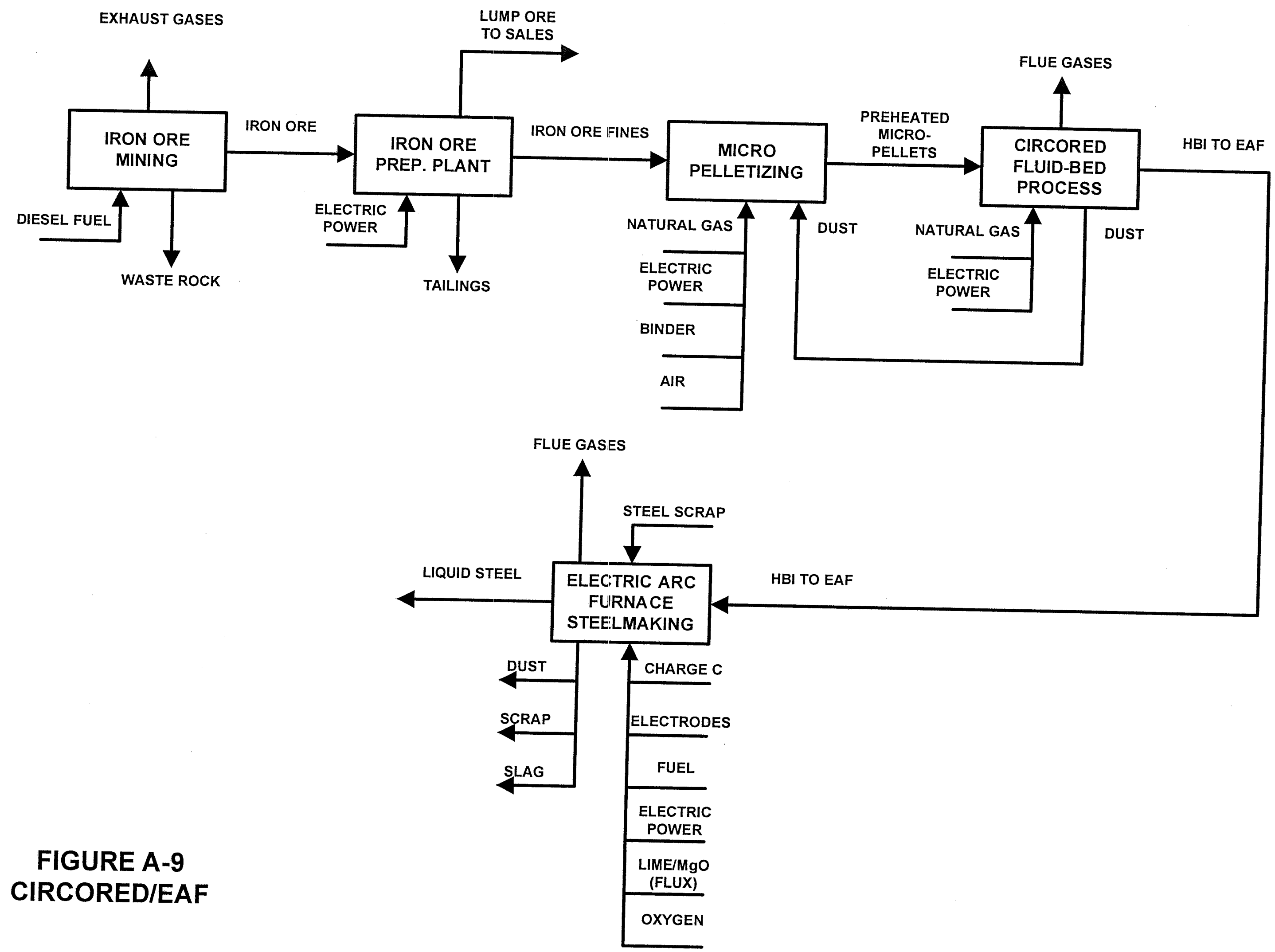


FIGURE A-9
CIRCORED/EAF

APPENDIX A-3.10

CIRCOFER/EAF

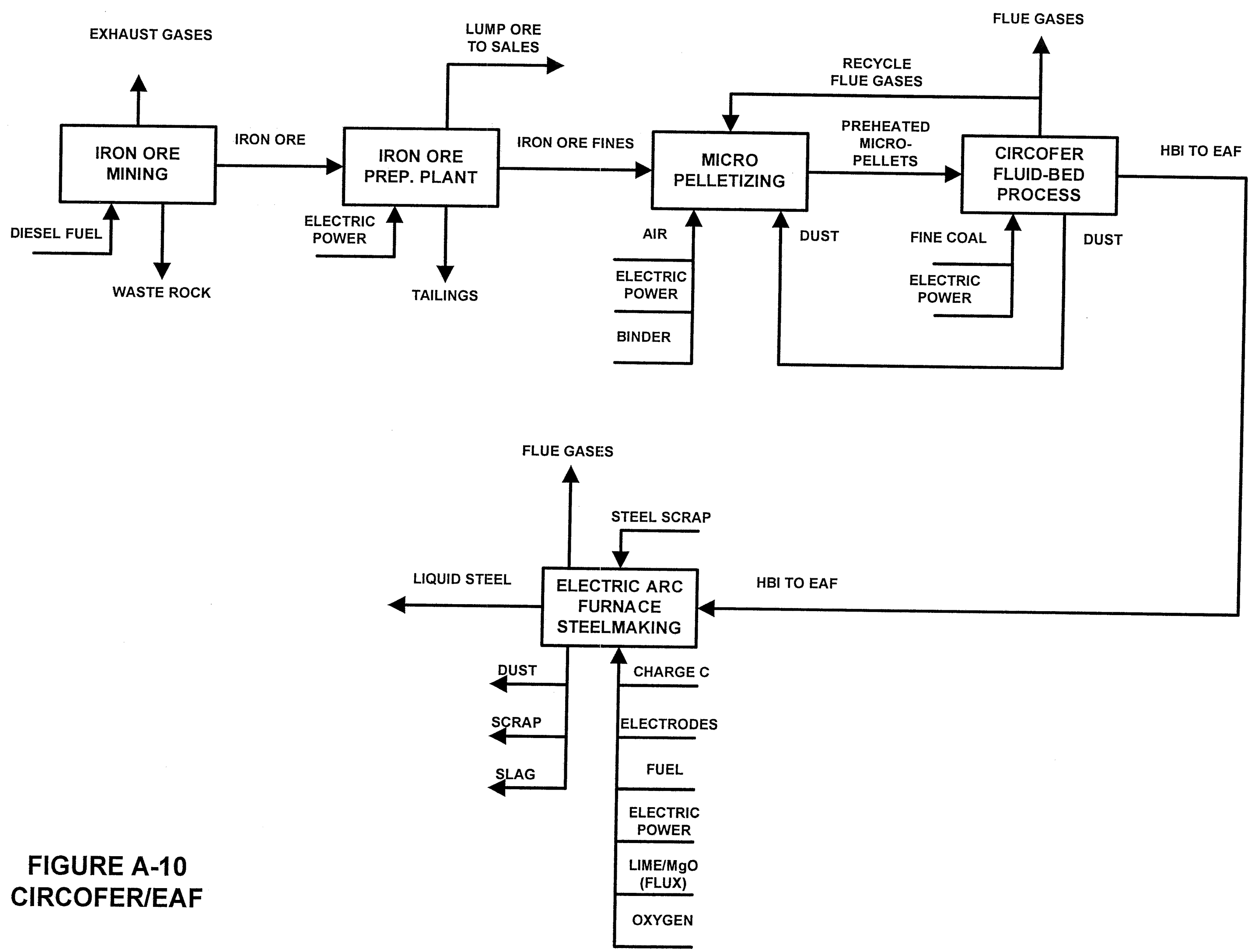


FIGURE A-10
CIRCOFER/EAF

APPENDIX A-3.11

FINMET/EAF

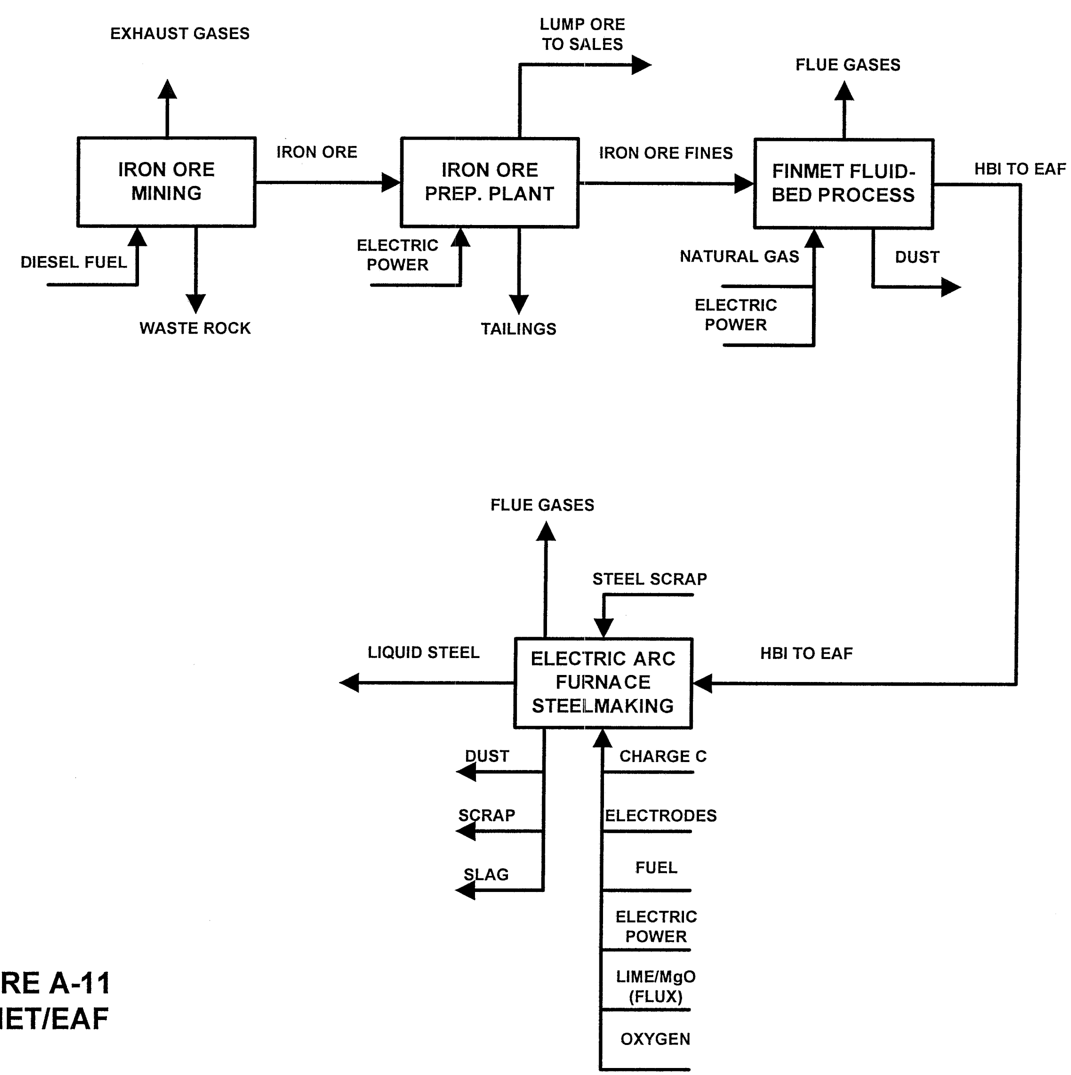


FIGURE A-11
FINMET/EAF

APPENDIX A-3.12

REDSMELT/EAF

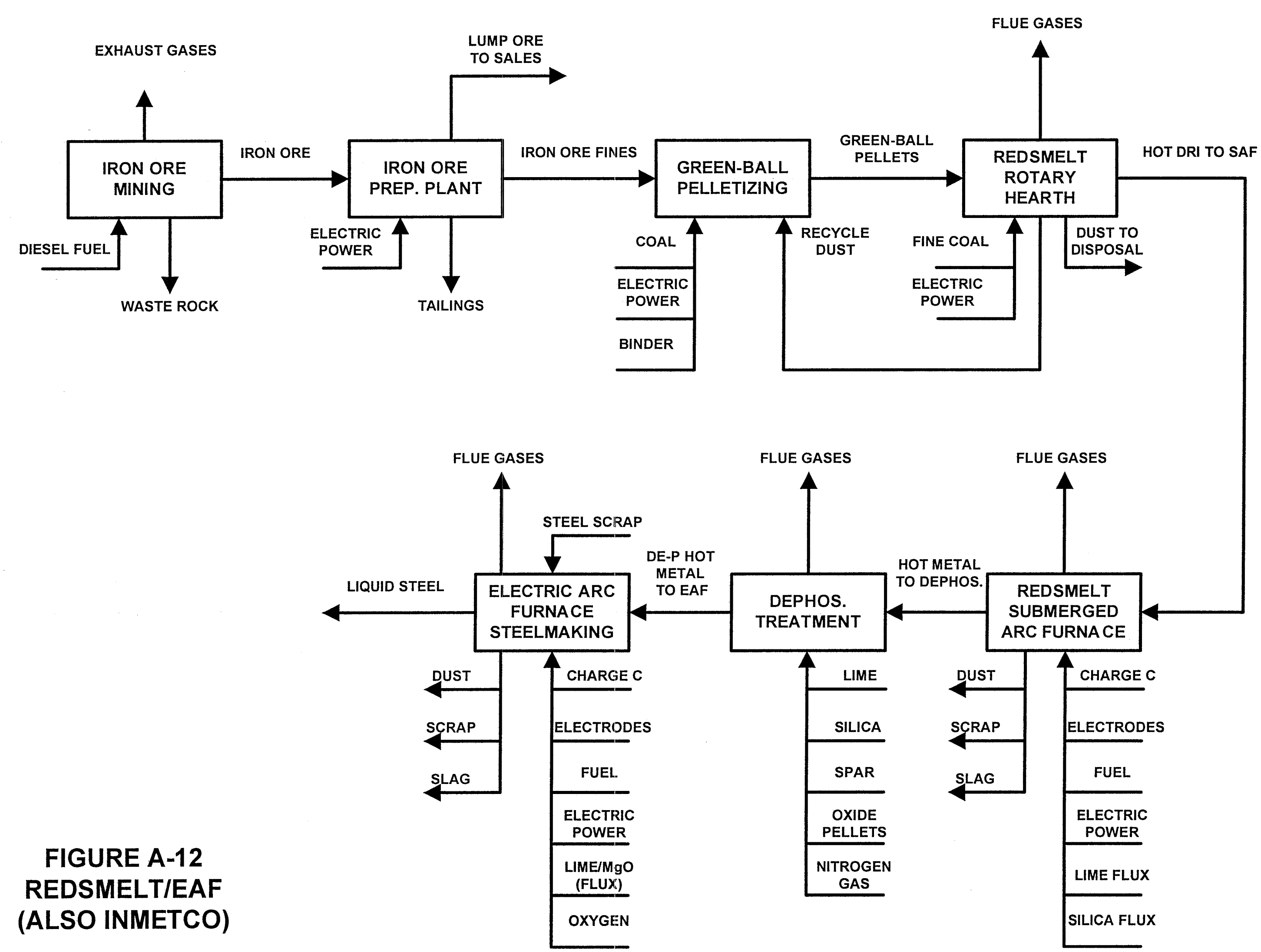


FIGURE A-12
REDSMELT/EAF
(ALSO INMETCO)

APPENDIX A-3.13

IRON DYNAMICS/EAF

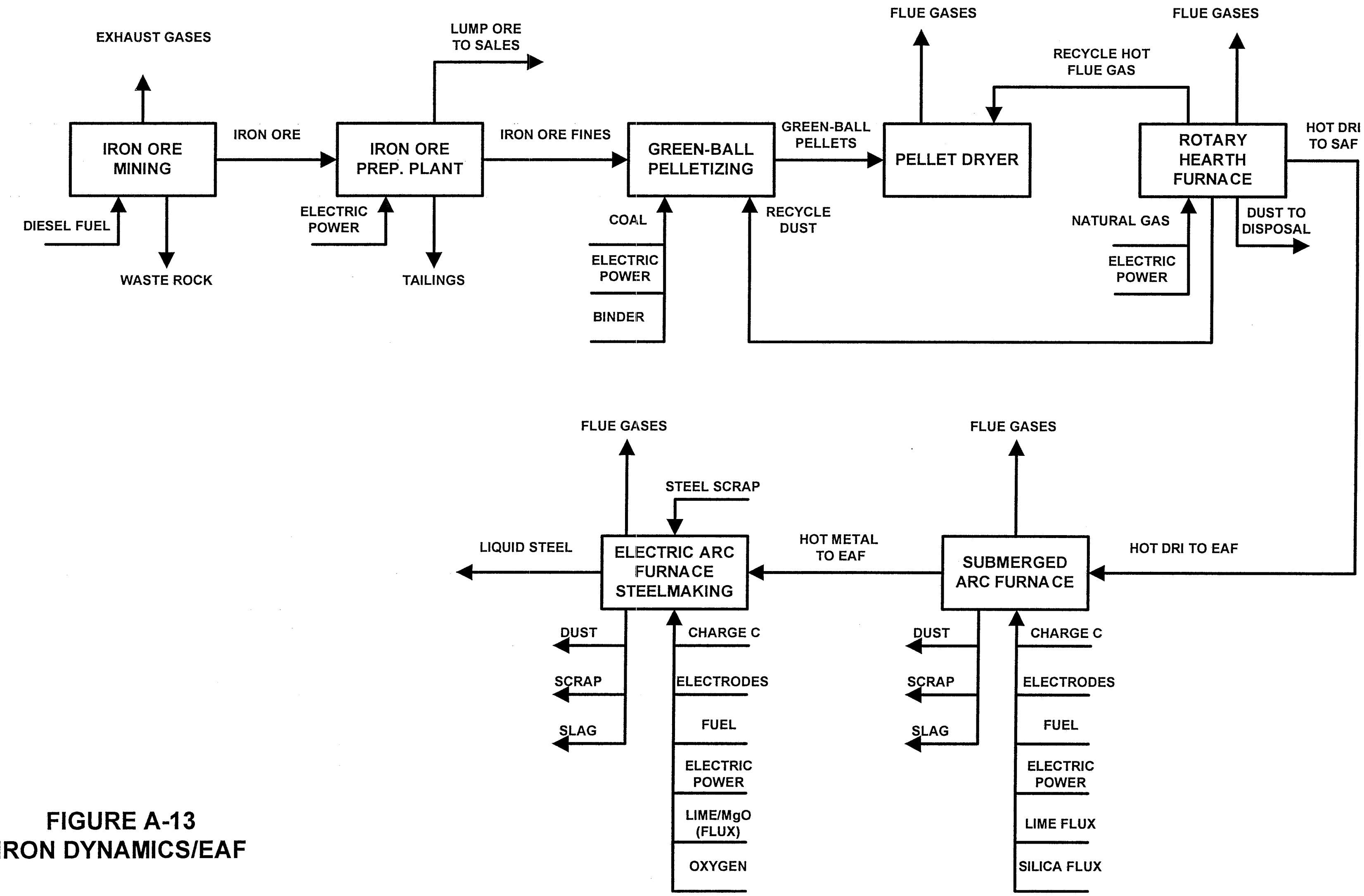


FIGURE A-13
IRON DYNAMICS/EAF

APPENDIX A-3.14

MAUMEE R&E/EAF

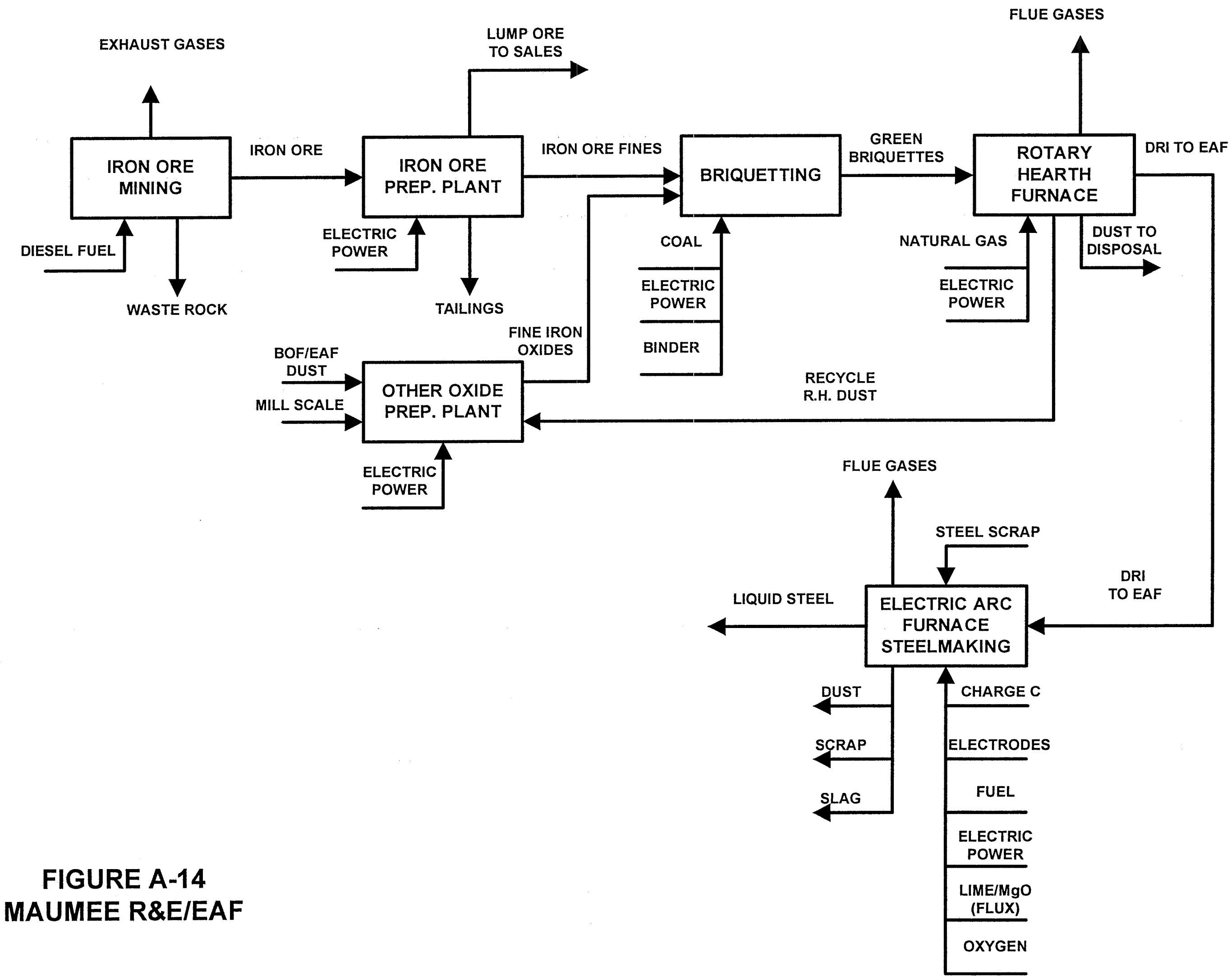


FIGURE A-14
MAUMEE R&E/EAF

APPENDIX A-4:

GROUPINGS OF PROCESSES

A. IRONMAKING PROCESSES BY REDUCTION PROCESS TYPE

1) SHAFT FURNACE

Blast Furnace
Corex
Midrex
Hylsa (HYLIII etc.)
Tecnored

2) ROTARY KILN

SL/RN

3) ROTARY HEARTH

Redsmelt
Fastmet/Fastmelt
Itmk3
Inmetco
Iron Dynamics
MauMee

4) FLUIDIZED BED

Finmet
Circored
Circofer
Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)
Procedyne (Multi-stage IC)

5) OTHER (REACTOR ETC.)

HIsmelt
Dios
Romelt
Gridsmelter
Comet
PlasmaRed

B. IRONMAKING PROCESSES BY PRODUCT TYPE:

1) PROCESSES PRODUCING MOLTEN HOT METAL/PIG IRON

Blast Furnace
Corex
Redsmelt
Iron Dynamics
Tecnored
Fastmet/Fastmelt
Hismelt
Gridsmelter
Dios
Romelt

2) PROCESSES PRODUCING DRI/HBI

Midrex
Hylsa (HYLIII etc.)
Circored
Finmet
Inmetco
SL/RN
ITmk3
Circofer
MauMee
Comet
PlasmaRed

3) PROCESSES PRODUCING IRON CARBIDE

Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)
Procedyne (Multi-Stage IC)

C. IRONMAKING PROCESSES BY STAGE OF COMMERCIAL DEVELOPMENT

1) PROVEN COMMERCIAL PROCESSES

Blast Furnace
Midrex
Hylsa (HYLIII, HYLIV, etc.)
Corex
SL/RN

2) PROCESSES AT SEMI-COMMERCIAL OR FIRST-OF-A-KIND STAGE OF DEVELOPMENT

Finmet
Circored
Iron Dynamics
MauMee
Inmetco
Redsmelt
Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)

3) PROCESSES AT PILOT PLANT STAGE OF DEVELOPMENT

Tecnored
Hismelt
Fastmet/Fastmelt
Itmk3
Dios
Romelt

4) PROCESSES AT COMPONENT TEST STAGE OF DEVELOPMENT

Procedyne (Multi-stage IC)
Circofer
Gridsmelter
Comet
PlasmaRed

D. IRONMAKING PROCESSES BY IRON UNIT FEED MATERIAL

1) LUMP IRON ORE/PELLET/BRIQUETTE/RECYCLE IRON UNITS AND/OR SINTER

Blast Furnace
Corex
Midrex
Hylsa (HYLIII, HYLIV, etc.)
SL/RN
Tecnored
Fastmet/Fastmelt
Redsmelt
Itmk3
Inmetco
Iron Dynamics
MauMee

2) FINE ORE DIRECT

Finmet
Circored
Circofer
Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)
Procedyne (Multi-stage IC)
HIsmelt
Dios
Romelt
Gridsmelter
Comet
PlasmaRed

E. IRONMAKING PROCESSES BY PRIMARY REDUCTANT TYPE

1) COKE

Blast Furnace
Tecnored

2) COAL

Corex
SL/RN
Tecnored (optional)
Redsmelt
Fastmet/Fastmelt
Inmetco
Iron Dynamics
MauMee
Circofer

3) NATURAL GAS/HYDROGEN/REFORMED GAS

Midrex
Hylsa (HYLIII etc.)
Circored
Finmet
Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)
Procedyne (Multi-stage IC)
PlasmaRed

4) COAL/NATURAL GAS MIXTURE

Itmk3
HIsmelt
Dios
Romelt
Gridsmelter
Comet

F. IRONMAKING PROCESSES BY <u>TARGET</u> NOMINAL SIZE OF REDUCTION UNIT/TRAIN

1) LESS THAN 200,000 MTPY

MauMee
Inmetco
Romelt
Gridsmelter
Comet
PlasmaRed

2) 200,000 TO 500,000 MTPY

Tecnored
HIsmelt
Iron Dynamics
SL/RN
Circofer
Nucor/ICH (Single-Stage IC)
Qualitech/Kawasaki (Two-Stage IC)
Procedyne (Multi-stage IC)

3) 500,000 TO 1,000,000 MTPY

Finmet
Circored
Redsmelt
Fastmet/Fastmelt
Itmk3
Dios

4) GREATER THAN 1,000,000 MTPY

Blast Furnace
Corex
Midrex
Hylsa (HYLIII, HYLIV, etc.)

IRONMAKING PROCESSES BY PRODUCT TYPE

HOT METAL/PIG IRON

BLAST FURNACE
COREX
REDSMELT
IRON DYNAMICS
TECNORED
FASTMET/FASTMELT
HISMELT
GRIDSMELTER
DIOS
ROMELT

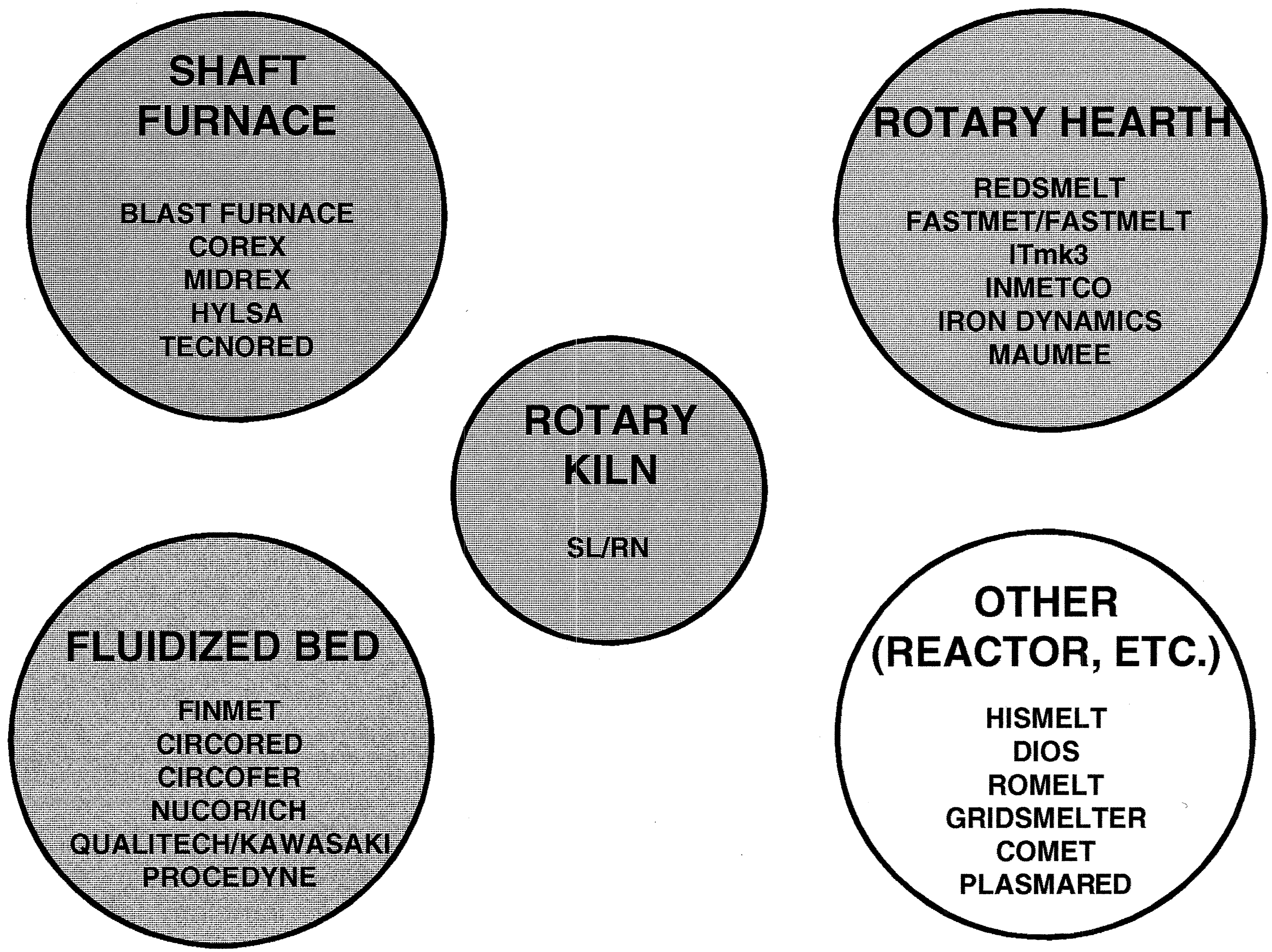
DRI/HBI

MIDREX
HYLSA
FINMET
CIRCORED
INMETCO
SL/RN
ITmk3
CIRCOFER
MAUMEE
COMET
PLASMARED

IRON CARBIDE

NUCOR/ICH
QUALITECH/KAWASAKI
PROCEDYNE

IRONMAKING PROCESSES BY REDUCTION PROCESS TYPE



IRONMAKING PROCESSES BY STAGE OF COMMERCIAL DEVELOPMENT

PROVEN COMMERCIAL

BLAST FURNACE
MIDREX
HYLSA
COREX
SL/RN

SEMI-COMMERCIAL

FINMET
CIRCORED
IRON DYNAMICS
MAUMEE
NUCOR/ICH
QUALITECH/KAWASAKI
INMETCO
REDSMELT

PILOT PLANT

TECNORED
HISMELT
FASTMET/FASTMELT
DIOS
ROMELT
ITmk3

COMPONENT TEST

PROCEDYNE
CIRCOFER
GRIDSMELTER
COMET
PLASMARED

IRONMAKING PROCESSES BY IRON UNIT FEED MATERIAL

LUMP ORE/PELLET/BRIQUETTE/ RECYCLE IRON UNITS, ETC.

BLAST FURNACE
COREX
MIDREX
HYLSA
SL/RN
TECNORED
FASTMET/FASTMELT
ITmk3
REDSMELT
INMETCO
IRON DYNAMICS
MAUMEE

FINE ORE

FINMET
CIRCORED
CIRCOFER
NUCOR/ICH
QUALITECH/KAWASAKI
PROCEDYNE
HISMELT
DIOS
ROMELT
GRIDSMELTER
COMET
PLASMARED

IRONMAKING PROCESSES BY PRIMARY REDUCTANT TYPE

COKE

BLAST FURNACE
TECNORED

PREDOMINATELY COAL

COREX
TECNORED (OPTION)
SL/RN
FASTMET/FASTMELT
REDSMELT
INMETCO
IRON DYNAMICS
MAUMEE
CIRCOFER

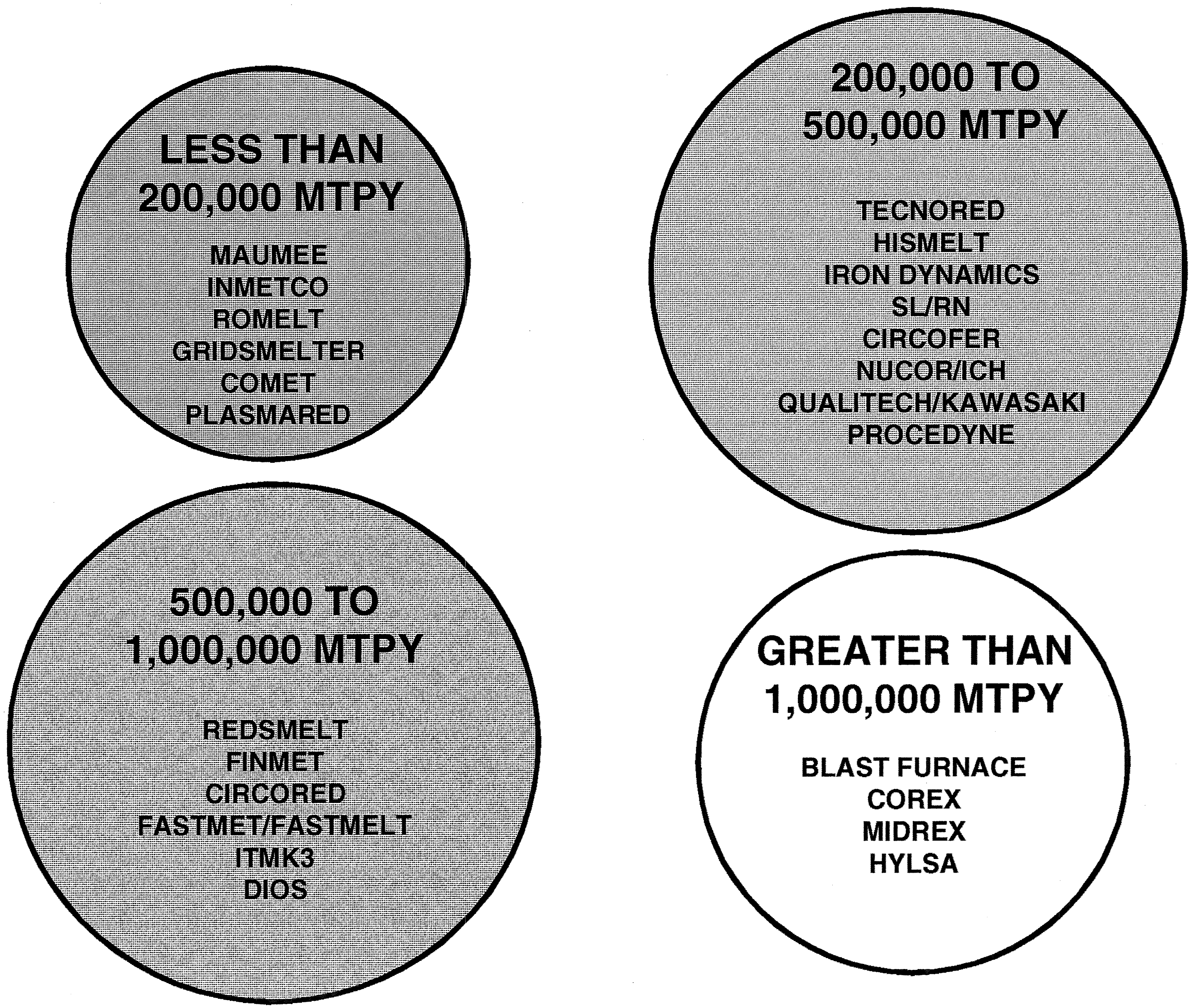
NATURAL GAS/ H2/REFORMED GAS

MIDREX
HYLSA
CIRCORED
FINMET
NUCOR/ICH
QUALITECH/KAWASAKI
PROCEDYNE
PLASMARED

COAL/NATURAL GAS MIXTURE

ITmk3
HISMELT
DIOS
ROMELT
GRIDSMELTER
COMET

IRONMAKING PROCESSES BY TARGET NOMINAL SIZE OF REDUCTION UNIT/TRAIN



APPENDIX B

PROCESS COMPONENT SPREADSHEETS

APPENDIX B-1

ELECTRIC POWER GENERATION - COAL, NATURAL GAS & FUEL OIL

DOEELEC2
07-June-2000
Rev. 2

D.O.E. IRONMAKING STUDY -OVERALL SUMMARY MASS BALANCES
ELECTRIC POWER GENERATION - COAL, NATURAL GAS AND FUEL OIL

BASIS:						
1.000000	MM kWhr/YEAR ELECTRICAL POWER GENERATED (TARGET)					
1.002621	MM kWhr/YEAR GR. ELEC. POWER (CALC. COAL)	lbs/MM BTU	BTU/lb			
1.000000	MM kWhr/YEAR NET ELEC. POWER (CALC. COAL)	68.729	14,550	NOMINAL HEAT CONTENT OF COAL		
1.002283	MM kWhr/YEAR GR. ELEC. POWER (CALC. N.G.)	52.757	18,955	NOMINAL HEAT CONTENT OF NATURAL GAS		
1.000000	MM kWhr/YEAR NET ELEC. POWER (CALC. N.G.)	52.910	18,900	NOMINAL HEAT CONTENT OF FUEL OIL (API GRAV. 19)		
1.008218	MM kWhr/YEAR GR. ELEC. POWER (CALC. F.O.)	BTU/kg				
1.000000	MM kWhr/YEAR NET ELEC. POWER (CALC. F.O.)	6,598.6	2,058.82	kWhr/mt NET CONTENT - COAL (Assumption)		
		8,596.4	4,380.48	kWhr/mt NET CONTENT - NATURAL GAS (Assumption)		
SUMMARY:		8,571.4	3,650.40	kWhr/mt NET CONTENT - FUEL OIL (Assumption)		
732.31	MT/YEAR AS-MINED COAL RESOURCE					
219.69	MT/YEAR MINE WASTE ROCK	485.71 mt/MM kWhr	1.071	lbs/kWhr COAL(3)	0.486	kg/kWhr COAL
512.62	MT/YEAR COAL TO PREP. PLANT	228.29 mt/MM kWhr	0.50	lbs/kWhr N.G.(3)	0.228	kg/kWhr N.G.
486.99	MT/YEAR NET COAL TO SHIPPING	273.94 mt/MM kWhr	0.60	lbs/kWhr Fuel Oil (3)	0.274	kg/kWhr N.G.
0.000912	NET CO_2 EMISSIONS- mt/kWhr POWER		30.00%	AMOUNT OF WASTE ROCK MINED		
			5.00%	AMOUNT OF WASTE IN COAL CLEANING/PREP		
ASSUMPTIONS: (Ref. 1)			80.00%	PERCENT CARBON IN COAL		
85.00%	DIESEL FUEL (COAL MINING) %C		86.00%	PERCENT CARBON IN FUEL OIL		
0.000010	SHOVEL OPERATION (hrs/mt ROCK)					
0.000020	LOADER OPERATION (hrs/mt ROCK)	1.000	BTU =	0.0002930 kWhrs		
0.000012	HAUL TRUCK WASTE (hrs/mt ROCK)	3,412.79	BTU =	1.000 kWhrs		
0.000029	HAUL TRUCK ORE (hrs/mt ROCK)					
102.865	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)		4.263	NOMINAL HEAT CONTENT OF COAL - kWhrs Gross/lb		
188.018	TOTAL LOADER FUEL CONSUMPTION (kg/hr)		5.554	NOMINAL HEAT CONTENT N.G. - kWhrs Gross/lb		
703.024	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)		5.538	NOMINAL HEAT CONTENT FUEL OIL - kWhrs Gross/lb		
993.907	TOTAL FUEL FOR ALL ROCK (kg/hr)		21.90%	NET EFFICIENCY FOR POWER GENERATION - COAL		
0.0007	TOTAL FUEL (kg/mt ROCK) - SHOVEL (1)		35.77%	NET EFFICIENCY FOR POWER GENERATION - N.G.		
0.0027	TOTAL FUEL (kg/mt ROCK) - LOADERS (2)		29.89%	NET EFFICIENCY FOR POWER GENERATION - FUEL OIL		
0.0201	TOTAL FUEL (kg/mt ROCK) - TRUCKS (4)					
0.0235	TOTAL FUEL MINING (kg/mt ROCK)			REFERENCES:		
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)			1) SME Mining Engineering Handbook, 2nd Edition, 1992		
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)			2) COMPONENT BLOCK DIAGRAM: FIGURE A-1		
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)			3) EPRI Databook, 1995		
85.00%	DIESEL FUEL, HAUL TRUCK % CARBON			4) Inventory of U.S. Greenhouse Gas Emmissions & Sinks: 1990-1997		
0.71	COAL MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)			5) DOE/EIA-0623, Challenges of Electric Power Industry		
4.10	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt COAL)			Restructuring for Fuel Suppliers, September 1998		
0.101	FUEL REQUIREMENT RAW COAL TRANS. TRUCK 30 mt - (kg/mt)					
5	RAW COAL TRANSPORT DISTANCE, ONE WAY - (km)			PERCENTAGES OF ELECTRIC POWER (USA) BY:		
10.092	FUEL REQUIREMENT COAL TRANS. - (kg/mt)		57.00%	COAL		
500	COAL TRANSPORT DISTANCE, ONE WAY - (km)		10.00%	NATURAL GAS		
10.000	ELEC. POWER REQUIRED FOR N.G. TRANS.- (kWhr/mt)		3.00%	FUEL OIL		
30.000	ELEC. POWER REQUIRED FOR F.O. PIPELINE TRANS.- (kWhr/mt)		14.00%	NUCLEAR*		
			16.00%	OTHER (RENEWABLE, HYDRO, WASTES, ETC.)*		
				*NON-EMISSION GENERATING		

D.O.E. IRONMAKING STUDY -OVERALL SUMMARY MASS BALANCES
ELECTRIC POWER GENERATION - COAL, NATURAL GAS AND FUEL OIL

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (mt/YR)	LIQUID (mt/YR)	TOTAL (mt/YR)	%Fe (DRY)	Fe UNITS (mt/YR)	%C (DRY)	C UNITS (mt/YR)	CO2 (mt/YR)
	COAL:								
	AS-MINED COAL/ROCK	732.31	21.97	754.28			80.00%	585.850	
	WASTE ROCK	219.69	6.59	226.28			80.00%	175.755	
	RAW COAL TO PREP PLANT	512.62	15.38	528.00			80.00%	410.095	
	DIESEL FUEL (MINING ETC.)		0.01				85.00%	0.010	
	EXHAUST GASES								0.038
	MINE ELECTRICAL POWER REQ'D	(kWhr/yr) 521.90							
	AS-MINED RAW TRANS. TO PREP PLANT		0.05				85.00%	0.045	
	EXHAUST GASES								0.164
	NET PREPPED COAL TO USE	486.99	14.61	501.60			80.00%	389.590	
	REJECT TAILINGS TO DISPOSAL	25.63	0.77	26.40			80.00%	20.505	
	PREP. P ELECTRICAL POWER REQ'D	(kWhr/yr) 2,099.26							
	NET PREPPED COAL TO USE	486.99	14.61	501.60			80.00%	389.590	
	DIESEL FUEL - COAL TRANSPORT		2.43				85.00%	2.070	
	EXHAUST GASES - COAL TRANS.								7.589
	COAL:	**(kWhr/yr)**							
	EQUIV. ELEC. POWER PRODUCED	**1,002,621.16**							
	GROSS:	**(kWhr/yr)**							
	TOTAL ELECTRICAL POWER REQ'D	**2,621.16**							
	COAL REQUIRED mt	**5.40**					**80.00%**	**4.317**	**15.830**
	NET:	**(kWhr/yr)**							**mt CO2/kWhr**
	NET ELEC. POWER FOR COAL:	**1,000,000.00**							**0.001448**
	TOTAL MT COAL/1.0 MM kWhr NET	**485.71**						**388.571**	
	TOTAL CO2 FOR 1.000 MM KWHR							**395.013**	**1,448.382**

D.O.E. IRONMAKING STUDY -OVERALL SUMMARY MASS BALANCES
ELECTRIC POWER GENERATION - COAL, NATURAL GAS AND FUEL OIL

STREAM NUMBER	STREAM LABLE	GAS (mt/YR)			%Fe (DRY)	Fe UNITS (mt/YR)	%C (DRY)	C UNITS (mt/YR)	CO2 (mt/YR)
	NATURAL GAS:								
	ELEC. POWER FOR N.G. TRANS.	2,282.86							
	AMOUNT OF N.G. REQ'D (W/O TRANS)	228.29					72.00%	164.366	
	EQUIV. NAT. GAS FOR TRANS.	0.52					72.00%	0.375	
	NET N.G. REQUIRED (W TRANS.)	228.81						164.741	
	POWER PLANT FLUE GAS							164.741	604.050
	GROSS POWER GENERATED:	(kWhr/yr) 1,002,282.86							
	NET POWER GENERATED:	1,000,000.00							mt CO2/kWhr 0.000604
	FUEL OIL:								
	ELEC. POWER FOR F.O. TRANS.	(kWhr/yr) 8,218.29							
	AMOUNT OF F.O. REQ'D (W/O TRANS)	273.94					86.00%	235.591	
	EQUIV. FUEL OIL FOR TRANS.	2.25					86.00%	1.936	
	NET F.O. REQUIRED (W TRANS.)	276.19						237.527	
	POWER PLANT FLUE GAS							237.527	870.932
	GROSS POWER GENERATED:	(kWhr/yr) 1,008,218.29							
	NET POWER GENERATED:	1,000,000.00							mt CO2/kWhr 0.000871
	U.S.A. DISTRIBUTION:		mt CO2/kWhr	mt CO2/kWhr					
	COAL	57.00%	0.001448						
	NATURAL GAS	10.00%	0.000604						
	FUEL OIL	3.00%	0.000871						
	OTHER NON-CO2 EMISSION	30.00%	0.000000						
	WEIGHTED U.S.A.:			0.000912					

APPENDIX B-2

LUMP IRON ORE

D.O.E. IRONMAKING STUDY -OVERALL SUMMARY MASS BALANCES
OVERALL SUMMARY MASS BALANCES - LUMP IRON ORE

BASIS:

1.000	MM MT/YEAR LUMP ORE DELIVERED

SUMMARY:

3.163	MM MT/YEAR AS-MINED ROCK		
1.913	MM MT/YEAR WASTE ROCK		
1.250	MM MT/YEAR ORE ROCK TO PREP PLANT	60.47%	PERCENT MINE WASTE ROCK
1.000	MM MT/YEAR CRUSHED LUMP ORE	20.00%	PERCENT FINE ORE REJECTED - WT.% FEED
0.250	MM MT/YEAR FINE ORE REJECTS		

ASSUMPTIONS: (Ref. 1)

85.00%	DIESEL FUEL (ORE MINING) %C
0.006350	SHOVEL OPERATION (hrs/mt ORE)
0.012701	LOADER OPERATION (hrs/mt ORE)
0.015360	HAUL TRUCK WASTE (hrs/mt ORE)
0.010041	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.817	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
2.985	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
22.322	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
26.124	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
6.53	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
9.26	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.028	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
3000	ASSUMED LUMP ORE SHIPPING DISTANCE (km)
0.00449	FUEL REQUIREMENT - SHIPPING (kg/mt/km)
13.46	FUEL REQUIREMENT SHIPPING (kg/mt LUMP ORE)

REFERENCES:

1) SME Mining Engineering Handbook, 2nd Edition, 1992
2) BASE PROCESS BLOCK DIAGRAM: Figure A-4
3) BASE PROCESS (DRI/EAF) MASS BALANCE S.S. (APPENDIX C-1)

D.O.E. IRONMAKING STUDY -OVERALL SUMMARY MASS BALANCES
OVERALL SUMMARY MASS BALANCES - LUMP IRON ORE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK (3)	3.163	0.095	3.258	35.00%	1.107	0.00%	0.000	
1002	WASTE ROCK (3)	1.913	0.057	1.970	14.94%	0.294	0.00%	0.000	
1	IRON ORE TO PREP PLANT	1.250	0.038	2.564	65.00%	0.813	0.00%	0.000	
	DIESEL FUEL REQ'D		0.0327				85.00%	0.028	
	EXHAUST GASES								0.1018
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 20.666							
	CRUSHED LUMP ORE TO SHIPPING	1.000	0.030	1.030	65.00%	0.650	0.00%	0.000	
	FINE ORE TO DISPOSAL	0.250	0.008	0.258	65.00%	0.163	0.00%	0.000	
	PREP. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 11.573							
	SHIPPING FUEL REQ'D		0.0135				85.00%	0.011	
	EXHAUST GASES, SHIPPING								0.0419
	PROCESS ELECTRIC POWER REQ'D	**(MM kWhr/yr) 32.24**							
	TOTAL CO2 PRODUCED							**0.0392**	**0.1437**

APPENDIX B-3

PELLETIZING BINDER - BENTONITE

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
PELLETIZING BINDER BALANCES

BASIS:

1.000	MM MT/YEAR PELLETIZING BINDER (BENTONITE)

SUMMARY:

2.1053	MM MT/YEAR AS-MINED BENTONITE RESOURCE
1.0527	MM MT/YEAR MINE WASTE ROCK
1.0527	MM MT/YEAR BENTONITE ROCK TO PREP. PLANT
1.0000	MM MT/YEAR NET BENTONITE TO SHIPPING

50.00%	PERCENT WASTE ROCK(1)
5.00%	PERCENT OF LOSSES IN PREP. PLANT(1)

ASSUMPTIONS: (1)

85.00%	DIESEL FUEL (ROCK MINING) %C
0.003553	SHOVEL OPERATION (hrs/mt ROCK)
0.007106	LOADER OPERATION (hrs/mt ROCK)
0.007106	HAUL TRUCK WASTE (hrs/mt ROCK)
0.007106	HAUL TRUCK ORE (hrs/mt ROCK)
102.865	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
188.018	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
703.024	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
993.907	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.183	TOTAL FUEL (kg/mt ROCK) - SHOVEL (1)
0.668	TOTAL FUEL (kg/mt ROCK) - LOADERS (2)
4.996	TOTAL FUEL (kg/mt ROCK) - TRUCKS (4)
5.846	TOTAL FUEL MINING (kg/mt ROCK)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
2.50	BENTONITE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
14.18	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.101	FUEL REQUIREMENT RAW ROCK TRANS. TRUCK 30 mt - (kg/mt)
5	RAW ROCK TRANSPORT DISTANCE, ONE WAY - (km)
10.092	FUEL REQUIREMENT BENTONITE TRANS. TRUCK 30 mt - (kg/mt)
500	BENTONITE TRANSPORT DISTANCE, ONE WAY - (km)

REFERENCES:
1) SME Mining Engineering Handbook, 2nd Edition, 1992
2) COMPONENT BLOCK DIAGRAM: FIGURE A-3

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
PELLETIZING BINDER BALANCES

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	AS-MINED CLAY/ROCK	2.105	0.063	2.168			0.00%	0.000	
	WASTE ROCK	1.053	0.032	1.084			0.00%	0.000	
	BENTONITE ROCK TO PREP PLANT	1.053	0.032	1.084			0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0062				85.00%	0.005	
	EXHAUST GASES								0.0192
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 5.262							
	AS-MINED ROCK TRANS. TO PREP PLANT		0.0005				85.00%	0.00045	
	EXHAUST GASES								0.0017
	NET PREPPED BENTONITE TO PELLET PLA	1.000	0.030	1.030			0.00%	0.000	
	REJECT TAILINGS TO DISPOSAL	0.053	0.002	0.054			0.00%	0.000	
	PREP. P ELECTRICAL POWER REQ'D	(MM kWhr/yr) 14.928							
	NET PREPPED BENTONITE TO PELLET PLA	1.000	0.030	1.030			0.00%	0.000	
	DIESEL FUEL - BENTONITE TRANS.		0.0050				85.00%	0.00425	
	EXHAUST GASES - BENTONITE TRANS.								0.0156
	TOTAL ELECTRICAL POWER	**(MM kWhr/yr) 20.19**							
	TOTAL CO2 PRODUCED							**0.0099**	**0.0364**

APPENDIX B-4

COAL

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
COAL ONLY - DELIVERED TO USE

BASIS:

1.000	MM MT/YR COAL DELIVERED

SUMMARY:

1.5038	MM MT/YEAR AS-MINED COAL RESOURCE
0.4511	MM MT/YEAR MINE WASTE ROCK
1.0527	MM MT/YEAR COAL TO PREP. PLANT
1.0000	MM MT/YEAR NET COAL TO SHIPPING

ASSUMPTIONS: (Ref. 1)

85.00%	DIESEL FUEL (COAL MINING) %C
0.004974	SHOVEL OPERATION (hrs/mt ROCK)
0.009948	LOADER OPERATION (hrs/mt ROCK)
0.005969	HAUL TRUCK WASTE (hrs/mt ROCK)
0.013927	HAUL TRUCK ORE (hrs/mt ROCK)
102.865	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
188.018	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
703.024	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
993.907	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.358	TOTAL FUEL (kg/mt ROCK) - SHOVEL (1)
1.309	TOTAL FUEL (kg/mt ROCK) - LOADERS (2)
9.791	TOTAL FUEL (kg/mt ROCK) - TRUCKS (4)
11.459	TOTAL FUEL MINING (kg/mt ROCK)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
0.29	COAL MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
1.62	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt COAL)
0.101	FUEL REQUIREMENT RAW COAL TRANS. TRUCK 30 mt - (kg/mt)
5	RAW COAL TRANSPORT DISTANCE, ONE WAY - (km)
6.728	FUEL REQUIREMENT COAL TRANS. - (kg/mt)
500	COAL TRANSPORT DISTANCE, ONE WAY - (km)

30.00%	AMOUNT OF WASTE ROCK MINED (1)
5.00%	AMOUNT OF WASTE IN COAL CLEANING/PREP (1)

REFERENCES:

1) SME Mining Engineering Handbook, 2nd Edition, 1992
2) COMPONENT BLOCK DIAGRAM: FIGURE A-4

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
COAL ONLY - DELIVERED TO USE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	AS-MINED COAL/ROCK	1.504	0.045	1.549			0.00%	0.000	
	WASTE ROCK	0.451	0.014	0.465			0.00%	0.000	
	RAW COAL TO PREP PLANT	1.053	0.032	1.084			0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0121				85.00%	0.010	
	EXHAUST GASES								0.0376
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 0.430							
	AS-MINED RAW TRANS. TO PREP PLANT		0.0000				85.00%	0.00004	
	EXHAUST GASES								0.0001
	NET PREPPED COAL TO USE	1.000	0.030	1.030			0.00%	0.000	
	REJECT TAILINGS TO DISPOSAL	0.053	0.002	0.054			0.00%	0.000	
	PREP. P ELECTRICAL POWER REQ'D	(MM kWhr/yr) 1.708							
	NET PREPPED COAL TO USE	1.000	0.030	1.030			0.00%	0.000	
	DIESEL FUEL - COAL TRANS.		0.0050				85.00%	0.00425	
	EXHAUST GASES - COAL TRANS.								0.0156
	TOTAL ELEC. POWER FOR COAL:	**(MM kWhr/yr) 2.1379**							
	TOTAL CO2 FOR 1.000 MM mt/YR							**0.0145**	**0.0533**

APPENDIX B-5

BURNT LIME/DOLOMITE

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
BURNT LIME/DOLOMITE BALANCES

BASIS:

1.000	MM MT/YEAR BURNT LIME/DOLOMITE

SUMMARY:

2.780	MM MT/YEAR AS-MINED LIMESTONE/MGO ROCK
0.927	MM MT/YEAR MINE WASTE ROCK
1.853	MM MT/YEAR LIME ROCK TO PREP. PLANT
1.761	MM MT/YEAR NET LIMESTONE TO CALCINATION
1.000	MMM MT/YEAR TARGET CALCINED LIME

36.00%	PERCENT CARBONATE IN LIME ROCK
33.33%	PERCENT WASTE ROCK
5.00%	PERCENT OF LOSSES IN PREP. PLANT
43.20%	PERCENT CO2 IN CLEANED LIME ROCK

ASSUMPTIONS: (Ref. 1)

85.00%	DIESEL FUEL (ROCK MINING) %C
0.002691	SHOVEL OPERATION (hrs/mt ROCK)
0.005381	LOADER OPERATION (hrs/mt ROCK)
0.003587	HAUL TRUCK WASTE (hrs/mt ROCK)
0.007175	HAUL TRUCK ORE (hrs/mt ROCK)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.231	TOTAL FUEL (kg/mt LIME ROCK) - SHOVEL (1)
0.843	TOTAL FUEL (kg/mt LIME ROCK) - LOADERS (2)
6.305	TOTAL FUEL (kg/mt LIME ROCK) - TRUCKS (4)
7.379	TOTAL FUEL (kg/mt LIME ROCK)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
3.35	LIMESTONE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
19.03	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.126	FUEL REQUIREMENT LS TRANS. TRUCK 30 mt - (kg/mt)
5	LIMESTONE TRANSPORT DISTANCE, ONE WAY - (km)
6.308	FUEL REQUIREMENT LIME TRANS. TRUCK 30 mt - (kg/mt)
250	LIME TRANSPORT DISTANCE, ONE WAY - (km)
6.18	FUEL REQUIREMENT - CALCINING (GJ/mt CALCINE)
124.05	FUEL REQUIREMENT - CALCINING (kg N.G./mt CALCINE)
26.5	CALCINING PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

REFERENCES:
1) SME Mining Engineering Handbook, 2nd Edition, 1992
2) COMPONENT BLOCK DIAGRAM: FIGURE A-5

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
BURNT LIME/DOLOMITE BALANCES

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	AS-MINED LIME ROCK	2.780	0.083	2.863			9.82%	0.273	
	WASTE ROCK	0.927	0.028	0.954			5.89%	0.055	
	LIME ROCK TO PREP PLANT	1.853	0.056	1.909			11.78%	0.218	
	DIESEL FUEL (MINING ETC.)		0.0137				85.00%	0.012	
	EXHAUST GASES								0.0426
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 9.323							
	NET PREPPED LIME ROCK TO CALC.	1.761	0.053	1.813			11.78%	0.207	
	REJECT TAILINGS TO DISPOSAL	0.093	0.003	0.095			11.78%	0.011	
	PREP. P ELECTRICAL POWER REQ'D	(MM kWhr/yr) 35.274							
	NET PREPPED LIME ROCK TO CALC.	1.761	0.053	1.813			11.78%	0.207	
	DIESEL FUEL - LIME ROCK TRANS.		0.0002				85.00%	0.00019	
	EXHAUST GASES - LIME ROCK TRANS.								0.0007
	BURNT LIME/DOLOMITE	1.000	0.000	1.000			0.00%	0.000	
	FUEL (DRYING, CALCINATION, ETC.)		AS N.G. 0.2184				72.00%	0.157	
	CALCINATION FLUE GASES								1.3372
	CALC, ELECTRICAL POWER REQ'D	(MM kWhr/yr) 46.587							
	NET LIME/MgO SHIPPED	1.000	0.000	1.000					
	LIME TRANSPORT FUEL		0.0063				85.00%	0.005	
	EXHAUST GASES FOR LIME TRANS.								0.0197
	TOTAL ELECTRICAL POWER	**(MM kWhr/yr) 91.19**							
	TOTAL CO2 PRODUCED							**0.3819**	**1.4002**

APPENDIX B-6

OXYGEN GAS

DOEOXY
08-June-2000
Rev. 2

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
BULK (CRYOGENIC) OXYGEN GAS PRODUCTION

BASIS:

1.000	MM Nm3/YEAR OXYGEN GAS (99%)

SUMMARY:

4.807	MM Nm3 AIR INLET
1.00947	MM Nm3 OXYGEN INLET
0.020	MM Nm3 OXYGEN LOSSES
0.990	MM Nm3/YEAR OXYGEN GAS (99%)
1.000	MM Nm3/YEAR OXYGEN GAS (99%)

ASSUMPTIONS:

21.00%	MOLE % OXYGEN IN AIR
23.30%	WT. % OXYGEN IN AIR
98.00%	PERCENT OXYGEN RECOVERED
99.00%	VOLUME PERCENT OXYGEN IN GAS
60.0	ELECTRICAL REQUIREMENT - kWhr/1000 SFT3(Ref. 1)
2,118.64	ELECTRICAL REQUIREMENT - kWhr/1000 Nm3

REFERENCES:
1) Perry's Chemical Engineering Handbook, 7th Edition, 1997
2) COMPONENT BLOCK DIAGRAM: FIGURE A-2

	(MM kWhr/Nm3)
PROCESS ELECTRIC POWER REQ'D	2.12

APPENDIX B-7

CARBON ELECTRODE

DOEELCTR
08-June-2000
Rev. 2

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
CARBON GRAPHITE ELECTRODES

BASIS:

1.000	MM MT/YR ELECTRODES DELIVERED

SUMMARY:

1.1500	MM MT/YEAR PETROLEUM COKE FEED
0.1500	MM MT/YEAR PITCH BINDER FEED
1.0000	MM MT/YEAR ELECTRODE PRODUCT

ASSUMPTIONS: (Ref. 1)

5.000	FUEL REQUIREMENT ELECTRODE TRANS. - (kg/mt)
500	TRANSPORT DISTANCE, ONE WAY - (km)
9,000.00	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ELECTRODES)
0.050	PREP PLANT AUXILIARY N.G. FUEL - T/T ELECTRODES
1.150	AMOUNT OF PET. COKE FEED - (T/T OF ELECTRODE)
0.150	PITCH BINDER (C5H8) - (T/T ELECTRODE)

REFERENCES:
1) The Making, Shaping and Treating of Steel, 10th Edition, 1985
2) COMPONENT BLOCK DIAGRAM: - FIGURE A-2

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
CARBON GRAPHITE ELECTRODES

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	PETROLEUM COKE FEED	1.150	0.000	1.150			94.00%	1.081	
	PITCH FEED	0.150	0.000	0.150			88.20%	0.132	
	TOTAL FEED TO ELECTRODES	1.300	0.000	1.300			93.33%	1.213	
	ELECTRODES PRODUCED	1.000	0.000	1.000			96.00%	0.960	
	WASTE GASES PROCESS							0.2533	0.9287
	SUPPLEMENTAL FUEL		(AS GAS) 0.05				72.00%	0.0360	0.1320
	TOTAL FLUE GASES							0.2893	1.0607
	ELECTRICAL POWER REQ'D	(MM kWhr/yr) 9,000.00							
	TRANS. OF ELECTRODES		0.0050				85.00%	0.00425	
	EXHAUST GASES								0.0156
	TOTAL ELEC. POWER FOR ELECTRODES:	**(MM kWhr/yr) 9000.0000**							
	TOTAL CO2 FOR 1.000 MM mt/YR							**0.2935**	**1.0763**

APPENDIX B-8

CO-PRODUCT COKE

DOECPCOK
08-June-2000
Rev. 2

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
COPRODUCT COKE PRODUCTION

BASIS:

1.000	MM MT/YR COPRODUCT COKE DELIVERED (TARGET)
1.000	MM MT/YR COPRODUCT COKE DELIVERED (CALCULATED)

SUMMARY:

1.5873	MM MT/YEAR BITUMINOUS COAL FEED
1.1111	MM MT/YEAR TOTAL COKE PRODUCT
0.111	MM MT/YEAR FINE COKE BREEZE
1.000	MM MT/YEAR SIZED COKE PRODUCT TO USE

ASSUMPTIONS: (Ref. 1)

5.000	FUEL REQUIREMENT COKE TRANS. - (kg/mt)
500	TRANSPORT DISTANCE, ONE WAY - (km)
24.50	COKE PLANT ELECTRICAL POWER REQ'D (kWhr/mt COKE)

10.00% PERCENT OF COKE PRODUCED REJECTED AS FINE BREEZE (2)

REFERENCES:

1) The Making, Shaping and Treating of Steel, 10th Edition, 1985
2) COMPONENT BLOCK DIAGRAM: - FIGURE A-5

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
COPRODUCT COKE PRODUCTION

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	COAL FEED	1.587	0.000	1.587			80.00%	1.270	
	CUMULATIVE CO2 + ELEC. IN COAL	(MM kWhr/yr) 3.3935						0.0533	0.0846
	COKE PRODUCT GROSS	1.111	0.000	1.111			94.00%	1.044	
	COKE BREEZE (FINES)	0.111	0.000	0.111			94.00%	0.104	
	COKE PRODUCED (NET TO SHIPMENT)	1.000	0.000	1.000			94.00%	0.940	
	WASTE GASES PROCESS (FROM CARBON)							0.209	0.7659
	COKE OVEN GAS							0.035	0.1297
	TOTAL FLUE GASES							0.244	0.8956
	ELECTRICAL POWER REQ'D	(MM kWhr/yr) 27.22							
	TRANS. OF COKE		0.0056				85.00%	0.00472	
	EXHAUST GASES								0.0173
	TOTAL ELEC. POWER FOR COKE:	**(MM kWhr/yr) 30.6157**							
	TOTAL CO2 FOR 1.000 MM mt/YR							**0.2720**	**0.9975**

APPENDIX B-9

NON-RECOVERY COKE PROCESS WITH CO-GENERATION

DOENRCOK
08-June-2000
Rev. 2

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
NON-RECOVERY COKE PRODUCTION WITH CO-GENERATION OF ELECTRICAL POWER

BASIS:

1.000	MM MT/YR NON-RECOVERY COKE DELIVERED (TARGET)
1.000	MM MT/YR NON-RECOVERY COKE DELIVERED (CALCULATED)

SUMMARY:

4.2045	MM MT/YEAR FINE COAL SLURRY RECLAIMED FROM WASTE POND
0.0334	MM MT/YEAR COARSE REJECT SLURRY
4.1711	NET FEED TO COAL CLEANING/CONCENTRATION
1.2551	CLEANED COAL TO DRYER
0.9413	MM MT/YEAR BITUMINOUS COAL FEED TO CHARRING (DRY BASIS)
0.8256	MM MT/YEAR NET CHAR PRODUCT
1.1541	MM MT/YEAR TOTAL COKE PRODUCT
0.1541	MM MT/YEAR FINE COKE BREEZE
1.0000	MM MT/YEAR SIZED COKE PRODUCT TO USE

ASSUMPTIONS: (Ref. 1)

5.000	FUEL REQUIREMENT COKE TRANS. - (kg/mt)
500	TRANSPORT DISTANCE, ONE WAY - (km)
14.00	COKE PLANT ELECTRICAL POWER REQ'D (kWhr/mt COKE)
0.80%	PERCENT REJECT IN RECLAIM OF COAL FINES
76.14%	PERCENT COAL RECOVERY IN CLEANING PLANT
25.00%	PERCENT MOISTURE IN FEED TO DRYER
6.00%	PERCENT MOISTURE IN FEED TO CHAR REACTORS
87.71%	PERCENT YIELD OF COAL INTO CHAR
86.80%	PERCENT YIELD OF GREEN COKE FEED INTO COKE (DRY BASIS)
96.02%	NET PERCENT CARBON YIELD INTO COKE PRODUCT
5.50	ELECTRIC POWER CONSUMMED IN RECLAIM (kWhr/MT FEED)
7.50	ELECTRIC POWER CONSUMMED IN CLEANING (kWhr/MT COAL FD.)
11.00	ELECTRIC POWER CONSUMMED IN CHARRING (kWhr/MT CHAR)
12.00	ELECTRIC POWER CONSUMMED IN BRIQUET. (kWhr/MT BRIQ. FD.)
3.2306	CHAR OFF-GAS HEAT CONTENT (MM BTU/MT CHAR)
45.00%	CO-GENERATION EFFICIENCY (CHAR GAS)
425.67	(kWhr/MT CHAR) ELECTRIC POWER GENERATED
3.9124	COKE OFF-GAS HEAT CONTENT (MM BTU/MT COKE)
45.00%	CO-GENERATION EFFICIENCY (COKE GAS)
515.50	(kWhr/MT COKE) ELECTRIC POWER GENERATED

ASSUMPTIONS:

1.00%	PERCENT VOLATILES IN COKE (C5H8)
94.53%	PERCENT CARBON IN COKE
37.00%	PERCENT CARBON IN PITCH
63.00%	PERCENT VOLATILES OTHER IN PITCH
88.24%	PERCENT CARBON IN VOLATILES (C5H8 RATIO)
6.30%	PERCENT VOLATILES IN CHAR OFF GAS
89.30%	PERCENT FIXED CARBON IN CHAR
3.59%	PERCENT ASH IN CLEANED COAL FINES
17.85%	PERCENT VOLATILES IN CLEANED COAL FINES
78.56%	PERCENT FIXED CARBON IN CLEANED COAL FINES
9.70%	PERCENT ASH IN COAL FINES (IN POND)
16.72%	PERCENT VOLATILES IN COAL FINES (IN POND)
73.58%	PERCENT FIXED CARBON IN COAL FINES (IN POND)
11.11%	PERCENT RECYCLE COKE BREEZE IN COKE FEED
17.80%	PERCENT RAW COAL FINES TO COKE FEED
59.54%	PERCENT CHAR IN COKE FEED
11.55%	PERCENT PITCH BINDER IN COKE FEED
9.00%	PERCENT OF COKE PRODUCED REJECTED AS FINE BREEZE (2)

REFERENCES:

1) LGE Confidential Client, Non-Recovery Coke Process Heat and Material Balances, 1998
2) COMPONENT BLOCK DIAGRAM: - FIGURE A-7

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
NON-RECOVERY COKE PRODUCTION WITH CO-GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	VOLATILES % (DRY)	VOLATILES (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	CHAR PRODUCT								
	FINE COAL SLURRY RECLAIMED	1.261	2.943	4.204	16.72%	0.211	73.58%	0.928	
	COARSE REJECTS TO POND	0.025	0.008	0.033	7.93%	0.002	22.07%	0.006	
	ELECTRIC POWER IN COAL RECLAIM	(MM kWhr/yr) 6.937							
	FINE COAL TO CLEANING	1.236	2.935	4.171	16.90%	0.209	74.62%	0.923	
	COAL REJECTS FROM CLEANING	0.295	2.621	2.916	13.86%	0.041	62.06%	0.183	
	ELECTRICAL POWER IN CLEANING	(MM kWhr/yr) 9.272							
	CLEANED COAL TO DRYER	0.941	0.314	1.255	17.85%	0.168	78.56%	0.740	
	DRIED COAL TO CHARRING FURNACE	0.941	0.060	1.001	17.85%	0.168	78.56%	0.740	
	CHAR PRODUCT TO BRIQUETTING	0.826	0.000	0.826	6.30%	0.052	89.30%	0.737	
	CHAR SYSTEMS TOTAL OFF-GASES							0.105	0.383
	ELECTRICAL POWER IN CHARRING	(MM kWhr/yr) 10.355							
	TOTAL ELEC. THROUGH CHARRING	(MM kWhr/yr) 26.564							
	CO-GENERATED ELECTRIC POWER	351.444							
	NET ELECTRICAL POWER GENERATED	324.880							

D.O.E. IRONMAKING STUDY - OVERALL SUMMARY MASS BALANCES
NON-RECOVERY COKE PRODUCTION WITH CO-GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	VOLATILES % (DRY)	VOLATILES (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	BRIQUTTING OPERATION								
	CHAR FEED TO BRIQUETTING	0.826	0.000	0.826	6.30%	0.052	89.30%	0.737	
	COAL FEED TO BRIQUETTING	0.247	0.000	0.247	17.85%	0.044	78.56%	0.194	
	RECYCLE BREEZE FEED TO BRIQUET.	0.154	0.000	0.154	1.00%	0.002	94.53%	0.146	
	PITCH FEED TO BRIQUETTING	0.160	0.000	0.160	63.00%	0.101	37.00%	0.059	
	TOTAL FEED TO BRIQUETTING	1.387	0.000	1.387	14.32%	0.199	81.93%	1.136	
	ELECTRIC POWER IN BRIQUETTING	(MM kWhr/yr) 16.641							
	COKE PRODUCT GROSS	1.154	0.000	1.154	1.00%	0.012	94.53%	1.091	
	COKE BREEZE (FINES)	0.154	0.000	0.154	1.00%	0.002	94.53%	0.000	
	COKE PRODUCED (NET TO SHIPMENT)	1.000	0.000	1.000	1.00%	0.010	94.53%	1.091	
	WASTE GASES, COKING (FROM CARBON)							0.210	0.7707
	COKING ELECTRICAL POWER REQ'D	(MM kWhr/yr) 16.152							
	COKE ELECT. POWER CO-GENERATED	(MM kWhr/yr) 515.493							
	TOTAL ELECT. POWER REQUIRED COKE	(MM kWhr/yr) 32.793							
	NET ELECT. POWER PRODUCED COKE	482.700							
	TRANS. OF COKE		0.0058				85.00%	0.00490	
	EXHAUST GASES DURING TRANSPORT								0.0180
	CUM ELEC. POWER FOR N.R. COKE:	**(MM kWhr/yr) 59.358**							
	CUM NET ELEC. POWER CO-GENERATED	**(MM kWhr/yr) 866.937**							
	TOTAL CO2 FOR 1.000 MM mt/YR FOR NON-RECOVERY PROCESS COKE							**0.3197**	**1.1721**

APPENDIX B-10

RAW MATERIAL ASSUMPTIONS

COMPONENT ASSUMPTIONS FOR BALANCES

COMPONENT (BASIS: 1.0 MM mt/yr)	%Fe	%C	%CO2	CUM. CO2 (MT/mt)	%OTHER	BTU/lb	CUM. POWER COMSUMP. (kWhr/mt)	EQUIV.* CUM. CO2 (MT/mt)
AS-MINED-ROCK	30.00%				70.00%			
RUN-OF-MINE ORE TO CONC.	50.00%			0.0409	50.00%		12.66	0.0115
LUMP IRON ORE	65.00%			0.1437	35.00%		32.24	0.0294
WASTE ROCK	16.93%				83.07%			
IRON ORE CONCENTRATE (TO PL)	68.56%			0.0695	31.44%		69.23	0.0631
IRON ORE CONC. (AFTER PL)	68.56%			0.0695	31.44%		152.57	0.1392
IRON ORE PELLETS (AT PP)	67.81%			0.1779	32.19%		225.00	0.2052
DIESEL FUEL		85.00%			15.00%	19,000		
NATURAL GAS FUEL		72.00%			28.00%	18,955		
FUEL OIL		86.00%			14.00%	18,900		
OXYGEN GAS (99%)					100.00%		(kWhr/Nm3) 2.12	(T/Nm3) 0.0019
COAL (COKING)		80.00%		0.0533	20.00%	14,550	2.14	0.0020
CO-PRODUCT COKE (FROM COAL)		94.00%		0.9975	6.00%	15,970	30.62	0.0279
COAL FINES (RECLAIMED/CLEANED)		78.56%			21.44%	14,288	17.23	0.0157
NON-RECOVERY COKE (COAL FINES)		94.53%		1.1721	5.47%	16,060	59.36 (866.94)	0.0541 -0.7907
CHINA COKE (FROM COAL)		85.70%		1.0000	14.30%	14,560	15.64	0.0143
PETROLEUM COKE (BY-PRODUCT)		94.00%		0.0156	6.00%	15,970	16.94	0.0156
CHARCOAL REDUCTANT		80.00%		1.0000	20.00%			0.0133
CARBON-GRAPHITE ELECTRODES		96.00%		1.0763	4.00%	16,500	9,000.00	8.2090

COMPONENT ASSUMPTIONS FOR BALANCES

COMPONENT (BASIS: 1.0 MM mt/yr)	%Fe	%C	%CO2	CUM. CO2 (T/t)	%OTHER	BTU/lb	CUM. POWER COMSUMP. (kW/t)	EQUIV.* CUM. CO2 (T/t)
BINDER (BENTONITE)	11.60%			0.0364	88.40%		20.19	0.0184
LIME/DOLOMITE FOR PELLET	1.61%			1.4002	98.39%		91.69	0.0836
RECYCLE EAF DUST	47.50%				52.50%			
RECYCLE DRI DUST	87.47%				12.53%			
BURNT LIME CaO (METALLURGICAL)	1.61%			1.4002	98.39%		91.69	0.0836
SiO2					100.00%			
IRON ORE PELLETS (GREEN)	68.76%				31.24%			
INDURATED IRON ORE PELLETS	67.81%			0.2051	32.19%		197.37	0.2384
DRI (HIGH C)	90.48%	2.50%			7.02%		496.94	0.3002
DRI (LOW C)	92.80%	1.00%		0.8797	6.20%		499.69	0.3018
LIQUID STEEL (100% DRI CHG)	99.70%	0.10%		0.9731	0.20%		1,326.90	83.8919
LIQUID STEEL (30% DRI CHG)	99.70%	0.10%		0.9731	0.20%		1,030.37 (MM kwhr/mt)	65.3303
CO-GEN. E.P. FROM N.R. COKE	% DISTR.						866.937 (1 MM kwhr/yr)	
ELECTRICAL POWER (COAL)	57.00%			0.001448			1.00 (1 MM kwhr/yr)	
ELECTRICAL POWER (N.G.)	10.00%			0.000604			1.00 (1 MM kwhr/yr)	
ELECTRIC POWER (FUEL OIL)	3.00%			0.000871			1.00 (1 MM kwhr/yr)	
ELECTRIC POWER (OTHER)	30.00%			0.000000			1.00 (1 MM kwhr/yr)	
ELECTRICAL POWER (NET)				0.000912			1.00	

D.O.E. Ironmaking Study, Revision 2 (June 2000)

APPENDIX C

PROCESS SUMMARY SPREADSHEETS

SHAFT FURNACE DRI – VARIATION IN CARBON AND SCRAP CHARGE

C-1: BASE CASE: 100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT. % DRI CARBON

C-2: 100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% DRI CARBON

C-3: 100% STEEL SCRAP CHARGE TO EAF

C-4: 30% SHAFT FURNACE DRI/70% SCRAP CHARGE TO EAF, 1.0 WT.% DRI CARBON

C-5: 30% SHAFT FURNACE DRI/70% SCRAP CHARGE TO EAF, 2.5 WT.% DRI CARBON

C-6 HYLSA SHAFT FURNACE WITHOUT REFORMER (HYL IV), HOT DRI CHARGE TO EAF

HOT METAL VARIATIONS

C-7: 30% BLAST FURNACE HOT METAL/70% SCRAP CHARGE TO EAF, CO-PRODUCT COKE

C-8: 30% BLAST FURNACE HOT METAL/70% SCRAP CHARGE TO EAF, N. R. COKE WITH POWER GENERATION

C-9: 30% COLD PIG IRON/70% SCRAP CHARGE TO EAF, 4.5% CARBON PIG

C-10: 30% TECHNORED HOT METAL/70% SCRAP CHARGE TO EAF, 4.5% CARBON H. M. WITH CO-GENERATION OF ELECTRICAL POWER

C-11: 30% TECHNORED HOT METAL/70% SCRAP CHARGE TO EAF, 4.5% CARBON H. M. WITHOUT CO-GENERATION OF ELECTRICAL POWER

C-12: COREX/MIDREX WITH 60% HOT METAL AND 40% DRI CHARGE TO EAF

C-13: HISMELT WITH 34.5% HOT METAL CHARGE TO EAF

ROTARY HEARTH FURNACES

C-14: REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF

C-15: MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

C-16: ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

FLUID-BED DRI/HBI

C-17: CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

C-18: CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

C-19: FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

C-20: GENERIC IRON CARBIDE/EAF RECYCLE SCRAP TO EAF (REPRESENTS NUCOR/ICH, QUALITECH/KAWASAKI, PROCEDYNE PROCESSES)

OTHER PROCESSES

C-21 SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF

SHAFT FURNACE DRI PROCESSES

APPENDIX C-1

BASE CASE: 100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT. % DRI CARBON

OVERALL SUMMARY MASS BALANCES - BASE PROCESS DRI/EAF

100% DRI CHARGE - 1.0 wt.% CARBON

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

6.294	MM MT/YEAR AS-MINED ROCK
3.806	MM MT/YEAR WASTE ROCK
2.488	MM MT/YEAR ORE ROCK TO CONCENTRATOR
1.465	MM MT/YEAR CONCENTRATE
1.940	MM MT/YEAR NET GREENBALL PELLETS
1.836	MM MT/YEAR NET INDURATED PELLETS
1.781	MM MT/YEAR PELLET FEED TO DRI
1.089	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

85.00%	DIESEL FUEL (ORE MINING) %C
0.003192	SHOVEL OPERATION (hrs/mt ORE)
0.006384	LOADER OPERATION (hrs/mt ORE)
0.007721	HAUL TRUCK WASTE (hrs/mt ORE)
0.005046	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.410	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
1.500	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
11.220	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
13.131	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
5.00	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
28.12	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
250	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
1.30	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

11.70	FUEL TO DRI - (GJ/mt DRI)
7.15	FUEL TO DRI - (GJ/mt FEED OXIDE)
234.75	FUEL TO DRI - (kg/mt DRI)
143.51	FUEL TO DRI - (kg/mt FEED OXIDE)
130.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
698.1	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.19	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - BASE PROCESS DRI/EAF

100% DRI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	6.294	0.195	6.488	30.00%	1.888	0.00%	0.000	
1002	WASTE ROCK	3.806	0.118	3.924	16.93%	0.644	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	2.488	0.077	2.564	50.00%	1.244	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0327				85.00%	0.028	
	EXHAUST GASES								0.1018
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 31.479							
47	CONCENTRATE TO PIPELINE FEED	1.465	0.789	2.254	68.56%	1.005	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	1.022	1.899	2.921	23.40%	0.239	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 69.941							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 122.098							
218	NET OXIDE FEED TO PELLETIZING	1.969	0.173	2.142	70.47%	1.388	0.00%	0.000	
221	BINDER TO PELLETIZING	0.012	0.000	0.012					
222	DOLOMITE TO PELLETIZING	0.040	0.000	0.040					
	TOTAL OTHER FEED TO PELLETIZING	0.504			76.03%	0.383			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0514				72.00%	0.037	
	PELLET PLANT FLUE GASES	0.123			67.81%	0.115			0.1356
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 128.005							
300	NET PELLETS, ETC. TO SHAFT FCE.	1.781	0.000	1.781	67.81%	1.207			
317	DRI TO SCREENS (1.0 %C)	1.089	0.000	1.089	92.80%	1.010	1.00%	0.011	
319	DRI TO EAF (1.0% C)	1.045	0.000	1.045	92.80%	0.970	1.00%	0.010	

100% DRI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.2555				72.00%	0.184	
	DRI OFF GASES	0.1661			87.80%	0.146			0.6746
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 141.514							
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.00010	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120			94.00%	0.01129	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00359	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 11.00						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0182	
	TOT. C IN OFF GASES (INCL. LRF)							0.0166	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0166	0.0610
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 736.027							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.897							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1561	0.0000	0.1561	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.974	0.15%	0.00147	

100% DRI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 1,263.96							
	BINDER TO PELLET	0.0118	(MM kWhr/yr) 0.2386					0.0001	0.0004
	BURNT LIME/DOLOMITE TO PELLET	0.0402	3.6649					0.0153	0.0563
	LIME TO EAF	0.0124	1.1267					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 11.0000	23.3200						
	EAF ELECTRODES	0.0038	34.3878					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0120	0.2033					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 1,326.90	DRI 496.94						
	TOTAL CO2 PRODUCED (PROCESS)							0.2867	**1.0514**
	EQUIVALENT CO2 FROM POWER GEN.								**1.2103**
	TOTAL CO2 FROM ALL SOURCES								**2.2617**

APPENDIX C-2

100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% DRI CARBON

DOE10025

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

08-June-2000

100% DRI CHARGE - 2.5% C

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

6.301	MM MT/YEAR AS-MINED ROCK
3.811	MM MT/YEAR WASTE ROCK
2.491	MM MT/YEAR ORE ROCK TO CONCENTRATOR
1.467	MM MT/YEAR CONCENTRATE
1.943	MM MT/YEAR NET GREENBALL PELLETS
1.838	MM MT/YEAR NET INDURATED PELLETS
1.783	MM MT/YEAR PELLET FEED TO DRI
1.107	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

85.00%	DIESEL FUEL (ORE MINING) %C
0.003188	SHOVEL OPERATION (hrs/mt ORE)
0.006376	LOADER OPERATION (hrs/mt ORE)
0.007711	HAUL TRUCK WASTE (hrs/mt ORE)
0.005040	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.410	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
1.498	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
11.206	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
13.114	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
5.00	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
28.10	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
250	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
1.30	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

11.70	FUEL TO DRI - (GJ/mt DRI)
7.26	FUEL TO DRI - (GJ/mt FEED OXIDE)
234.75	FUEL TO DRI - (kg/mt DRI)
145.74	FUEL TO DRI - (kg/mt FEED OXIDE)
130.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
698.1	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

100% DRI CHARGE - 2.5% C

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	6.301	0.195	6.496	30.00%	1.890	0.00%	0.000	
1002	WASTE ROCK	3.811	0.118	3.929	16.93%	0.645	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	2.491	0.077	2.568	50.00%	1.245	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0327				85.00%	0.028	
	EXHAUST GASES								0.1018
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 31.502							
47	CONCENTRATE TO PIPELINE FEED	1.467	0.790	2.257	68.56%	1.006	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	1.024	1.901	2.925	23.40%	0.240	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 69.994							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 122.250							
218	NET OXIDE FEED TO PELLETIZING	1.971	0.173	2.144	70.29%	1.386	0.00%	0.000	
221	BINDER TO PELLETIZING	0.012	0.000	0.012					
222	DOLOMITE TO PELLETIZING	0.040	0.000	0.040					
	TOTAL OTHER FEED TO PELLETIZING	0.504			75.33%	0.380			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0514				72.00%	0.037	
	PELLET PLANT FLUE GASES	0.123			67.64%	0.115			0.1358
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 128.142							
300	NET PELLETS, ETC. TO SHAFT FCE.	1.783	0.000	1.783	67.64%	1.206			
317	DRI TO SCREENS (2.5 %C)	1.107	0.000	1.107	91.39%	1.011	2.50%	0.028	
319	DRI TO EAF (2.5% C)	1.062	0.000	1.062	91.39%	0.971	2.50%	0.027	

100% DRI CHARGE - 2.5% C

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.2598				72.00%	0.187	
	DRI OFF GASES	0.1661			86.39%	0.144			0.6859
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 143.870							
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.00010	
403	MISC. ADDITIVES	0.0072	0.0000	0.0072	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0099	0.0000	0.0099			94.00%	0.00932	
405	EAF ELECTRODES	0.0045	0.0000	0.0045			94.00%	0.00420	
401	LIME CHARGED	0.0126	0.0000	0.0126					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 19.25						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0549	1.0549	99.70%	1.0518	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0434	
	TOT. C IN OFF GASES (INCL. LRF)							0.0418	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0418	0.1534
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 736.472							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.918							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1587	0.0000	0.1587	26.95%	0.0428			
421	REFINED STEEL TO CASTING	0.0000	1.0528	1.0528	99.70%	1.050	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9774	0.0000	0.9774	99.70%	0.975	0.15%	0.00147	

100% DRI CHARGE - 2.5% C

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 1,267.15							
	BINDER TO PELLET	0.0118	(MM kWhr/yr) 0.2388					0.0001	0.0004
	BURNT LIME/DOLOMITE TO PELLET	0.0402	3.6950					0.0154	0.0563
	LIME TO EAF	0.0126	1.1536					0.0048	0.0176
	OXYGEN TO EAF	(MM Nm3/YR) 19.2500	40.8100						
	EAF ELECTRODES	0.0045	40.2046					0.0013	0.0048
	PETROLEUM COKE TO EAF	0.0099	0.1678					0.0000	0.0002
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 1,353.42	DRI 499.69						
	TOTAL CO2 PRODUCED (PROCESS)							0.3153	1.1562
	EQUIVALENT CO2 FROM POWER GEN.								1.2345
	TOTAL CO2 FROM ALL SOURCES								2.3906

APPENDIX C-3

100% STEEL SCRAP CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - EAF

100% SCRAP CHARGED TO EAF

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

0.000	MM MT/YEAR AS-MINED ROCK
0.000	MM MT/YEAR WASTE ROCK
0.000	MM MT/YEAR ORE ROCK TO CONCENTRATOR
0.000	MM MT/YEAR CONCENTRATE
0.000	MM MT/YEAR NET GREENBALL PELLETS
0.000	MM MT/YEAR NET INDURATED PELLETS
0.000	MM MT/YEAR PELLET FEED TO DRI
0.000	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

0.00%	DIESEL FUEL (ORE MINING) %C
0.000000	SHOVEL OPERATION (hrs/mt ORE)
0.000000	LOADER OPERATION (hrs/mt ORE)
0.000000	HAUL TRUCK WASTE (hrs/mt ORE)
0.000000	HAUL TRUCK ORE (hrs/mt ORE)
0.000	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
0.000	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
0.000	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
0.000	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.000	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
0.000	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
0.000	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
0.000	TOTAL FUEL (kg/mt ORE)
0	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
0	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
0	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
0.00%	DIESEL FUEL % CARBON
0.00	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
0.00	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.000	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
0	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
0.00	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
0.00	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
0.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

11.70	FUEL TO DRI - (GJ/mt DRI)
5.65	FUEL TO DRI - (GJ/mt FEED OXIDE)
234.75	FUEL TO DRI - (kg/mt DRI)
113.31	FUEL TO DRI - (kg/mt FEED OXIDE)
130.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
689.5	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000599	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001355	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000977	CUM. CO2 EMMISSIONS - 50% N.G./50% COAL - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - EAF

100% SCRAP CHARGED TO EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	2.087	0.065	2.152	30.00%	0.626	0.00%	0.000	
1002	WASTE ROCK	1.262	0.039	1.301	16.93%	0.214	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	0.825	0.026	0.851	50.00%	0.413	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0000				0.00%	0.000	
	EXHAUST GASES								0.0000
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 0.000							
47	CONCENTRATE TO PIPELINE FEED	0.486	0.262	0.748	68.56%	0.333	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	0.339	0.630	0.969	23.41%	0.079	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 0.000							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 0.000							
218	NET OXIDE FEED TO PELLETIZING	0.842	0.074	0.916	73.53%	0.619	0.00%	0.000	
221	BINDER TO PELLETIZING	0.005	0.000	0.005					
222	DOLOMITE TO PELLETIZING	0.017	0.000	0.017					
	TOTAL OTHER FEED TO PELLETIZING	0.356			80.31%	0.286			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0000				72.00%	0.000	
	PELLET PLANT FLUE GASES	0.053			70.74%	0.071			0.0000
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 0.000							
300	NET PELLETS, ETC. TO SHAFT FCE.	0.761	0.000	0.761	70.74%	0.539			
317	DRI TO SCREENS (1.0 %C)	0.367	0.000	0.367	92.80%	0.341	1.00%	0.004	
319	DRI TO EAF (1.0% C)	0.353	0.000	0.353	92.80%	0.327	1.00%	0.004	

100% SCRAP CHARGED TO EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.0000				72.00%	0.000	
	DRI OFF GASES	0.0000			87.80%	0.000			0.0000
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 0.000							
409	TOTAL STEEL SCRAP (100%)	1.0776	0.0000	1.0776	99.70%	1.0743	0.15%	0.00162	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0119	0.0000	0.0119			94.00%	0.01117	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00356	
401	LIME CHARGED	0.0122	0.0000	0.0122					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 11.91						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0196	
	TOT. C IN OFF GASES (INCL. LRF)							0.0180	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0180	0.0661
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 726.931							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.896							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1545	0.0000	0.1545	26.99%	0.0417			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.974	0.15%	0.00147	

100% SCRAP CHARGED TO EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 761.83							
	BINDER TO PELLET	0.0000	(MM kWhr/yr) 0.0000					0.0000	0.0000
	BURNT LIME/DOLOMITE TO PELLET	0.0000	0.0000					0.0000	0.0000
	LIME TO EAF	0.0122	1.1232					0.0047	0.0171
	OXYGEN TO EAF	(MM Nm3/YR) 11.9131	25.2558						
	EAF ELECTRODES	0.0038	34.0404					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0119	0.2013					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 822.45							
	TOTAL CO2 PRODUCED (PROCESS)							0.0238	0.0874
	EQUIVALENT CO2 FROM POWER GEN.								0.8035
	TOTAL CO2 FROM ALL SOURCES								0.8909

APPENDIX C-4

30% SHAFT FURNACE DRI/70% SCRAP CHARGE TO EAF, 1.0 WT.% DRI CARBON

DOE3010

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

08-June-2000

30% DRI CHARGE - 1.0 WT.% CARBON

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

2.087	MM MT/YEAR AS-MINED ROCK
1.262	MM MT/YEAR WASTE ROCK
0.825	MM MT/YEAR ORE ROCK TO CONCENTRATOR
0.486	MM MT/YEAR CONCENTRATE
0.830	MM MT/YEAR NET GREENBALL PELLETS
0.785	MM MT/YEAR NET INDURATED PELLETS
0.761	MM MT/YEAR PELLET FEED TO DRI
0.367	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

85.00%	DIESEL FUEL (ORE MINING) %C
0.009624	SHOVEL OPERATION (hrs/mt ORE)
0.019247	LOADER OPERATION (hrs/mt ORE)
0.023279	HAUL TRUCK WASTE (hrs/mt ORE)
0.015215	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.376	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
1.373	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
10.273	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
12.023	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
7.76	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
43.72	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
250	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
1.30	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

11.70	FUEL TO DRI - (GJ/mt DRI)
5.65	FUEL TO DRI - (GJ/mt FEED OXIDE)
234.75	FUEL TO DRI - (kg/mt DRI)
113.31	FUEL TO DRI - (kg/mt FEED OXIDE)
130.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
699.4	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

DOE3010
08-June-2000
Rev. 2

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

30% DRI CHARGE - 1.0 WT.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	2.087	0.065	2.152	30.00%	0.626	0.00%	0.000	
1002	WASTE ROCK	1.262	0.039	1.301	16.93%	0.214	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	0.825	0.026	0.851	50.00%	0.413	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0099				85.00%	0.008	
	EXHAUST GASES								0.0309
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 16.188							
47	CONCENTRATE TO PIPELINE FEED	0.486	0.262	0.748	68.56%	0.333	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	0.339	0.630	0.969	23.41%	0.079	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 36.071							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 40.497							
218	NET OXIDE FEED TO PELLETIZING	0.842	0.074	0.916	73.53%	0.619	0.00%	0.000	
221	BINDER TO PELLETIZING	0.005	0.000	0.005					
222	DOLOMITE TO PELLETIZING	0.017	0.000	0.017					
	TOTAL OTHER FEED TO PELLETIZING	0.356			80.31%	0.286			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0220				72.00%	0.016	
	PELLET PLANT FLUE GASES	0.053			70.74%	0.071			0.0580
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 54.721							
300	NET PELLETS, ETC. TO SHAFT FCE.	0.761	0.000	0.761	70.74%	0.539			
317	DRI TO SCREENS (1.0 %C)	0.367	0.000	0.367	92.80%	0.341	1.00%	0.004	
319	DRI TO EAF (1.0% C)	0.353	0.000	0.353	92.80%	0.327	1.00%	0.004	

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

30% DRI CHARGE - 1.0 WT.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.0863				72.00%	0.062	
	DRI OFF GASES	0.1661			87.80%	0.146			0.2277
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 47.767							
409	TOTAL STEEL SCRAP (100% DRI)	0.7364	0.0000	0.7364	99.70%	0.7342	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0122	0.0000	0.0122			94.00%	0.01144	
405	EAF ELECTRODES	0.0039	0.0000	0.0039			94.00%	0.00364	
401	LIME CHARGED	0.0125	0.0000	0.0125					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 11.81						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0541	1.0541	99.70%	1.0510	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0194	
	TOT. C IN OFF GASES (INCL. LRF)							0.0179	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0179	0.0655
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 737.292							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.891							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1583	0.0000	0.1583	26.96%	0.0427			
421	REFINED STEEL TO CASTING	0.0000	1.0520	1.0520	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9767	0.0000	0.9767	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF

30% DRI CHARGE - 1.0 WT.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 967.43							
	BINDER TO PELLET	0.0051	(MM kWhr/yr) 0.1020					0.0001	0.0002
	BURNT LIME/DOLOMITE TO PELLET	0.0172	1.5779					0.0066	0.0241
	LIME TO EAF	0.0125	1.1506					0.0048	0.0175
	OXYGEN TO EAF	(MM Nm3/YR) 11.8117	25.0409						
	EAF ELECTRODES	0.0039	34.8696					0.0011	0.0042
	PETROLEUM COKE TO EAF	0.0122	0.2062					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 1,030.37							
	TOTAL CO2 PRODUCED (PROCESS)							0.1168	**0.4283**
	EQUIVALENT CO2 FROM POWER GEN.								**0.9398**
	TOTAL CO2 FROM ALL SOURCES								**1.3681**

APPENDIX C-5

30% SHAFT FURNACE DRI/70% SCRAP CHARGE TO EAF, 2.5 WT.% DRI CARBON

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF
(30% DRI CHARGE - 2.5% C)

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

2.089	MM MT/YEAR AS-MINED ROCK
1.263	MM MT/YEAR WASTE ROCK
0.826	MM MT/YEAR ORE ROCK TO CONCENTRATOR
0.486	MM MT/YEAR CONCENTRATE
0.830	MM MT/YEAR NET GREENBALL PELLETS
0.785	MM MT/YEAR NET INDURATED PELLETS
0.762	MM MT/YEAR PELLET FEED TO DRI
0.373	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

85.00%	DIESEL FUEL (ORE MINING) %C
0.009617	SHOVEL OPERATION (hrs/mt ORE)
0.019234	LOADER OPERATION (hrs/mt ORE)
0.023264	HAUL TRUCK WASTE (hrs/mt ORE)
0.015205	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.375	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
1.373	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
10.267	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
12.015	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
7.75	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
43.71	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
250	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
1.30	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

11.70	FUEL TO DRI - (GJ/mt DRI)
5.74	FUEL TO DRI - (GJ/mt FEED OXIDE)
234.75	FUEL TO DRI - (kg/mt DRI)
115.08	FUEL TO DRI - (kg/mt FEED OXIDE)
130.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
699.4	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - BASE PROCESS SHAFT FURNACE DRI/EAF (30% DRI CHARGE - 2.5% C)

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	2.089	0.065	2.153	30.00%	0.627	0.00%	0.000	
1002	WASTE ROCK	1.263	0.039	1.302	16.93%	0.214	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	0.826	0.026	0.851	50.00%	0.413	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0099				85.00%	0.008	
	EXHAUST GASES								0.0309
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 16.195							
47	CONCENTRATE TO PIPELINE FEED	0.486	0.262	0.748	68.56%	0.333	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	0.339	0.630	0.970	23.41%	0.079	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 36.086							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 40.524							
218	NET OXIDE FEED TO PELLETIZING	0.842	0.074	0.916	73.10%	0.616	0.00%	0.000	
221	BINDER TO PELLETIZING	0.005	0.000	0.005					
222	DOLOMITE TO PELLETIZING	0.017	0.000	0.017					
	TOTAL OTHER FEED TO PELLETIZING	0.356			79.32%	0.282			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0220				72.00%	0.016	
	PELLET PLANT FLUE GASES	0.053			70.34%	0.070			0.0580
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 54.745							
300	NET PELLETS, ETC. TO SHAFT FCE.	0.762	0.000	0.762	70.34%	0.536			
317	DRI TO SCREENS (2.5 %C)	0.373	0.000	0.373	91.39%	0.341	2.50%	0.009	
319	DRI TO EAF (2.5% C)	0.358	0.000	0.358	91.39%	0.328	2.50%	0.009	

(30% DRI CHARGE - 2.5% C)

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.0876				72.00%	0.063	
	DRI OFF GASES	0.1661			86.39%	0.144			0.2314
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 48.536							
409	TOTAL STEEL SCRAP (100% DRI)	0.7364	0.0000	0.7364	99.70%	0.7342	0.15%	0.00110	
403	MISC. ADDITIVES	0.0072	0.0000	0.0072	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0099	0.0000	0.0099			94.00%	0.00934	
405	EAF ELECTRODES	0.0045	0.0000	0.0045			94.00%	0.00421	
401	LIME CHARGED	0.0126	0.0000	0.0126					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 25.08						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0542	1.0542	99.70%	1.0510	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0269	
	TOT. C IN OFF GASES (INCL. LRF)							0.0253	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0253	0.0927
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 737.332							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.893							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1591	0.0000	0.1591	26.95%	0.0429			
421	REFINED STEEL TO CASTING	0.0000	1.0520	1.0520	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9767	0.0000	0.9767	99.70%	0.974	0.15%	0.00147	

(30% DRI CHARGE - 2.5% C)

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 968.31							
	BINDER TO PELLET	0.0051	(MM kWhr/yr) 0.1020					0.0001	0.0002
	BURNT LIME/DOLOMITE TO PELLET	0.0172	1.5786					0.0066	0.0241
	LIME TO EAF	0.0126	1.1568					0.0048	0.0176
	OXYGEN TO EAF	(MM Nm3/YR) 25.0833	53.1766						
	EAF ELECTRODES	0.0045	40.3162					0.0013	0.0048
	PETROLEUM COKE TO EAF	0.0099	0.1683					0.0000	0.0002
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 1,064.81							
	TOTAL CO2 PRODUCED (PROCESS)							0.1254	0.4599
	EQUIVALENT CO2 FROM POWER GEN.								0.9712
	TOTAL CO2 FROM ALL SOURCES								1.4311

APPENDIX C-6

HYLSA SHAFT FURNACE WITHOUT REFORMER (HYL IVM) HOT DRI CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - HYL IVM SHAFT FCE. PROCESS DRI/EAF

08-June-2000

100% DRI CHARGE - 4.0 wt.% CARBON

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

6.294	MM MT/YEAR AS-MINED ROCK
3.806	MM MT/YEAR WASTE ROCK
2.488	MM MT/YEAR ORE ROCK TO CONCENTRATOR
1.465	MM MT/YEAR CONCENTRATE
1.940	MM MT/YEAR NET GREENBALL PELLETS
1.836	MM MT/YEAR NET INDURATED PELLETS
1.781	MM MT/YEAR PELLET FEED TO DRI
1.089	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

85.00%	DIESEL FUEL (ORE MINING) %C
0.003192	SHOVEL OPERATION (hrs/mt ORE)
0.006384	LOADER OPERATION (hrs/mt ORE)
0.007721	HAUL TRUCK WASTE (hrs/mt ORE)
0.005046	HAUL TRUCK ORE (hrs/mt ORE)
128.581	TOTAL SHOVEL FUEL CONSUMPTION (kg/hr)
235.022	TOTAL LOADER FUEL CONSUMPTION (kg/hr)
878.780	TOTAL HAUL TRUCK FUEL CONSUMPTION (kg/hr)
1242.383	TOTAL FUEL FOR ALL ROCK (kg/hr)
0.410	TOTAL FUEL (kg/mt ORE) - SHOVEL (1)
1.500	TOTAL FUEL (kg/mt ORE) - LOADERS (2)
11.220	TOTAL FUEL (kg/mt ORE) - TRUCKS (4)
13.131	TOTAL FUEL (kg/mt ORE)
755	SHOVEL HORSEPOWER (CAT 13.75 CU YD)
690	LOADER HORSEPOWER (CAT 992D, 14 CU YD)
1290	HAUL TRUCK HORSEPOWER (CAT 785B, 130 TON)
85.00%	DIESEL FUEL % CARBON
5.00	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
28.12	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
250	ASSUMED CONC. SLURRY PIPELINE LENGTH (km)
1.30	FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

9.45	FUEL TO DRI - (GJ/mt DRI)
5.77	FUEL TO DRI - (GJ/mt FEED OXIDE)
189.61	FUEL TO DRI - (kg/mt DRI)
115.77	FUEL TO DRI - (kg/mt FEED OXIDE)
100.00	DRI ELEC. POWER REQ'D - (kWhr/mt DRI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
606.3	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - HYL IVM SHAFT FCE. PROCESS DRI/EAF

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
1001	AS-MINED ROCK	6.294	0.195	6.488	30.00%	1.888	0.00%	0.000	
1002	WASTE ROCK	3.806	0.118	3.924	16.93%	0.644	0.00%	0.000	
1	IRON ORE TO CONCENTRATOR	2.488	0.077	2.564	50.00%	1.244	0.00%	0.000	
	DIESEL FUEL (MINING ETC.)		0.0327				85.00%	0.028	
	EXHAUST GASES								0.1018
	MINE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 31.479							
47	CONCENTRATE TO PIPELINE FEED	1.465	0.789	2.254	68.56%	1.005	0.00%	0.000	
50	DEWATERED TAILINGS TO DISPOSAL	1.022	1.899	2.921	23.40%	0.239	0.00%	0.000	
	CONC. ELECTRICAL POWER REQ'D	(MM kWhr/yr) 69.941							
	CONC. SLURRY PIPELINE POWER	(MM kWhr/yr) 122.098							
218	NET OXIDE FEED TO PELLETIZING	1.969	0.173	2.142	70.47%	1.388	0.00%	0.000	
221	BINDER TO PELLETIZING	0.012	0.000	0.012					
222	DOLOMITE TO PELLETIZING	0.040	0.000	0.040					
	TOTAL OTHER FEED TO PELLETIZING	0.504			76.03%	0.383			
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0514				72.00%	0.037	
	PELLET PLANT FLUE GASES	0.123			67.81%	0.115			0.1356
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 128.005							
300	NET PELLETS, ETC. TO SHAFT FCE.	1.781	0.000	1.781	67.81%	1.207			
317	DRI TO SCREENS (1.0 %C)	1.089	0.000	1.089	92.80%	1.010	4.00%	0.044	
319	DRI TO EAF (1.0% C)	1.045	0.000	1.045	92.80%	0.970	4.00%	0.042	

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	FUEL TO DRI		AS N.G. 0.2062				72.00%	0.148	
	DRI OFF GASES	0.1661			87.80%	0.146			0.5443
	DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 108.857							
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.00010	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0084	0.0000	0.0084			94.00%	0.00791	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00359	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 44.00						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0149	
	TOT. C IN OFF GASES (INCL. LRF)							0.0133	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0133	0.0487
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 639.221							
417	LIME TO LADLE REF. FCE.	0.005	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.897							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1561	0.0000	0.1561	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.974	0.15%	0.00147	

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 1,134.50							
	BINDER TO PELLET	0.0118	(MM kWhr/yr) 0.2386					0.0001	0.0004
	BURNT LIME/DOLOMITE TO PELLET	0.0402	3.6910					0.0153	0.0563
	LIME TO EAF	0.0124	1.1347					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 44.0000	93.2800						
	EAF ELECTRODES	0.0038	34.3878					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0084	0.1425					0.0000	0.0001
	COMPONENTS ELEC. POWER REQ'D								
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 1,267.37							
	TOTAL CO2 PRODUCED (PROCESS)							0.2478	0.9086
	EQUIVALENT CO2 FROM POWER GEN.								1.1560
	TOTAL CO2 FROM ALL SOURCES								2.0646

HOT METAL VARIATIONS

APPENDIX C-7

30% BLAST FURNACE HOT METAL/70% SCRAP CHARGE TO EAF, CO-PRODUCT COKE

DOEBF

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

08-June-2000 30% BLAST FURNACE HOT METAL CHARGE - CO-PRODUCT COKE

Rev. 2

BASIS: 28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.105	MMM MT/YEAR LUMP IRON ORE
0.210	MMM MT/YEAR IRON ORE PELLETS FEED
0.210	MMM MT/YEAR FLUXED IRON SINTER
0.034	MMM MT/YEAR IRON SCRAP
0.003	MMM MT/YEAR LIMESTONE
0.003	MMM MT/YEAR SIO2/GRAVEL
0.175	MMM MT/YEAR COKE
0.739	MMT MT/YEAR TOTAL SOLID BF FEED (ASSUMPTION)

ASSUMPTIONS:

4320		
14.26%	PERCENT LUMP IRON ORE OF FEED	
28.38%	PERCENT IRON ORE PELLETS OF FEED	
28.38%	PERCENT SINTER OF FEED	
4.56%	PERCENT SCRAP IN FEED	
0.35%	PERCENT LIMESTONE IN FEED	
0.35%	PERCENT GRAVEL IN FEED	
23.73%	PERCENT COKE IN FEED	
64.00%	PERCENT IRON IN LUMP ORE	
64.50%	PERCENT IRON IN PELLETS	
50.00%	PERCENT IRON IN SINTER	
85.70%	PERCENT C IN COKE	Wtd. Avg.
2.00%	PERCENT C IN SCRAP CHARGED	0.000977
0.016	MOISTURE TO FURNACE - (mt/mt HM)	
1.639	AIR TO FURNACE - (mt/mt HM)	
20.500	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)	
41.7	BLAST FURNACE ELEC. POWER REQ'D (kWhr/mt FEED)	
42.70%	PERCENT C IN LIMESTONE	
0.249	SLAG FROM FURNACE (mt/mt HM)	
0.006	SCRAP FROM BF (mt/mt HM)	
2.539	BF TOP GAS FROM FURNACE (mt/mt HM)	
0.042	DUST FROM FURNACE (mt/mt HM)	
2.00%	PERCENT C IN BF SLAG	

40.00%	PERCENT IRON IN BF DUST
20.00%	PERCENT CARBON IN BF DUST
4.50%	PERCENT CARBON IN HOT METAL
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN BLAST FCE SLAG
24.90%	WEIGHT BF FCE SLAG PRODUCED - (mt/mt HM)
95.13%	PERCENT IRON IN HM
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
514.1	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
30.6157	ELECTRIC POWER REQ'D - (kWhr/mt)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000599	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001355	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
	LUMP IRON ORE DELIVERED
32.24	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1437	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON ORE PELLETS DELIVERED
197.3739	ELECTRIC POWER REQ'D - (kWhr/mt)
0.2374	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON SINTER DELIVERED
89.5474	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1356	CUMULATIVE CO2 EMMISSIONS - (MT/mt)

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

30% BLAST FURNACE HOT METAL CHARGE - CO-PRODUCT COKE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	LUMP IRON ORE FEED	0.1054	0.000	0.105	64.00%	0.067	0.00%	0.000	
	IRON PELLET FEED	0.2097	0.000	0.210	64.50%	0.135	0.00%	0.000	
	IRON SINTER FEED	0.2097	0.000	0.210	50.00%	0.105	0.00%	0.000	
	IRON SCRAP FEED	0.0337	0.000	0.034	97.70%	0.033	2.00%	0.001	
	LIMESTONE FEED	0.0026	0.000	0.003	0.00%	0.000	43.20%	0.001	
	GRAVEL FEED	0.0026	0.000	0.003	0.00%	0.000	0.00%	0.000	
	COKE FEED	0.1753	0.000	0.175	0.00%	0.000	85.70%	0.150	
	AIR TO FURNACE	0.0000	AS GAS 0.587	0.587	0.00%	0.000	0.00%	0.000	
	MOISTURE TO FURNACE	0.0000	AS GAS 0.006	0.006	0.00%	0.000	0.00%	0.000	
	NET SOLID FEED TO FURNACE	0.7390	0.000	0.739	46.08%	0.3405	21.11%	0.1560	
	N.G. FUEL TO FURNACE	0.0000	AS GAS 0.007	(MM mt/YR) 0.005			72.00%	0.004	0.0144
	BF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.8336							
	BLAST GAS FROM FURNACE	0.0000	(MM mt/YR) 0.9100	0.910	0.00%	0.000	14.83%	0.135	0.4948
	SLAG FROM FURNACE	0.0892	0.000	0.089	46.08%	0.041	2.00%	0.002	
	BF HOT METAL FROM FURNACE	0.3584	0.000	0.358	95.13%	0.341	4.50%	0.016	
	BF SCRAP FROM FCE	0.0022	0.000	0.0022	95.13%	0.002	4.50%	0.000	
	BF DUST FROM FCE	0.0151	0.000	0.0151	40.00%	0.006	20.00%	0.003	

30% BLAST FURNACE HOT METAL CHARGE - CO-PRODUCT COKE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR) AS N.G.	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	0.0000	0.7366	99.70%	0.6862	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	0.0029			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 38.99						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	0.0000	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0265	
	TOT. C IN OFF GASES (INCL. LRF)							0.0249	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0266	0.0976
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 542.1070							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.042			
421	REFINED STEEL TO CASTING	1.000	0.0000	1.000	99.70%	0.997	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

30% BLAST FURNACE HOT METAL CHARGE, CO-PRODUCT COKE - SUMMARY

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 607.8438							
	COKE TO BLAST FURNACE	0.1753	(MM kWhr/yr) 5.3682					0.0477	0.1749
	LUMP IRON ORE TO BLAST FURNACE	0.1054	3.3973					0.0041	0.0151
	IRON ORE PELL. TO BLAST FURNACE	0.2097	41.3943					0.0136	0.0498
	IRON SINTER TO BLAST FURNACE	0.2097	18.7804					0.0078	0.0284
	LIMESTONE TO BLAST FURNACE	0.0026	0.0827					0.0001	0.0004
	SiO2/GRAVEL TO BLAST FURNACE	0.0026	0.0827					0.0001	0.0004
	LIME TO EAF	0.0124	1.1412					0.0047	0.0174
	OXYGEN TO EAF	(MM Nm3/YR) 38.9907	82.6602						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.00003	0.00009
	COMPONENTS ELEC. POWER REQ'D		187.5950						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 795.4388							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	795.4388							
	TOTAL CO2 PRODUCED (PROCESS)							0.2448	0.8974
	EQUIVALENT CO2 FROM POWER GEN.								0.7771
	TOTAL CO2 FROM ALL SOURCES								1.6746

DOEBF

IRON/STEELMAKING WATER & SOLIDS BALANCE

19-Sept.-1999 30% BLAST FURNACE HOT METAL CHARGE - CO-PRODUCT COKE

Revision A: OREBODY ASSUMPTIONS EAF STEELMAKING/LMF (PFD-009) BASIS: 1.00 (MM T/YR LIQUID STEEL)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL HOT METAL FEED TO EAF	0.0%	0.000	0.358	0.358	47.1%	95.13%	0.341
401	LUMP LIME FLUX TO EAF	100.0%	0.012	0.000	0.012	1.6%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	4.2%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.006	0.000	0.006	7.1%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	1.1%		
406	TOTAL EAF COOLING WATER CIRC. (MM	0.0%	0.000	70.627	70.627	0.0%		
407	REVERT SCRAP	100.0%	0.048	0.000	0.048	6.4%	99.70%	0.048
408	PURCHASED SCRAP	100.0%	0.688	0.000	0.688	90.4%	99.70%	0.686
409	NET SCRAP CHARGED	100.0%	0.737	0.000	0.737	96.8%	99.70%	0.734
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.026	0.000	0.026	3.4%	50.80%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.015	0.000	0.015	1.9%		
412	PROCESS/COOLING WATER OUT OF EAF	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.157	0.157	0.0%	25.60%	0.040
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	2.6%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR	0.0%	0.000	38.991	38.991	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.054	1.054	0.0%	99.70%	1.051
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.7%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.4%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

IRON/STEELMAKING WATER & SOLIDS BALANCE

19-Sept.-1999 30% BLAST FURNACE HOT METAL CHARGE - CO-PRODUCT COKE

Revision A: OREEEAF STLMAKING/LMF (PFD-009) BASIS: 1.00 (MM T/YR LIQUID STEEL)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.052	1.052	0.0%	99.70%	1.049
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.014	0.000	0.012	1.5%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.157	0.000	0.157	20.6%	26.97%	0.042
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.7%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	3.1%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.8%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	2.4%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	11.3%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	3.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR	0.0%	0.162	9.600	9.762	21.3%		
509	NET STEEL TO CASTING	0.0%	0.000	1.000	1.000	0.0%	99.70%	0.997
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
511	THIN SLAB TO HOT BAND	0.0%	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX C-8

30% BLAST FURNACE HOT METAL/70% SCRAP CHARGE TO EAF, N. R. COKE WITH POWER GENERATION

DOEBFNRC

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

08-June-2000 30% BLAST FURNACE HOT METAL CHARGE - WITH N.R. COKE & PWR. GEN.

Rev. 2

BASIS: 28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.108	MMM MT/YEAR LUMP IRON ORE
0.214	MMM MT/YEAR IRON ORE PELLETS FEED
0.214	MMM MT/YEAR FLUXED IRON SINTER
0.034	MMM MT/YEAR IRON SCRAP
0.003	MMM MT/YEAR LIMESTONE
0.003	MMM MT/YEAR SIO2/GRAVEL
0.163	MMM MT/YEAR COKE
0.739	MMT MT/YEAR TOTAL SOLID BF FEED (ASSUMPTION)

ASSUMPTIONS:

4224		
14.56%	PERCENT LUMP IRON ORE OF FEED	
29.02%	PERCENT IRON ORE PELLETS OF FEED	
29.02%	PERCENT SINTER OF FEED	
4.66%	PERCENT SCRAP IN FEED	
0.36%	PERCENT LIMESTONE IN FEED	
0.36%	PERCENT SILICA GRAVEL IN FEED	
22.02%	PERCENT COKE IN FEED	
64.00%	PERCENT IRON IN LUMP ORE	E.P. Gen.
64.50%	PERCENT IRON IN PELLETS	866.937
50.00%	PERCENT IRON IN SINTER	
94.53%	PERCENT C IN COKE	FUEL OIL
2.00%	PERCENT C IN SCRAP CHARGED	0.000871
0.016	MOISTURE TO FURNACE - (mt/mt HM)	
1.639	AIR TO FURNACE - (mt/mt HM)	
20.500	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)	
41.7	BLAST FURNACE ELEC. POWER REQ'D (kWhr/mt FEED)	
42.70%	PERCENT C IN LIMESTONE	
0.249	SLAG FROM FURNACE (mt/mt HM)	
0.006	SCRAP FROM BF (mt/mt HM)	
2.539	BF TOP GAS FROM FURNACE (mt/mt HM)	
0.042	DUST FROM FURNACE (mt/mt HM)	
2.00%	PERCENT C IN BF SLAG	

40.00%	PERCENT IRON IN BF DUST
20.00%	PERCENT CARBON IN BF DUST
4.50%	PERCENT CARBON IN HOT METAL
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN BLAST FCE SLAG
24.90%	WEIGHT BF FCE SLAG PRODUCED - (mt/mt HM)
95.13%	PERCENT IRON IN HM
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
514.1	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	NON-RECOVERY COKE
59.358	ELECTRIC POWER REQ'D - (kWhr/mt)
1.1721	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
0.000912	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
	LUMP IRON ORE DELIVERED
32.24	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1437	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON ORE PELLETS DELIVERED
197.3739	ELECTRIC POWER REQ'D - (kWhr/mt)
0.2374	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON SINTER DELIVERED
89.5474	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1356	CUMULATIVE CO2 EMMISSIONS - (kg/mt)

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

30% BLAST FURNACE HOT METAL CHARGE - WITH N.R. COKE & PWR. GEN.

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	LUMP IRON ORE FEED	0.1076	0.000	0.108	64.00%	0.069	0.00%	0.000	
	IRON PELLET FEED	0.2145	0.000	0.214	64.50%	0.138	0.00%	0.000	
	IRON SINTER FEED	0.2145	0.000	0.214	50.00%	0.107	0.00%	0.000	
	IRON SCRAP FEED	0.0345	0.000	0.034	97.70%	0.034	2.00%	0.001	
	LIMESTONE FEED	0.0026	0.000	0.003	0.00%	0.000	43.20%	0.001	
	GRAVEL FEED	0.0026	0.000	0.003	0.00%	0.000	0.00%	0.000	
	N.R. COKE FEED	0.1627	0.000	0.163	0.00%	0.000	94.53%	0.154	
	AIR TO FURNACE	0.0000	AS GAS 0.587	0.587	0.00%	0.000	0.00%	0.000	
	MOISTURE TO FURNACE	0.0000	AS GAS 0.006	0.006	0.00%	0.000	0.00%	0.000	
	NET SOLID FEED TO FURNACE	0.7390	0.000	0.739	47.11%	0.3481	21.59%	0.1596	
	N.G. FUEL TO FURNACE	0.0000	AS GAS 0.007	(MM mt/YR) 0.005			72.00%	0.004	0.0144
	BF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.8336							
	BLAST GAS FROM FURNACE	0.0000	(MM mt/YR) 0.9100	0.910	0.00%	0.000	15.23%	0.139	0.5080
	SLAG FROM FURNACE	0.0892	0.000	0.089	47.11%	0.042	2.00%	0.002	
	BF HOT METAL FROM FURNACE	0.3584	0.000	0.358	95.13%	0.341	4.50%	0.016	
	BF SCRAP FROM FCE	0.0022	0.000	0.0022	95.13%	0.002	4.50%	0.000	
	BF DUST FROM FCE	0.0151	0.000	0.0151	40.00%	0.006	20.00%	0.003	

30% BLAST FURNACE HOT METAL CHARGE - WITH N.R. COKE & PWR. GEN.

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR) AS N.G.	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	0.0000	0.7366	99.70%	0.6862	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	0.0029			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 38.99						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	0.0000	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0265	
	TOT. C IN OFF GASES (INCL. LRF)							0.0249	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0266	0.0976
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 542.1070							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.042			
421	REFINED STEEL TO CASTING	1.000	0.0000	1.000	99.70%	0.997	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

30% BLAST FURNACE HOT METAL CHARGE (N.R. COKE) - SUMMARY

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 607.8438							
	N.R. COKE TO BLAST FURNACE	0.1627	(MM kWhr/yr) 9.6592					0.0520	0.1907
	LUMP IRON ORE TO BLAST FURNACE	0.1076	3.4688					0.0042	0.0155
	IRON ORE PELL. TO BLAST FURNACE	0.2145	42.3335					0.0139	0.0509
	IRON SINTER TO BLAST FURNACE	0.2145	19.2065					0.0079	0.0291
	LIMESTONE TO BLAST FURNACE	0.0026	0.0846					0.0001	0.0004
	SiO2/GRAVEL TO BLAST FURNACE	0.0026	0.0846					0.0001	0.0004
	BURNT LIME TO EAF	0.0124	1.1412					0.0132	0.0483
	OXYGEN TO EAF	(MM Nm3/YR) 38.9907	82.6602						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.00003	0.00009
	COMPONENTS ELEC. POWER REQ'D		193.3265						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 801.1703							
	TOTAL ELEC. POWER GEN. N.R. COKE	141.0750							
	TOTAL NET ELEC. ADDITIONAL	660.0953							
	TOTAL CO2 PRODUCED (PROCESS)							0.2617	0.9594
	EQUIVALENT CO2 FROM POWER GEN.								0.6021
	TOTAL CO2 FROM ALL SOURCES								1.5615

APPENDIX C-9

30% COLD PIG IRON/70% SCRAP CHARGE TO EAF, 4.5% CARBON PIG

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

30% COLD BLAST FURNACE PIG IRON CHARGE

BASIS: 28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.105	MMM MT/YEAR LUMP IRON ORE
0.210	MMM MT/YEAR IRON ORE PELLETS FEED
0.210	MMM MT/YEAR FLUXED IRON SINTER
0.034	MMM MT/YEAR IRON SCRAP
0.003	MMM MT/YEAR LIMESTONE
0.003	MMM MT/YEAR SIO2/GRAVEL
0.175	MMM MT/YEAR COKE
0.739	MMT MT/YEAR TOTAL SOLID BF FEED (ASSUMPTION)

ASSUMPTIONS:

4320			
14.26%	PERCENT LUMP IRON ORE OF FEED		
28.38%	PERCENT IRON ORE PELLETS OF FEED		
28.38%	PERCENT SINTER OF FEED		
4.56%	PERCENT SCRAP IN FEED		
0.35%	PERCENT LIMESTONE IN FEED		
0.35%	PERCENT GRAVEL IN FEED		
23.73%	PERCENT COKE IN FEED		
64.00%	PERCENT IRON IN LUMP ORE		
64.50%	PERCENT IRON IN PELLETS		
50.00%	PERCENT IRON IN SINTER		
85.70%	PERCENT C IN COKE	FUEL OIL	
2.00%	PERCENT C IN SCRAP CHARGED	0.000871	
0.016	MOISTURE TO FURNACE - (mt/mt HM)		
1.639	AIR TO FURNACE - (mt/mt HM)		
20.500	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)		
48.7	BF ELEC. POWER REQ'D - INCL. PIG IRON (kWhr/mt FEED)		
42.70%	PERCENT C IN LIMESTONE		
0.249	SLAG FROM FURNACE (mt/mt HM)		
0.006	SCRAP FROM BF (mt/mt HM)		
2.539	BF TOP GAS FROM FURNACE (mt/mt HM)		
0.042	DUST FROM FURNACE (mt/mt HM)		
2.00%	PERCENT C IN BF SLAG		

40.00%	PERCENT IRON IN BF DUST
20.00%	PERCENT CARBON IN BF DUST
4.50%	PERCENT CARBON IN HOT METAL/PIG IRON
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN BLAST FCE SLAG
24.90%	WEIGHT BF FCE SLAG PRODUCED - (mt/mt HM)
95.13%	PERCENT IRON IN HM/PIG IRON
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
698.1	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/mt)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
0.000912	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
	LUMP IRON ORE DELIVERED
32.24	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1437	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON ORE PELLETS DELIVERED
197.3739	ELECTRIC POWER REQ'D - (kWhr/mt)
0.2374	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	IRON SINTER DELIVERED
89.5474	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1356	CUMULATIVE CO2 EMMISSIONS - (MT/mt)

OVERALL SUMMARY MASS BALANCES - BLAST FURNACE HOT METAL/EAF

30% COLD BLAST FURNACE PIG IRON CHARGE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	LUMP IRON ORE FEED	0.1054	0.000	0.105	64.00%	0.067	0.00%	0.000	
	IRON PELLET FEED	0.2097	0.000	0.210	64.50%	0.135	0.00%	0.000	
	IRON SINTER FEED	0.2097	0.000	0.210	50.00%	0.105	0.00%	0.000	
	IRON SCRAP FEED	0.0337	0.000	0.034	97.70%	0.033	2.00%	0.001	
	LIMESTONE FEED	0.0026	0.000	0.003	0.00%	0.000	43.20%	0.001	
	GRAVEL FEED	0.0026	0.000	0.003	0.00%	0.000	0.00%	0.000	
	COKE FEED	0.1753	0.000	0.175	0.00%	0.000	85.70%	0.150	
	AIR TO FURNACE	0.0000	AS GAS 0.587	0.587	0.00%	0.000	0.00%	0.000	
	MOISTURE TO FURNACE	0.0000	AS GAS 0.006	0.006	0.00%	0.000	0.00%	0.000	
	NET SOLID FEED TO FURNACE	0.7390	0.000	0.739	46.08%	0.3405	21.11%	0.1560	
	N.G. FUEL TO FURNACE	0.0000	AS GAS 0.007	(MM mt/YR) 0.005			72.00%	0.004	0.0144
	BF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 36.0066							
	BLAST GAS FROM FURNACE	0.0000	(MM mt/YR) 0.9100	0.910	0.00%	0.000	14.83%	0.135	0.4948
	SLAG FROM FURNACE	0.0892	0.000	0.089	46.08%	0.041	2.00%	0.002	
	BF HOT METAL FROM FURNACE	0.3584	0.000	0.358	95.13%	0.341	4.50%	0.016	
	BF COLD PIG IRON	0.3584	0.000	0.358	95.13%	0.341	4.50%	0.016	
	BF SCRAP FROM FCE	0.0022	0.000	0.0022	95.13%	0.002	4.50%	0.000	
	BF DUST FROM FCE	0.0151	0.000	0.0151	40.00%	0.006	20.00%	0.003	

30% COLD BLAST FURNACE PIG IRON CHARGE

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR) AS N.G.	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	0.0000	0.7366	99.70%	0.6862	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	0.0029			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0050	0.0000	0.0050			94.00%	0.00470	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 38.99						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	0.0000	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0276	
	TOT. C IN OFF GASES (INCL. LRF)							0.0260	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0277	0.1015
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 736.1518							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.042			
421	REFINED STEEL TO CASTING	1.000	0.0000	1.000	99.70%	0.997	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

30% BLAST FURNACE HOT METAL CHARGE - SUMMARY

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 807.0616							
	COKE TO BLAST FURNACE	0.1753	(MM kWhr/yr) 2.7254					0.0477	0.1749
	LUMP IRON ORE TO BLAST FURNACE	0.1054	3.3973					0.0041	0.0151
	IRON ORE PELL. TO BLAST FURNACE	0.2097	41.3943					0.0136	0.0498
	IRON SINTER TO BLAST FURNACE	0.2097	18.7804					0.0078	0.0284
	LIMESTONE TO BLAST FURNACE	0.0026	0.0827					0.0001	0.0004
	SiO2/GRAVEL TO BLAST FURNACE	0.0026	0.0827					0.0001	0.0004
	LIME TO EAF	0.0124	1.1412					0.0047	0.0174
	OXYGEN TO EAF	(MM Nm3/YR) 38.9907	82.6602						
	EAF ELECTRODES	0.0050	44.9613					0.0015	0.0054
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.00003	0.00009
	COMPONENTS ELEC. POWER REQ'D		195.3279						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 1,002.3895							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	1,002.3895							
	TOTAL CO2 PRODUCED (PROCESS)							0.2462	0.9027
	EQUIVALENT CO2 FROM POWER GEN.								0.9143
	TOTAL CO2 FROM ALL SOURCES								1.8170

APPENDIX C-10

30% TECHNORED HOT METAL/70% SCRAP CHARGE TO EAF, 4.5% C H. M. WITH CO-GENERATION OF ELECTRICAL POWER

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL (COKE BASED)

30% HOT METAL CHARGE - WITH CO-GENERATION OF ELECTRICAL POWER

BASIS:

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.508	MMM MT/YEAR FINE ORE FEED
0.098	MMM MT/YEAR EAF SLAG
0.076	MMM MT/YEAR CHARCOAL
0.005	MMM MT/YEAR BINDER C
0.149	MMM MT/YEAR COKE
0.722	MMM MT/YEAR NET GREENBALL PELLETS
0.656	MMM MT/YEAR NET CURED/DRIED PELLETS
0.638	MMM MT/YEAR PELLET FEED TO FCE

ASSUMPTIONS:

0.508	FINE ORE FEED TO PELLETIZING - (MM MT/YEAR)
72.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
1.00%	PERCENT BINDER C IN PELLET
12.00%	PERCENT EAF SLAG TO PELLET
15.00%	PERCENT CHARCOAL TO PELLET
1.22%	PERCENT RETURN FINES TO PELLET MIX
0.00%	PERCENT CEMENT TO PELLET
25.26%	PERCENT IRON IN EAF SLAG
80.00%	PERCENT C IN BINDER C
80.00%	PERCENT C IN CHARCOAL
10.00%	PERCENT C IN RETURN FINES
85.70%	PERCENT C IN CHINA COKE
48.83%	PERCENT Fe IN RETURN FINES
52.72%	PERCENT Fe IN GREEN PELLET (DRY BASIS)
9.91%	PERCENT C IN GREEN PELLET (DRY BASIS)
9.09%	PERCENT MOISTURE IN GREEN PELLET
0.00%	PERCENT MOISTURE DRIED PELLET
97.14%	NET PERCENT OF DRIED PELLET TO FURNACE
52.72%	PERCENT Fe IN DRIED PELLET
0.002	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
30.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

4.50%	EAF SLAG TO FURNACE - (% OF FEED)
18.09%	CHINA COKE TO FURNACE - (% OF FEED)
77.41%	DRIED PELLET TO FURNACE - (% OF FEED)
4,809.2	TOTAL OFF-GASES FROM FURNACE -(Nm3/mt HM)
1.500	DENSITY OF OFF-GASES - (kg/Nm3)
0.27%	BURNT LIME TO SCRUBBER - (mt/mt FEED)
0.10	AUX FUEL TO FCE - (kg/mt FEED OXIDE)
4.50%	PERCENT CARBON IN HOT METAL
459.00	TECHNO. ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN TECNORED FCE SLAG
37.17%	WEIGHT TECNORED FCE SLAG PRODUCED - (mt/mt HM)
95.13%	PERCENT IRON IN HM
70.00	ELECTRIC POWER CONSUMPTION TECNO. FCE. - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
461.3	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
2.00%	PERCENT C IN TECNORED SLAG
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL (COKE BASED)

30% HOT METAL CHARGE - WITH CO-GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES TO PELLET	0.5080	0.000	0.508	64.50%	0.328	0.00%	0.000	
	EAF SLAG TO PELLET	0.0610	0.000	0.061	25.26%	0.015	0.00%	0.000	
	CHARCOAL TO PELLET	0.0762	0.000	0.076	0.00%	0.000	80.00%	0.061	
	BINDER C TO PELLET	0.0051	0.000	0.005	0.00%	0.000	80.00%	0.004	
	CEMENT TO PELLET	0.0000	0.000	0.000	10.00%	0.000	0.00%	0.000	
	FINES RECYCLE TO PELLET	0.0062	0.000	0.006	48.83%	0.003	0.00%	0.000	
	WATER TO PELLET	0.0000	0.066	0.066	0.00%	0.000	0.00%	0.000	
	GREEN PELLET MIXTURE	0.6565	0.066	0.722	52.72%	0.346	9.91%	0.065	
	DRY PELLET PRODUCT	0.6565	0.000	0.656	52.72%	0.346	9.91%	0.065	
	NET PELLET PRODUCT TO FURNACE	0.6377	0.000	0.638	52.72%	0.336	9.91%	0.063	
	HEAT FOR DRYING (N.G. EQUIV.)	(MM BTU/yr) 0.4545	(MM Nm3 NG) 0.002	(MM mt/YR) 0.001			72.00%	0.001	0.0034
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 21.6632							
	EAF SLAG TO FURNACE	0.0371	0.000	0.037	25.26%	0.009	0.00%	0.000	
	CHINA COKE TO FURNACE	0.1490	0.000	0.149	0.00%	0.000	85.70%	0.128	
	PELLETS TO FURNACE	0.6377	0.000	0.638	52.72%	0.336	9.91%	0.063	
	TOTAL SOLID FEED TO FURNACE	0.8238	0.000	0.824	41.95%	0.346	23.17%	0.191	
	BURNT LIME TO SCRUBBER	0.0022	0.000	0.0022					
	AUXILLARY FUEL REQUIREMENT	(MM mt/YR) 0.0638					72.00%	0.046	0.1684
	ELECTRICAL POWER - CONSUMED FC	(MM kWhr/yr) 25.074	GENERATED	(MM kWhr/yr) 378.1112					
	NET GASES PRODUCED	(MM Nm3/YR) 1722.6565	(MM mt/YR) 1.1484					0.175	0.641
	SLAG PRODUCED		0.1331		3.61%	0.005	2.00%	0.003	
	HOT METAL PRODUCED	TARGET 0.3585	CALC. 0.3582		95.13%	0.341	4.50%	0.016	

30% HOT METAL CHARGE - WITH CO-GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	AS N.G. 0.0000	0.7366	99.70%	0.7344	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 36.84						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	1.0513	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0265	
	TOT. C IN OFF GASES (INCL. LRF)							0.0249	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0266	0.0975
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 486.4149							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.0423			
421	REFINED STEEL TO CASTING	0.0000	1.0523	1.0523	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL (COKE BASED)
30% HOT METAL CHARGE - WITH CO-GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 568.0553							
	CHINA COKE TO TECNORED FCE	0.1490	(MM kWhr/yr) 2.3162					0.1277	0.1486
	CHARCOAL TO PELLET	0.0762	1.1844					0.0207	0.0760
	BURNT LIME TO FCE SCRUB	0.0022	0.2053					0.0009	0.0031
	LIME TO EAF	0.0124	1.1412					0.0034	0.0124
	OXYGEN TO EAF	(MM Nm3/YR) 36.8404	78.1017						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.0000	0.0001
	EAF/LRF OFF-GASES	0.0831						0.0266	0.0975
	COMPONENTS ELEC. POWER REQ'D		117.6368						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 685.6921							
	TOTAL ELECTRIC POWER PROD.	378.1112							
	TOTAL NET ELEC. ADDITIONAL	307.5809							
	TOTAL CO2 PRODUCED (PROCESS)							0.3149	1.1545
	EQUIV. CO2 FROM EXTR. POWER GEN								0.2805
	TOTAL CO2 FROM ALL SOURCES								1.4350

APPENDIX C-11

30% TECHNORED HOT METAL/70% SCRAP CHARGE TO EAF, 4.5% C H. M. WITHOUT CO-GENERATION OF ELECTRICAL POWER

DOETECN2

08-June-2000

Rev. 2

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

BASIS:

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.508	MMM MT/YEAR FINE ORE FEED
0.098	MMM MT/YEAR EAF SLAG
0.076	MMM MT/YEAR CHARCOAL
0.005	MMM MT/YEAR BINDER C
0.149	MMM MT/YEAR COKE
0.722	MMM MT/YEAR NET GREENBALL PELLETS
0.656	MMM MT/YEAR NET CURED/DRIED PELLETS
0.638	MMM MT/YEAR PELLET FEED TO FCE

ASSUMPTIONS:

0.508	FINE ORE FEED TO PELLETIZING - (MM MT/YEAR)
72.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
1.00%	PERCENT BINDER C IN PELLET
12.00%	PERCENT EAF SLAG TO PELLET
15.00%	PERCENT CHARCOAL TO PELLET
1.22%	PERCENT RETURN FINES TO PELLET MIX
0.00%	PERCENT CEMENT TO PELLET
25.26%	PERCENT IRON IN EAF SLAG
80.00%	PERCENT C IN BINDER C
80.00%	PERCENT C IN CHARCOAL
10.00%	PERCENT C IN RETURN FINES
85.70%	PERCENT C IN CHINA COKE
48.83%	PERCENT Fe IN RETURN FINES
52.72%	PERCENT Fe IN GREEN PELLET (DRY BASIS)
9.91%	PERCENT C IN GREEN PELLET (DRY BASIS)
9.09%	PERCENT MOISTURE IN GREEN PELLET
0.00%	PERCENT MOISTURE DRIED PELLET
97.14%	NET PERCENT OF DRIED PELLET TO FURNACE
52.72%	PERCENT Fe IN DRIED PELLET
0.002	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
30.0	PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

4.50%	EAF SLAG TO FURNACE - (% OF FEED)
18.09%	CHINA COKE TO FURNACE - (% OF FEED)
77.41%	DRIED PELLET TO FURNACE - (% OF FEED)
4,809.2	TOTAL OFF-GASES FROM FURNACE -(Nm3/mt HM)
1.500	DENSITY OF OFF-GASES - (kg/Nm3)
0.27%	BURNT LIME TO SCRUBBER - (mt/mt FEED)
0.10	AUX FUEL TO FCE - (kg/mt FEED OXIDE)
4.50%	PERCENT CARBON IN HOT METAL
0.00	TECHNO. ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN TECNORED FCE SLAG
37.17%	WEIGHT TECNORED FCE SLAG PRODUCED - (mt/mt HM)
95.13%	PERCENT IRON IN HM
70.00	ELECTRIC POWER CONSUMPTION TECNO. FCE. - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
461.3	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
2.00%	PERCENT C IN TECNORED SLAG
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO_2 (MM T/YR)
	IRON ORE FINES TO PELLET	0.5080	0.000	0.508	64.50%	0.328	0.00%	0.000	
	EAF SLAG TO PELLET	0.0610	0.000	0.061	25.26%	0.015	0.00%	0.000	
	CHARCOAL TO PELLET	0.0762	0.000	0.076	0.00%	0.000	80.00%	0.061	
	BINDER C TO PELLET	0.0051	0.000	0.005	0.00%	0.000	80.00%	0.004	
	CEMENT TO PELLET	0.0000	0.000	0.000	10.00%	0.000	0.00%	0.000	
	FINES RECYCLE TO PELLET	0.0062	0.000	0.006	48.83%	0.003	0.00%	0.000	
	WATER TO PELLET	0.0000	0.066	0.066	0.00%	0.000	0.00%	0.000	
	GREEN PELLET MIXTURE	0.6565	0.066	0.722	52.72%	0.346	9.91%	0.065	
	DRY PELLET PRODUCT	0.6565	0.000	0.656	52.72%	0.346	9.91%	0.065	
	NET PELLET PRODUCT TO FURNACE	0.6377	0.000	0.638	52.72%	0.336	9.91%	0.063	
	HEAT FOR DRYING (N.G. EQUIV.)	(MM BTU/yr) 0.4545	(MM Nm3 NG) 0.002	(MM mt/YR) 0.001			72.00%	0.001	0.0034
	PELLET ELECTRICAL POWER REQ'D	(MM kWhr/yr) 21.6632							
	EAF SLAG TO FURNACE	0.0371	0.000	0.037	25.26%	0.009	0.00%	0.000	
	CHINA COKE TO FURNACE	0.1490	0.000	0.149	0.00%	0.000	85.70%	0.128	
	PELLETS TO FURNACE	0.6377	0.000	0.638	52.72%	0.336	9.91%	0.063	
	TOTAL SOLID FEED TO FURNACE	0.8238	0.000	0.824	41.95%	0.346	23.17%	0.191	
	BURNT LIME TO SCRUBBER	0.0022	0.000	0.0022					
	AUXILLARY FUEL REQUIREMENT	(MM mt/YR) 0.0638					72.00%	0.046	0.1684
	ELECTRICAL POWER - CONSUMED FC	(MM kWhr/yr) 25.074	GENERATED	(MM kWhr/yr) 0.0000					
	NET GASES PRODUCED	(MM Nm3/YR) 1722.6565	(MM mt/YR) 1.1484					0.175	0.641
	SLAG PRODUCED		0.1331		3.61%	0.005	2.00%	0.003	
	HOT METAL PRODUCED	TARGET 0.3585	CALC. 0.3582		95.13%	0.341	4.50%	0.016	

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	AS N.G. 0.0000	0.7366	99.70%	0.7344	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 36.84						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	1.0513	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0265	
	TOT. C IN OFF GASES (INCL. LRF)							0.0249	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0266	0.0975
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 486.4149							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.0423			
421	REFINED STEEL TO CASTING	0.0000	1.0523	1.0523	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - TECNORED PROCESS THROUGH HOT METAL
30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 568.0553							
	CHINA COKE TO TECNORED FCE	0.1490	(MM kWhr/yr) 2.3162					0.1277	0.1486
	CHARCOAL TO PELLET	0.0762	1.1844					0.0207	0.0760
	BURNT LIME TO FCE SCRUB	0.0022	0.2053					0.0009	0.0031
	LIME TO EAF	0.0124	1.1412					0.0034	0.0124
	OXYGEN TO EAF	(MM Nm3/YR) 36.8404	78.1017						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.0000	0.0001
	EAF/LRF OFF-GASES	0.0831	0.0000					0.0266	0.0975
	COMPONENTS ELEC. POWER REQ'D		117.6368						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 685.6921							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	685.6921							
	TOTAL CO2 PRODUCED (PROCESS)							0.3149	1.1545
	EQUIV. CO2 FROM EXTR. POWER GEN								0.6254
	TOTAL CO2 FROM ALL SOURCES								1.7799

APPENDIX C-12

COREX/MIDREX WITH 60% HOT METAL AND 40% DRI CHARGE TO EAF

DOECOREX

4-Aug-2000

Rev. 3

OVERALL SUMMARY MASS BALANCES - COREX HOT METAL/EAF

60% COREX HOT METAL CHARGE - 40%MIDREX DRI

BASIS: COREX

0.418	MM MT/YEAR MIDREX DRI CHARGED TO EAF
0.628	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.624	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.431	MMM MT/YEAR LUMP IRON ORE
0.431	MMM MT/YEAR IRON ORE PELLETS FEED
0.118	MMM MT/YEAR FLUXED IRON SINTER
0.000	MMM MT/YEAR IRON SCRAP
0.138	MMM MT/YEAR LIMESTONE
0.138	MMM MT/YEAR SIO2/GRAVEL
0.741	MMM MT/YEAR COAL
1.958	MMT MT/YEAR TOTAL SOLID COREX FEED (ASSUMPTION)

ASSUMPTIONS:

20.00%	PERCENT SUPPLIMENTAL GAS IN MIDREX
4320	
22.03%	PERCENT LUMP IRON ORE OF FEED
22.03%	PERCENT IRON ORE PELLETS OF FEED
6.03%	PERCENT SINTER OF FEED
0.00%	PERCENT SCRAP IN FEED
7.06%	PERCENT LIMESTONE IN FEED
7.06%	PERCENT DOLOMITE IN FEED
37.86%	PERCENT COAL IN FEED
68.00%	PERCENT IRON IN LUMP ORE
68.50%	PERCENT IRON IN PELLETS
50.00%	PERCENT IRON IN SINTER
80.00%	PERCENT C IN COAL
2.00%	PERCENT C IN SCRAP CHARGED
0.016	MOISTURE TO FURNACE - (mt/mt HM)
0.014	OXYGEN TO FURNACE - (mt/mt HM)
20.500	FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
20.5	COREX ELEC. POWER REQ'D (kWhr/mt FEED)
42.70%	PERCENT C IN LIMESTONE
0.360	SLAG FROM FURNACE (mt/mt HM)
0.000	SCRAP FROM COREX (mt/mt HM)
1.8	TOP GAS FROM FURNACE (mt/mt HM)
0.042	DUST FROM FURNACE (mt/mt HM)
2.00%	PERCENT C IN SLAG

COAL

2.1379	ELEC. PWR.
0.0533	CUM CO2

FUEL OIL

0.000871

40.00%	PERCENT IRON IN COREX DUST
20.00%	PERCENT CARBON IN COREX DUST
4.50%	PERCENT CARBON IN HOT METAL
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
3.61%	PERCENT Fe IN COREX FCE SLAG
36.00%	WEIGHT COREX FCE SLAG PRODUCED - (mt/mt HM)
93.00%	PERCENT IRON IN HM
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
385.2	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
30.6157	ELECTRIC POWER REQ'D - (kWhr/mt)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
0.000912	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (T/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (T/kWhr NET)
	LUMP IRON ORE DELIVERED
32.24	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1437	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	IRON ORE PELLETS DELIVERED
197.3739	ELECTRIC POWER REQ'D - (kWhr/mt)
0.2374	CUMULATIVE CO2 EMMISSIONS - (kg/mt)
	IRON SINTER DELIVERED
89.5474	ELECTRIC POWER REQ'D - (kWhr/mt)
0.1356	CUMULATIVE CO2 EMMISSIONS - (kg/mt)

DOECOREX
4-Aug-2000

OVERALL SUMMARY MASS BALANCES - COREX HOT METAL/EAF

60% COREX HOT METAL CHARGE - 40%MIDREX DRI

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	LUMP IRON ORE FEED	0.4313	0.000	0.431	68.00%	0.293	0.00%	0.000	
	IRON PELLET FEED	0.4313	0.000	0.431	68.50%	0.295	0.00%	0.000	
	IRON SINTER FEED	0.1181	0.000	0.118	50.00%	0.059	0.00%	0.000	
	IRON SCRAP FEED	0.0000	0.000	0.000	97.70%	0.000	2.00%	0.000	
	LIMESTONE FEED	0.1382	0.000	0.138	0.00%	0.000	43.20%	0.060	
	GRAVEL FEED	0.1382	0.000	0.138	0.00%	0.000	0.00%	0.000	
	COAL FEED	0.7413	0.000	0.741	0.00%	0.000	80.00%	0.593	
	OXYGEN TO FURNACE	0.0000	AS GAS 0.009	0.009	0.00%	0.000	0.00%	0.000	
	MOISTURE TO FURNACE	0.0000	AS GAS 0.010	0.010	0.00%	0.000	0.00%	0.000	
	NET SOLID FEED TO FURNACE	1.9985	0.000	1.999	32.41%	0.6478	32.66%	0.6528	2.3934
	N.G. FUEL TO FURNACE	0.0000	AS GAS 0.013	(MM mt/YR) 0.009			72.00%	0.007	0.0251
	COREX ELECTRICAL POWER REQ'D	(MM kWhr/yr) 40.1390							
	BLAST GAS FROM FURNACE	0.0000	(MM mt/YR) 1.1226	1.123	0.00%	0.000	54.78%	0.615	2.2549
	SLAG FROM FURNACE	0.2245	0.000	0.225	32.41%	0.073	2.00%	0.004	
	HOT METAL FROM FURNACE	0.6237	0.000	0.624	93.00%	0.580	4.50%	0.028	
	SCRAP FROM FCE	0.0000	0.000	0.0000	93.00%	0.000	4.50%	0.000	
	DUST FROM FCE	0.0262	0.000	0.0262	40.00%	0.010	20.00%	0.005	
	NET OXIDE FEED TO PELLET - MIDREX	0.7876	0.069	0.8568	70.47%		0.00%	0.000	
	BINDER TO PELLET - MIDREX	0.0050	0.000	0.0050					
	DOLOMITE TO PELLET - MIDREX	0.0160	0.000	0.0160					
	TOTAL OTHER FEED - MIDREX	0.2000			76.03%	0.153			

60% COREX HOT METAL CHARGE - 40%MIDREX DRI

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	NET PELLETS TO SHAFT FCE - MIDREX	0.7124	0.000	0.7124	67.81%	0.046			
	FUEL TO DRI	AS N.G.	0.020				72.00%	0.015	
	MIDREX ELECTRIC POWER REQ'D	(MM kWhr/yr) 82.4296							
409	MIDREX DRI (100% DRI)	0.4180	0.0000	0.4180	95.00%	0.3971	0.15%	0.00063	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	0.0029			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 38.99						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	0.0000	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0380	
	TOT. C IN OFF GASES (INCL. LRF)							0.0364	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0381	0.1396
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 406.2297							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.042			
421	REFINED STEEL TO CASTING	1.000	0.0000	1.000	99.70%	0.997	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

60% COREX HOT METAL CHARGE, 40% MIDREX DRI - SUMMARY

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 563.7015							
	COAL TO COREX FURNACE	0.7413	(MM kWhr/yr) 1.5848					0.0108	0.0395
	LUMP IRON ORE TO COREX FURNACE	0.4313	13.9066					0.0169	0.0620
	IRON ORE PELL. TO COREX FURNACE	0.4313	85.1367					0.0279	0.1024
	IRON SINTER TO COREX FURNACE	0.1181	10.5726					0.0044	0.0160
	LIMESTONE TO COREX FURNACE	0.1382	4.4567					0.0054	0.0199
	SiO2/GRAVEL TO COREX FURNACE	0.1382	4.4567					0.0054	0.0199
	NET PELLETS TO MIDREX FURNACE	0.7124	140.609					0.0461	0.1691
	FUEL TO DRI - MIDREX	AS N.G. 0.020						0.0147	0.0540
	LIME TO EAF	(MM kWhr/yr) 0.0124	1.1412					0.0047	0.0174
	OXYGEN TO EAF	(MM Nm3/YR) 38.9907	82.6602						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.00003	0.00009
	COMPONENTS ELEC. POWER REQ'D		379.2127						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 942.9142							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	942.9142							
	TOTAL CO2 PRODUCED (PROCESS)							0.7974	2.9239
	EQUIVALENT CO2 FROM POWER GEN.								0.8600
	TOTAL CO2 FROM ALL SOURCES								3.7839

DOECOREX
19-Sept.-1999
Revision A: OREBODY ASSUMPTIONS

IRON/STEELMAKING WATER & SOLIDS BALANCE

60% COREX HOT METAL CHARGE - 40%MIDREX DRI
EAF STEELMAKING/LMF (PFD-009)

BASIS: 1.00 (MM T/YR LIQUID STEEL)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL HOT METAL FEED TO EAF	0.0%	0.000	0.628	0.628	47.1%	93.00%	0.584
401	LUMP LIME FLUX TO EAF	100.0%	0.012	0.000	0.012	1.6%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	4.2%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.006	0.000	0.006	7.1%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	1.1%		
406	TOTAL EAF COOLING WATER CIRC. (MM	0.0%	0.000	70.627	70.627	0.0%		
407	MIDREX DRI	100.0%	0.418	0.000	0.418	6.4%	95.00%	0.397
408	PURCHASED SCRAP	100.0%	0.000	0.000	0.000	90.4%	99.70%	0.000
409	NET DRI CHARGED	100.0%	0.418	0.000	0.418	96.8%	95.00%	0.397
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.026	0.000	0.026	3.4%	50.80%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.015	0.000	0.015	1.9%		
412	PROCESS/COOLING WATER OUT OF EAF	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.157	0.157	0.0%	25.60%	0.040
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	2.6%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR	0.0%	0.000	38.991	38.991	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.054	1.054	0.0%	99.70%	0.981
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.7%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.4%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

DOECOREX
19-Sept.-1999
Revision A: OREEEAF STLMAKING/LMF (PFD-009)

IRON/STEELMAKING WATER & SOLIDS BALANCE

60% COREX HOT METAL CHARGE - 40%MIDREX DRI

BASIS: 1.00 (MM T/YR LIQUID STEEL)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.052	1.052	0.0%	99.70%	1.049
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.014	0.000	0.012	1.5%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.157	0.000	0.157	20.6%	26.97%	0.042
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.7%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	3.1%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.8%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	2.4%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	11.3%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	3.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR	0.0%	0.162	9.600	9.762	21.3%		
509	NET STEEL TO CASTING	0.0%	0.000	1.000	1.000	0.0%	99.70%	0.997
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
511	THIN SLAB TO HOT BAND	0.0%	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX C-13

HISMELT WITH 34.5% HOT METAL CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - HISMELT PROCESS TO PRODUCE HOT METAL

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

BASIS:

0.6882	MM MT/YEAR PURCHASED SCRAP CHARGED
0.3585	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.3585	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.534	MMM MT/YEAR FINE ORE FEED
454.376	MMM Nm3/YEAR AIR
61.452	MMM Nm3/YEAR OXYGEN
16.760	MMM Nm3/YEAR NATURAL GAS
0.204	MMM MT/YEAR COAL
0.061	MMM MT/YEAR FLUX ADDED
0.125	MMM MT/YEAR NET SLAG PRODUCED
316.573	MMM Nm3/YEAR WASTE FLUE GASES

ASSUMPTIONS:

0.534	FINE IRON ORE FEED - (MM MT/YR)
72.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
1.621	ORE/HM RATIO - (MT/mt HM)
0.620	COAL TO HM RATIO - (MT/mt HM)
2.200	NATURAL GAS - (GJ/mt HM)
50.847	NATURAL GAS - (Nm3/mt HM)
1,378.531	TOTAL AIR TO SRV - (Nm3/mt HM)
186.441	OXYGEN TO SRV - (Nm3/mt HM)
80.00%	PERCENT C IN COAL
960.45	GAS VOLUME LEAVING SRV - (Nm3/mt HM)
0.1864	FLUX CHARGED (B. LIME) TO SRV - (MT/mt HM)
0.3785	SLAG PRODUCED - (MT/mt HM)
4.50%	PERCENT C IN HOT METAL
174.81	SRV PLANT ELEC. POWER REQ'D, W/O O2 PLANT - (kWhr/mt HM)
0.3953	TOTAL ORE/TOTAL MINED ROCK RATIO - (MT/mt)
0.2000	FINE ORE FRACTION/TOTAL ORE FEED TO PREP. - (MT/mt)
10.69	FINE ORE TRUCK TRANSPORT FUEL - (kg/mt)

960.5	TOTAL OFF-GASES FROM FURNACE -(Nm3/mt HM)
1.692	DENSITY OF OFF-GASES - (kg/Nm3)
4.50%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN HISMELT FCE SLAG
95.13%	PERCENT IRON IN HM
95.00	ELECTRIC POWER CONSUMPTION HISMELT - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
461.3	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.1	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
2.00%	PERCENT C IN HISMELT SLAG
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	FINE ORE DELIVERED
25.246	ELECTRIC POWER REQ'D - (kWhr/mt)
0.00805	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	FINE COAL DELIVERED
5.533	ELECTRIC POWER REQ'D - (kWhr/mt)
0.01601	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - HISMELT PROCESS TO PRODUCE HOT METAL

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES FEED	0.5345	0.000	0.534	64.50%	0.345	0.00%	0.000	
	COAL FINES TO FEED	0.2045	0.000	0.204	0.00%	0.000	80.00%	0.164	
	AIR TO SRV	MM Nm3/YR 454.38	0.000	MM Nm3/YR 454.38	0.00%	0.000	0.00%	0.000	
	OXYGEN GAS TO SRV	MM Nm3/YR 61.45	0.000	MM Nm3/YR 61.45	0.00%	0.000	0.00%	0.000	
	FLUX CHARGED TO SRV (LIME)	0.0615	0.000	0.061	1.00%	0.001	0.00%	0.000	
	NATURAL GAS TO SRV	MM Nm3/YR 16.7598	0.000	16.76	0.00%	0.000	72.00%	0.009	
	SLAG LEAVING SRV	0.1248	0.000	0.125	3.42%	0.004	2.00%	0.002	
	TOTAL WASTE GAS LEAVING SRV	MM Nm3/YR 316.5732	0.000	MM Nm3/YR 316.573	0.00%	0.000	16.57%	0.154	0.563
	HOT METAL LEAVING SRV TO EAF	0.3585	0.000	0.359	95.13%	0.341	4.50%	0.016	
	ELECT. POWER CONSUMMED IN SRV	(MM kWhr/yr) 62.673							

OVERALL SUMMARY MASS BALANCES - HISMELT PROCESS TO PRODUCE HOT METAL

30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
409	TOTAL STEEL SCRAP (100% DRI)	0.7366	AS N.G. 0.0000	0.7366	99.70%	0.7344	0.15%	0.00110	
403	MISC. ADDITIVES	0.0071	0.0000	0.0071	40.72%	1.30%			
404	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060			94.00%	0.00568	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.00361	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 36.84						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545	99.70%	1.0513	0.15%	0.00158	
	TOTAL CARBON INTO EAF							0.0265	
	TOT. C IN OFF GASES (INCL. LRF)							0.0249	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.002	
	EAF/LRF OFF GASES	0.0831			48.50%	0.010		0.0266	0.0975
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 486.4149							
417	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.9032							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1570	0.0000	0.1570	26.97%	0.0423			
421	REFINED STEEL TO CASTING	0.0000	1.0523	1.0523	99.70%	1.049	0.15%	0.00158	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

DOEHISMT

08-June-2000

OVERALL SUMMARY MASS BALANCES - HISMELT PROCESS TO PRODUCE HOT METAL
30% HOT METAL CHARGE - WITH NO GENERATION OF ELECTRICAL POWER

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	ELEC. POW. (MM kWhr/yr)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 583.9908							
	IRON ORE FINES TO FEED	0.5345	13.4925					0.0012	0.0043
	COAL FINES TO FEED	0.2045	1.1313					0.0044	0.0160
	OXYGEN GAS TO SRV	(MM Nm3/YR) 61.4524	130.2792						
	FLUX CHARGED TO SRV (LIME)	0.0615	5.6438					0.0235	0.0860
	NATURAL GAS TO SRV	16.7598	0.0378						
	OXYGEN TO EAF	(MM Nm3/YR) 36.8404	78.1017						
	EAF ELECTRODES	0.0038	34.5856					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0060	0.1023					0.0000	0.0001
	EAF/LRF OFF-GASES	0.0831						0.0266	0.0975
	COMPONENTS ELEC. POWER REQ'D		263.3742						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 847.3650							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	847.3650							
	TOTAL CO2 PRODUCED (PROCESS)							0.2370	0.8689
	EQUIV. CO2 FROM EXTR. POWER GEN								0.7729
	TOTAL CO2 FROM ALL SOURCES								1.6417

ROTARY HEARTH
DRI FURNACES

APPENDIX C-14

REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - REDSMELT PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED -

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR DRI CHARGED
0.9078	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.9112	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.454	MMM MT/YEAR FINE ORE FEED
3,344.5	MMM Nm3/YEAR AIR
13.9	MMM Nm3/YEAR OXYGEN
2.1	MMM Nm3/YEAR NATURAL GAS
0.350	MMM MT/YEAR COAL
0.052	MMM MT/YEAR FLUX ADDED
2.014	MMM MT/YEAR NET G.B. PELLETS PRODUCED
3,442.3	MMM Nm3/YEAR WASTE FLUE GASES SAF
0.159	MM MT/YEAR NET SLAG PRODUCED

ASSUMPTIONS:

48.48	ELECTRIC POWER CONSUMPTION IN RHF - (kWhr/mt DRI)
1.454	FINE IRON ORE FEED - (MM MT/YR)
72.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
1.621	ORE/HM RATIO - (MT/mt HM)
0.384	COAL TO HM RATIO - (MT/mt HM)
2.375	NATURAL GAS - (GJ/mt HM)
54.890	NATURAL GAS TO RHF- (Nm3/mt HM)
3,344.546	TOTAL AIR TO RHF - (Nm3/mt HM)
13.500	OXYGEN TO RHF - (Nm3/mt HM)
80.00%	PERCENT C IN COAL
3,442.33	GAS VOLUME LEAVING RHF - (Nm3/mt HM)
0.0696	FLUX CHARGED (B. LIME) TO SAF+LRF - (MT/mt HM)
0.1742	TOTAL SLAG PRODUCED IN SAF+LRF - (MT/mt HM)
0.0000	SILICA FLUX TO SAF - (MT/mt HM)
0.0050	DESULFURIZING ADDITIVES TO LRF - (MT/mt HM)
0.0239	CARBON (AS COAL) CHARGE TO SAF - (MT/mt HM)
0.00194	ELECTRODES TO SAF - (MT/mt HM)
0.05613	TOTAL DUST LOSSES (SAF + LT) - (MT/mt HM)
69.71%	PERCENT IRON IN DUST
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
0.9301	NET IRON RECOVERY IN SAF + LTF

4.00%	PERCENT CARBON IN DRI
3,442.3	TOTAL OFF-GASES FROM SAF FURNACE -(Nm3/mt HM)
1.977	DENSITY OF OFF-GASES - (kg/Nm3)
3.60%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN SAF SLAG
96.11%	PERCENT IRON IN HM
291.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
130.0	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
30	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
2.00%	PERCENT C IN SAF SLAG
90.51%	PERCENT IRON IN DRI
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	FINE ORE DELIVERED
25.246	ELECTRIC POWER REQ'D - (kWhr/mt)
0.00805	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	FINE COAL DELIVERED
5.533	ELECTRIC POWER REQ'D - (kWhr/mt)
0.01601	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - REDSMELT PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES TO PELLETIZING	1.4535	0.000	1.4535	64.50%	0.938	0.00%	0.000	
	COAL FINES TO PELLETIZING	0.3496	0.0018	0.3514	0.00%	0.000	80.00%	0.280	
	BINDER TO PELLETIZING	0.0203	0.0015	0.0218	9.93%	0.002	0.00%	0.000	
	RECYCLE DUST TO PELLETIZING	0.2046	0.2046	0.4092	69.71%	0.143	2.00%	0.004	
	RECYCLE PELLETS TO PELLETIZING	0.0516	0.0070	0.0587	1.00%	0.001	14.09%	0.007	
	GROSS GREEN-BALL PELLETS	2.0653	0.2816	2.3469	0.00%	0.000	14.09%	0.291	
	GREEN-BALL PELLETS FEED TO RHF	2.0137	0.2746	2.2883	3.42%	0.069	14.09%	0.284	
	ELEC. POWER IN G-B PELLETIZING	(MM kWhr/yr) 38.4559869							
	NATURAL GAS FUEL TO RHF	(MM Nm3/yr) 54.8896	(MM MT/yr) 0.04074				72.00%	0.029	
	COMBUSTION AIR TO RHF	(MM Nm3/yr) 3,344.5459	(MM MT/yr) 4.32383				0.00%	0.000	
	TOTAL WASTE GAS LEAVING RHF	(MM Nm3/yr) 3,442.3299	(MM MT/yr) 4.45664				22.38%	0.272	0.998
	DRI LEAVING RHF TO SAF	1.0261	0.000	1.0261	90.51%	0.9287	4.00%	0.041	
	ELECT. POWER CONSUMMED IN RHF	(MM kWhr/yr) 49.7464							

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OVERALL SUMMARY MASS BALANCES - REDSMELT PROCESS TO PRODUCE HOT METAL

08-June-2000

MAXIMUM HOT METAL CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	NET DRI CHARGE TO SAF (>450 °C)	1.0261	0.0000	1.0261	90.51%	0.9287	4.00%	0.0410	
	LIME FLUX TO SAF	0.0635							
	SILICA FLUX TO SAF	0.0000							
	ELECTRODES TO SAF	0.0018					96.00%	0.0017	
	SAF CHARGE CARBON	0.0217					80.00%	0.0174	
	SLAG/WIRE DESULFURIZER TO LTF	0.0046							
	SAF FCE. SCRAP, SKULLS	0.0364			95.91%	0.0350	3.60%	0.0013	
	SAF + LADLE TREATMENT DUST	0.0511			69.71%	0.0357			
	MOLTEN SLAG SAF + LTF	0.1587			12.34%	0.0196	2.00%	0.0032	
	NET HOT METAL CHARGE TO EAF	0.9112			96.11%	0.8638	3.60%	0.0328	
	ELECTRIC POWER CONSUMP. SAF	(MM kWhr/yr) 265.1621							
	SAF OFF GASES							0.0228	0.0838
409	TOTAL STEEL SCRAP TO EAF	0.1544		0.1544	99.59%	0.1537	0.15%	0.00110	
403	MISC. ADDITIVES	0.0155		0.0155	40.72%	0.0063			
404	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130			94.00%	0.01218	
405	EAF ELECTRODES	0.0005		0.0005			94.00%	0.00043	
401	LIME CHARGED	0.0243		0.0243					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 52.60						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032	99.70%	1.0002	0.15%	0.00150	

OVERALL SUMMARY MASS BALANCES - REDSMELT PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	TOTAL CARBON INTO EAF							0.0465	
	TOT. C IN OFF GASES (INCL. LRF)							0.0450	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0185			48.50%	0.009		0.0467	0.1712
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 130.0000							
417	LIME TO LADLE REF. FCE.	0.0053		0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.0950							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.0410		0.0410	26.97%	0.0111			
421	REFINED STEEL TO CASTING	0.0000	1.0032	1.0032	99.70%	1.000	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - REDSMELT PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	ELEC. POW. (MM kWhr/yr)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 513.4595							
	IRON ORE FINES TO G.B. PEL. FEED	1.4535	36.6963					0.0032	0.0117
	COAL FINES TO G.B. PEL. FEED	0.3496	1.9343					0.0015	0.0056
	BINDER TO G.B. PELLET.	0.0218	0.4397					0.0002	0.0008
	FLUX TO SAF	0.0635	5.8283					0.0242	0.0889
	CARBON TO SAF	0.0217	0.1203					0.0001	0.0003
	ELECTRODES TO SAF	0.0018	15.9462					0.0005	0.0019
	OXYGEN GAS TO EAF	(MM Nm3/YR) 52.5985	111.5088						
	EAF ELECTRODES	0.0005	4.1273					0.0001	0.0005
	PETROLEUM COKE TO EAF	0.0130	0.2195					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		176.8207						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 690.2802							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	690.2802							
	TOTAL CO2 PRODUCED (PROCESS)							0.3716	1.3624
	EQUIV. CO2 FROM EXTR. POWER GEN								0.6296
	TOTAL CO2 FROM ALL SOURCES								1.9921

APPENDIX C-15

MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - MAUMEE ROTARY HEARTH/EAF

100% DRI CHARGE - 4.0 wt.% CARBON

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

0.787	MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.898	MM MT/YEAR NET GREEN BRIQUETTE FEED TO RHF
1.122	MM MT/YEAR NET DRI TO EAF
1.011	MM MT/YEAR NET DRI IRON UNITS TO EAF

ASSUMPTIONS:

500	ASSUMED FINE ORE SHIPMENT DISTANCE (km)
0.3333	FUEL REQUIREMENT SHIPPING (kg/km)
65,000	SHIPPING TONNAGE (MT FINE ORE/SHIP NET)
0.0026	TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
20.0	BRIQUETTING PLANT ELEC. POWER REQ'D (kWhr/mt FEED)
4.00%	DRI/HBI PERCENT CARBON - (WT.% C)
67.20%	ORE FINES PERCENT IRON - (WT.% Fe DRY)
75.00%	MILL SCALE PERCENT IRON - (WT.% Fe DRY)
47.50%	RESIDUAL IRON UNIT PERCENT IRON - (WT.% Fe DRY)
39.47%	PERCENT IRON ORE FINES IN FEED - (IRON ORE/BRIQUETTE)
19.74%	PERCENT MILL SCALE IN FEED - (SCALE/BRIQUETTE)
19.74%	PERCENT RESIDUAL IRON UNITS IN FEED - (RIU/BRIQUETTE)
16.29%	PERCENT COAL IN FEED - (COAL/BRIQUETTE)
4.76%	PERCENT RECYCLE BRIQUETTE MATERIAL IN FEED - (% RECYCLE)
80.00%	PERCENT CARBON IN COAL - (% C)
55.00	OXYGEN REQUIREMENT FOR EAF - (Nm2/mt HM)

2.52	SUPPLEMENTAL FUEL TO DRI - (GJ/mt DRI)
50.56	SUPPLEMENTAL FUEL TO DRI - (kg/mt DRI)
147.18	HBI ELEC. POWER REQ'D - (kWhr/mt HBI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
566.7	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - MAUMEE ROTARY HEARTH/EAF

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	ORE FINES DELIVERED TO PLANT SITE	0.7868		0.7868	67.20%	0.5287	0.00%	0.0000	
	FUEL OIL FOR ORE FINES DELIVERY		AS LIQUID 0.0020				85.00%	0.0017	0.0063
	NET ORE FINES FEED TO BRIQUETTING	0.7868		0.7868	67.20%	0.5287	0.00%	0.0000	
	COAL TO BRIQUETTING	0.3248		0.3248			80.00%	0.2598	
	MILL SCALE TO BRIQUETTING	0.3934		0.3934	75.00%	0.2950	0.00%	0.0000	
	RESIDUAL IRON UNITS TO BRIQUETTING	0.3934		0.3934	47.50%	0.1869	0.00%	0.0000	
	RECYCLE BRIQUETTES TO FEED	0.0949		0.0949	75.00%	0.0712	13.69%	0.0130	
	TOTAL FEED TO BRIQUETTING	1.9932		1.9932		1.0818	13.69%	0.2728	
	TOTAL BRIQUETTES TO RHF	1.8983		1.8983	75.00%	1.0106	13.69%	0.2598	
	BRIQUETTE ELECTRICAL POWER REQ'D	(MM kWhr/yr) 39.8645							
	NET HBI TO EAF (4.0% C)	1.1217		1.1217	90.10%	1.0106	4.00%	0.0449	
	AUXILARY FUEL TO DRI		AS N.G. 0.0567				72.00%	0.0408	
	DRI OFF GASES							0.2558	0.9379
	RHF DRI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 165.0916							

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OVERALL SUMMARY MASS BALANCES - MAUMEE ROTARY HEARTH/EAF

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	HBI FEED TO EAF	1.1217		1.1217	90.10%	1.0106	4.00%	0.0449	
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.0001	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	0.0130			
404	STEEL C (CHARGE+SLAG INJ)	0.0000	0.0000	0.0000			94.00%	0.0000	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.0036	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 44.0000						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.0016	
	TOTAL CARBON INTO EAF							0.0518	
	TOT. C IN OFF GASES (INCL. LRF)							0.0502	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0831			48.50%	0.0096		0.0502	0.1842
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 597.4453							
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.0633						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.8703							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1562	0.0000	0.1562	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.0490	0.15%	0.0016	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.9739	0.15%	0.0015	

OVERALL SUMMARY MASS BALANCES - MAUMEE ROTARY HEARTH/EAF

100% DRI CHARGE - 4.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 837.2718							
	LIME TO EAF	0.0124	(MM kWhr/yr) 1.1352					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 44.0000	93.2800						
	EAF ELECTRODES	0.0038	34.4015					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0000						0.0000	0.0000
	COMPONENTS ELEC. POWER REQ'D		(MM kWhr/yr) 128.8167						
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 966.0884							
	TOTAL CO2 PRODUCED (PROCESS)							0.3136	1.1498
	EQUIVALENT CO2 FROM POWER GEN.								0.8812
	TOTAL CO2 FROM ALL SOURCES								2.0310

APPENDIX C-16

ITMK3 TO EAF WITH ONLY RECYCLE SCRAP TO EAF

OVERALL SUMMARY MASS BALANCES - ITmk3 PROCESS TO PRODUCE SHOT IRON

MAXIMUM SHOT IRON CHARGED -

BASIS:	
0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR DRI CHARGED
0.9112	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.9112	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)
SUMMARY:	
1.454	MMM MT/YEAR FINE ORE FEED
2,725.4	MMM Nm3/YEAR AIR
0.0	MMM Nm3/YEAR OXYGEN
121.7	MMM Nm3/YEAR NATURAL GAS (PELLET+ITF)
0.404	MMM MT/YEAR COAL
0.000	MMM MT/YEAR FLUX ADDED
1.878	MMM MT/YEAR NET G.B. PELLETS PRODUCED
3,189.7	MMM Nm3/YEAR WASTE FLUE GASES SAF
ASSUMPTIONS:	
130	ELECTRIC POWER CONSUMPTION IN ITF - (kWhr/mt DRI)
1.454	FINE IRON ORE FEED - (MM MT/YR)
77.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
1.621	ORE/HM RATIO - (MT/mt HM)
0.384	COAL TO HM RATIO - (MT/mt HM)
4.850	NATURAL GAS - (GJ/mt HM)
121.692	NATURAL GAS TO ITF & PELLET- (Nm3/mt HM)
2,725.405	TOTAL AIR TO ITF - (Nm3/mt HM)
0.000	OXYGEN TO ITF - (Nm3/mt HM)
80.00%	PERCENT C IN COAL
3,189.73	GAS VOLUME LEAVING ITF - (Nm3/mt HM)
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
0.8999	NET IRON RECOVERY IN SCREENS

2.50%	PERCENT CARBON IN DRI
3,189.7	TOTAL OFF-GASES FROM SAF FURNACE -(Nm3/mt HM)
1.977	DENSITY OF OFF-GASES - (kg/Nm3)
3.60%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN SAF SLAG
97.00%	PERCENT IRON IN SI
0.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
467.0	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
34.703	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
2.00%	PERCENT C IN SAF SLAG
97.00%	PERCENT IRON IN SHOT IRON
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	FINE ORE DELIVERED
25.246	ELECTRIC POWER REQ'D - (kWhr/mt)
0.00805	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	FINE COAL DELIVERED
5.533	ELECTRIC POWER REQ'D - (kWhr/mt)
0.01601	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - ITmk3 PROCESS TO PRODUCE SHOT IRON

MAXIMUM SHOT IRON CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES TO PELLETIZING	1.4535	0.000	1.4535	64.50%	0.938	0.00%	0.000	
	COAL FINES TO PELLETIZING	0.4038	0.0018	0.4056	0.00%	0.000	80.00%	0.323	
	BINDER TO PELLETIZING	0.0203	0.0015	0.0218	9.93%	0.002	0.00%	0.000	
	RECYCLE DUST TO PELLETIZING	0.0000	0.0000	0.0000	0.00%	0.000	2.00%	0.000	
	RECYCLE PELLETS TO PELLETIZING	0.0000	0.0000	0.0000	1.00%	0.000	17.20%	0.000	
	GROSS PELLETS	1.8776	0.0033	1.8809	50.04%	0.940	17.20%	0.323	
	PELLETS FEED TO RHF	1.8776	0.0033	1.8809	50.04%	0.940	17.20%	0.323	
	ELEC. POWER IN PELLETIZING	(MM kWhr/yr) 34.9614795							
	NATURAL GAS FUEL TO ITF	(MM Nm3/yr) 121.6915	(MM MT/yr) 0.09033				72.00%	0.065	
	COMBUSTION AIR TO ITF	(MM Nm3/yr) 2,725.4053	(MM MT/yr) 3.52340				0.00%	0.000	
	TOTAL WASTE GAS LEAVING ITF	(MM Nm3/yr) 3,189.7336	(MM MT/yr) 4.14751				32.04%	0.362	1.329
	SI LEAVING ITF TO SCREENS	1.0261	0.000	1.0261	90.00%	0.9235	2.50%	0.026	
	ELECT. POWER CONSUMMED IN ITF	(MM kWhr/yr) 133.3960							

OVERALL SUMMARY MASS BALANCES - ITmk3 PROCESS TO PRODUCE SHOT IRON

MAXIMUM SHOT IRON CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	SHOT IRON + SLAG	1.0261	0.0000	1.0261	90.00%	0.9235	2.50%	0.0257	
	LIME FLUX TO SAF	#VALUE!							
	SILICA FLUX TO SAF	0.0000							
	ELECTRODES TO SAF	0.0000					96.00%	0.0000	
	SAF CHARGE CARBON	0.0000					80.00%	0.0000	
	SLAG/WIRE DESULFURIZER TO LTF	0.0000							
	SAF FCE. SCRAP, SKULLS	0.0231			95.91%	0.0221	3.60%	0.0008	
	SAF + LADLE TREATMENT DUST	0.0000			0.00%	0.0000			
	MOLTEN SLAG SAF + LTF				12.34%	0.0000	2.00%	0.0000	
	NET SHOT IRON CHARGE TO EAF	0.9235			97.00%	0.8311	3.60%	0.0332	
	ELECTRIC POWER CONSUMP. SAF	(MM kWhr/yr) 0.0000							
	SAF OFF GASES								0.0000
409	TOTAL STEEL SCRAP TO EAF	0.1544		0.1544	99.59%	0.1537	0.15%	0.00110	
403	MISC. ADDITIVES	0.0155		0.0155	40.72%	0.0063			
404	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130			94.00%	0.01218	
405	EAF ELECTRODES	0.0005		0.0005			94.00%	0.00043	
401	LIME CHARGED	0.0243		0.0243					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 52.60						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032	99.70%	1.0002	0.15%	0.00150	

OVERALL SUMMARY MASS BALANCES - ITmk3 PROCESS TO PRODUCE SHOT IRON

MAXIMUM SHOT IRON CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	TOTAL CARBON INTO EAF							0.0470	
	TOT. C IN OFF GASES (INCL. LRF)							0.0455	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0185			48.50%	0.009		0.0471	0.1728
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 467.0000							
417	LIME TO LADLE REF. FCE.	0.0053		0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.8129							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.0410		0.0410	26.97%	0.0111			
421	REFINED STEEL TO CASTING	0.0000	1.0032	1.0032	99.70%	1.000	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - ITmk3 PROCESS TO PRODUCE SHOT IRON
MAXIMUM SHOT IRON CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	ELEC. POW. (MM kWhr/yr)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 670.1703							
	IRON ORE FINES TO G.B. PEL. FEED	1.4535	36.6963					0.0032	0.0117
	COAL FINES TO G.B. PEL. FEED	0.4038	2.2339					0.0018	0.0065
	BINDER TO G.B. PELLET.	0.0218	0.4397					0.0002	0.0008
	FLUX TO SAF							0.0000	0.0000
	CARBON TO SAF	0.0000	0.0000					0.0000	0.0000
	ELECTRODES TO SAF	0.0000	0.0000					0.0000	0.0000
	OXYGEN GAS TO EAF	(MM Nm3/YR) 52.5985	111.5088						
	EAF ELECTRODES	0.0005	4.1273					0.0001	0.0005
	PETROLEUM COKE TO EAF	0.0130	0.2195					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		155.2255						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 825.3959							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	825.3959							
	TOTAL CO2 PRODUCED (PROCESS)							0.4149	1.5213
	EQUIV. CO2 FROM EXTR. POWER GEN								0.7529
	TOTAL CO2 FROM ALL SOURCES								2.2741

FLUID-BED
DRI PROCESSES

APPENDIX C-17

CIRCORED/HBI/EAF WITH ONLY RECYCLE CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - CIRCORED/HBI/EAF

08-June-2000

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.791	MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.544	MM MT/YEAR NET INDURATED MICRO PELLETS
1.089	MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

3,000	ASSUMED FINE ORE SHIPMENT DISTANCE (km)
0.3333	FUEL REQUIREMENT SHIPPING (kg/km)
65,000	SHIPPING TONNAGE (MT FINE ORE/SHIP NET)
0.0154	TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
1.30	FUEL REQUIREMENT - MICRO PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - MICRO-PELLET PLANT (kg N.G./mt PEL)
27.6	MICRO PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)
1.00%	DRI/HBI PERCENT CARBON - (WT.% C)
67.20%	ORE FINES PERCENT IRON - (WT.% Fe DRY)

15.05	FUEL TO DRI - (GJ/mt DRI)
301.95	FUEL TO DRI - (kg/mt DRI)

147.18	HBI ELEC. POWER REQ'D - (kWhr/mt HBI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
566.7	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - CIRCORED/HBI/EAF

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	ORE FINES DELIVERED TO PLANT SITE	1.7908		1.7908	67.20%	1.2034	0.00%	0.0000	
	FUEL OIL FOR ORE FINES DELIVERY		AS LIQUID 0.0276				85.00%	0.0234	0.0859
	NET ORE FINES FEED TO MICRO-PELL.	1.7908		1.7908	67.20%	1.2034	0.00%	0.0000	
	BINDER TO MICRO-PELLET	0.0015		0.0015					
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0467				72.00%	0.0336	
	MICRO-PELLET PLANT FLUE GASES								0.1233
	MICRO-PELLET ELECTRICAL POWER REQ	(MM kWhr/yr) 49.3584							
	NET IND. MICRO-PELLETS, ETC. TO CFB	1.5436		1.5436	67.81%	0.0000			
	NET HBI TO EAF (1.0% C)	1.0890		1.0890	92.80%	1.0106	1.00%	0.0109	
	FUEL TO DRI		AS N.G. 0.3288				72.00%	0.2368	
	DRI OFF GASES	0.1661			87.80%	0.1459			0.8681
	DRI/HBI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 160.2832							

OVERALL SUMMARY MASS BALANCES - CIRCORED/HBI/EAF

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	HBI FEED TO EAF	1.0890		1.0890	92.80%	1.0106	1.00%	0.0109	
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.0001	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	0.0130			
404	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120			94.00%	0.0113	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.0036	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 11.0000						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.0016	
	TOTAL CARBON INTO EAF							0.0291	
	TOT. C IN OFF GASES (INCL. LRF)							0.0275	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0831			48.50%	0.0096		0.0275	0.1010
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 597.4453							
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.0633						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.8703							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1562	0.0000	0.1562	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.0490	0.15%	0.0016	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.9739	0.15%	0.0015	

OVERALL SUMMARY MASS BALANCES - CIRCORED/HBI/EAF

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 841.9572							
	BINDER TO PELLET	0.0015	(MM kWhr/yr) 0.0302					0.0000	0.0001
	BURNT LIME/DOLOMITE TO PELLET	0.0000	0.0000					0.0000	0.0000
	LIME TO EAF	0.0124	1.1352					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 11.0000	23.3200						
	EAF ELECTRODES	0.0038	34.4015					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0120	0.2034					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		(MM kWhr/yr) 59.0903						
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 900.8441							
	TOTAL CO2 PRODUCED (PROCESS)							0.3273	1.1999
	EQUIVALENT CO2 FROM POWER GEN.								0.8217
	TOTAL CO2 FROM ALL SOURCES								2.0216

APPENDIX C-18

CIRCOFER/HAPSAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - CIRCOFER PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR DRI CHARGED
0.9112	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.9112	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.737	MMM MT/YEAR FINE ORE FEED
201.1	MMM Nm3/YEAR OXYGEN TO CFB
0.482	MMM MT/YEAR COAL IN CFB

ASSUMPTIONS:

112.24	ELECTRIC POWER CONSUMPTION IN CFB - (kWhr/mt DRI)
1.737	FINE IRON ORE FEED - (MM MT/YR)
72.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
1.857	ORE/HM RATIO - (MT/mt HM)
0.470	COAL TO DRI RATIO - (MT/mt DRI)
0.482	COAL CHARGED - (MT/YR COAL)
0.278	COAL TO ORE RATIO - (MT/mt FEED ORE)
196.000	OXYGEN TO CFB - (Nm3/mt DRI)
80.00%	PERCENT C IN COAL
0.001	BINDER TO MICROPELLETIZING - (MT/mt FEED ORE)
0.0696	FLUX CHARGED (B. LIME) TO SAF+LRF - (MT/mt HM)
0.1742	TOTAL SLAG PRODUCED IN SAF+LRF - (MT/mt HM)
0.0367	SILICA FLUX TO SAF - (MT/mt HM)
0.0050	DESULFURIZING ADDITIVES TO LRF - (MT/mt HM)
0.0239	CARBON (AS COAL) CHARGE TO SAF - (MT/mt HM)
0.00225	ELECTRODES TO SAF - (MT/mt HM)
0.05613	TOTAL DUST LOSSES (SAF + LT) - (MT/mt HM)
69.71%	PERCENT IRON IN DUST
18.6200	ELECTRIC POWER CONSUMMED IN SAF - (kWhr/mt GB)
0.9301	NET IRON RECOVERY IN SAF + LTF

4.00%	PERCENT CARBON IN DRI
	TOTAL OFF-GASES FROM SAF FURNACE -(Nm3/mt HM)
1.977	DENSITY OF OFF-GASES - (kg/Nm3)
3.60%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN SAF SLAG
96.11%	PERCENT IRON IN HM
350.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
130.0	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
30	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
2.00%	PERCENT C IN SAF SLAG
90.51%	PERCENT IRON IN DRI
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	FINE ORE DELIVERED
25.246	ELECTRIC POWER REQ'D - (kWhr/mt)
0.00805	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	FINE COAL DELIVERED
5.533	ELECTRIC POWER REQ'D - (kWhr/mt)
0.01601	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - CIRCOFER PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES TO CIRCOFER	1.7367		1.7367	64.50%	1.120	0.00%	0.000	
	COAL FINES TO CIRCOFER	0.4823		0.4823	0.00%	0.000	80.00%	0.386	
	BINDER TO MICROPELLETIZING	0.0017		0.0017	0.00%	0.000	0.00%	0.000	
	RECYCLE DUST TO MICROPELLETIZING	0.0868		0.0868	69.71%	0.061	2.00%	0.002	
	TOTAL WASTE GAS LEAVING CFB							0.347	1.271
	DRI LEAVING CFB TO SAF	1.0261	0.000	1.0261	90.51%	0.9287	4.00%	0.041	
		(MM kWhr/yr)							
	ELECT. POWER CONSUMMED IN CFB	115.1720							

OVERALL SUMMARY MASS BALANCES - CIRCOFER PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	NET DRI CHARGE TO SAF (>450 °C)	1.0261	0.0000	1.0261	90.51%	0.9287	4.00%	0.0410	
	LIME FLUX TO SAF	0.0635							
	SILICA FLUX TO SAF	0.0334							
	ELECTRODES TO SAF	0.0021					96.00%	0.0020	
	SAF CHARGE CARBON	0.0217					80.00%	0.0174	
	SLAG/WIRE DESULFURIZER TO LTF	0.0046							
	SAF FCE. SCRAP, SKULLS	0.0364			95.91%	0.0350	3.60%	0.0013	
	SAF + LADLE TREATMENT DUST	0.0511			69.71%	0.0357			
	MOLTEN SLAG SAF + LTF	0.1587			12.34%	0.0196	2.00%	0.0032	
	NET HOT METAL CHARGE TO EAF	0.9112			96.11%	0.8638	3.60%	0.0328	
	ELECTRIC POWER CONSUMP. SAF	(MM kWhr/yr) 318.9235							
	SAF OFF GASES							0.0231	0.0848
409	TOTAL STEEL SCRAP TO EAF	0.1544		0.1544	99.59%	0.1537	0.15%	0.00110	
403	MISC. ADDITIVES	0.0155		0.0155	40.72%	0.0063			
404	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130			94.00%	0.01218	
405	EAF ELECTRODES	0.0005		0.0005			94.00%	0.00043	
401	LIME CHARGED	0.0243		0.0243					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 52.60						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032	99.70%	1.0002	0.15%	0.00150	

OVERALL SUMMARY MASS BALANCES - CIRCOFER PROCESS TO PRODUCE HOT METAL

MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	TOTAL CARBON INTO EAF							0.0465	
	TOT. C IN OFF GASES (INCL. LRF)							0.0450	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0185			48.50%	0.009		0.0467	0.1712
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 130.0000							
417	LIME TO LADLE REF. FCE.	0.0053		0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.0950							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.0410		0.0410	26.97%	0.0111			
421	REFINED STEEL TO CASTING	0.0000	1.0032	1.0032	99.70%	1.000	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OVERALL SUMMARY MASS BALANCES - CIRCOFER PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	ELEC. POW. (MM kWhr/yr)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 594.1905							
	IRON ORE FINES TO G.B. PEL. FEED	1.7367	43.8436					0.0038	0.0140
	COAL FINES TO G.B. PEL. FEED	0.4823	2.6683					0.0021	0.0077
	BINDER TO G.B. PELLET.	0.0017	0.0351					0.0000	0.0001
	FLUX TO SAF	0.0635	5.8283					0.0242	0.0889
	CARBON TO SAF	0.0217	0.1203					0.0001	0.0003
	ELECTRODES TO SAF	0.0021	18.4520					0.0006	0.0022
	OXYGEN GAS TO EAF	(MM Nm3/YR) 52.5985	111.5088						
	EAF ELECTRODES	0.0005	4.1273					0.0001	0.0005
	PETROLEUM COKE TO EAF	0.0130	0.2195					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		186.8032						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 780.9938							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	780.9938							
	TOTAL CO2 PRODUCED (PROCESS)							0.4474	1.6404
	EQUIV. CO2 FROM EXTR. POWER GEN.								0.7124
	TOTAL CO2 FROM ALL SOURCES								2.3527

APPENDIX C-19

FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHANGE TO EAF

OVERALL SUMMARY MASS BALANCES - FINMET/HBI/EAF

08-June-2000 100% DRI/HBI CHARGE - 1.0 wt.% CARBON

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.751	MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.509	MM MT/YEAR NET INDURATED MICRO PELLETS TO FL. BEDS
1.089	MM MT/YEAR NET DRI/HBI TO EAF

ASSUMPTIONS:

3,000	ASSUMED FINE ORE SHIPMENT DISTANCE (km)
0.3333	FUEL REQUIREMENT SHIPPING (kg/km)
65,000	SHIPPING TONNAGE (MT FINE ORE/SHIP NET)
0.0154	TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
1.30	FUEL REQUIREMENT - MICRO PELLET PLANT (GJ/mt PEL)
26.08	FUEL REQUIREMENT - MICRO-PELLET PLANT (kg N.G./mt PEL)
16.5	MICRO PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)
1.00%	DRI/HBI PERCENT CARBON - (WT.% C)
67.20%	ORE FINES PERCENT IRON - (WT.% Fe DRY)

12.95	FUEL TO DRI - (GJ/mt DRI)
259.83	FUEL TO DRI - (kg/mt DRI)

172.27	HBI ELEC. POWER REQ'D - (kWhr/mt HBI)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
566.7	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

POWER & CO2 EMMISSIONS FOR COMPONENTS:

	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - FINMET/HBI/EAF

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	ORE FINES DELIVERED TO PLANT SITE	1.7511		1.7511	67.20%	1.1767	0.00%	0.0000	
	FUEL OIL FOR ORE FINES DELIVERY		AS LIQUID 0.0269				85.00%	0.0229	0.0840
	NET ORE FINES FEED TO MICRO-PELL.	1.7511		1.7511	67.20%	1.1767	0.00%	0.0000	
	BINDER TO MICRO-PELLET	0.0015		0.0015					
	FUEL (DRYING, INDURATION, ETC.)		AS N.G. 0.0457				72.00%	0.0329	
	MICRO-PELLET PLANT FLUE GASES								0.1206
	MICRO-PELLET ELECTRICAL POWER REQ	(MM kWhr/yr) 28.9590							
	NET IND. MICRO-PELLETS, ETC. TO FB	1.5091		1.5091	67.81%	0.0000			
	NET HBI TO EAF (1.0% C)	1.0890		1.0890	92.80%	1.0106	1.00%	0.0109	
	FUEL TO DRI		AS N.G. 0.2830				72.00%	0.2037	
	DRI OFF GASES	0.1661			87.80%	0.1459			0.7470
	DRI/HBI ELECTRICAL POWER REQ'D	(MM kWhr/yr) 187.5973							

OVERALL SUMMARY MASS BALANCES - FINMET/HBI/EAF

08-June-2000

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	HBI FEED TO EAF	1.0890		1.0890	92.80%	1.0106	1.00%	0.0109	
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.0001	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	0.0130			
404	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120			94.00%	0.0113	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.0036	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 11.0000						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.0016	
	TOTAL CARBON INTO EAF							0.0291	
	TOT. C IN OFF GASES (INCL. LRF)							0.0275	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0831			48.50%	0.0096		0.0275	0.1010
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 597.4453							
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.0633						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.8703							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1562	0.0000	0.1562	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.0490	0.15%	0.0016	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.9739	0.15%	0.0015	

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08-June-2000

OVERALL SUMMARY MASS BALANCES - FINMET/HBI/EAF

100% DRI/HBI CHARGE - 1.0 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 848.8720							
	BINDER TO PELLET	0.0015	(MM kWhr/yr) 0.0302					0.0000	0.0001
	BURNT LIME/DOLOMITE TO PELLET	0.0000	0.0000					0.0000	0.0000
	LIME TO EAF	0.0124	1.1352					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 11.0000	23.3200						
	EAF ELECTRODES	0.0038	34.4015					0.0011	0.0041
	PETROLEUM COKE TO EAF	0.0120	0.2034					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		(MM kWhr/yr) 59.0903						
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 907.7589							
	TOTAL CO2 PRODUCED (PROCESS)							0.2930	1.0742
	EQUIVALENT CO2 FROM POWER GEN.								0.8280
	TOTAL CO2 FROM ALL SOURCES								1.9022

APPENDIX C-20

GENERIC IRON CARBIDE/EAF RECYCLE SCRAP TO EAF (REPRESENTS NUCOR/ICH, QUALITEC/KAWASKI, PROCEDYNE)

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF

08-June-2000 100% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

Rev. 2

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.701	MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.229	MM MT/YEAR NET DRI/HBI TO EAF

ASSUMPTIONS:

3,000	ASSUMED FINE ORE SHIPMENT DISTANCE (km)
0.3333	FUEL REQUIREMENT SHIPPING (kg/km)
65,000	SHIPPING TONNAGE (MT FINE ORE/SHIP NET)
0.0154	TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
6.50%	EFFECTIVE IC PERCENT CARBON - (WT.% C)
67.20%	ORE FINES PERCENT IRON - (WT.% Fe DRY)

13.40	FUEL TO IRON CARBIDE - (GJ/mt IC)
268.86	FUEL TO IC - (kg/mt IC)
206.24	IC ELEC. POWER REQ'D - (kWhr/mt IC)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
483.0	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF

100% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	ORE FINES DELIVERED TO PLANT SITE	1.7011		1.7011	67.20%	1.1431	0.00%	0.0000	
	FUEL OIL FOR ORE FINES DELIVERY		AS LIQUID 0.0262				85.00%	0.0222	0.0816
	NET IRON CARBIDE TO EAF (1.0% C)	1.2289		1.2289	90.00%	1.1060	6.50%	0.0799	
	FUEL TO IRON CARBIDE REACTOR		AS N.G. 0.3304				72.00%	0.2379	
	IRON CARBIDE OFF GASES	0.0424			87.50%	0.0371			0.8723
	IRON CARBIDE ELEC. POWER REQ'D	(MM kWhr/yr) 253.4460							

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF

100% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON CARBIDE FEED TO EAF	1.2289		1.2289	90.00%	1.1060	6.50%	0.0799	
409	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648	99.70%	0.0646	0.15%	0.0001	
403	MISC. ADDITIVES	0.0070	0.0000	0.0070	40.72%	0.0130			
404	STEEL C (CHARGE+SLAG INJ)	0.0000	0.0000	0.0000			94.00%	0.0000	
405	EAF ELECTRODES	0.0038	0.0000	0.0038			94.00%	0.0036	
401	LIME CHARGED	0.0124	0.0000	0.0124					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 71.5000						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543	99.70%	1.0511	0.15%	0.0016	
	TOTAL CARBON INTO EAF							0.0868	
	TOT. C IN OFF GASES (INCL. LRF)							0.0852	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0831			48.50%	0.0096		0.0852	0.3126
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 509.2178							
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.0633						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 34.8703							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.1562	0.0000	0.1562	26.97%	0.0421			
421	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521	99.70%	1.0490	0.15%	0.0016	
510	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768	99.70%	0.9739	0.15%	0.0015	

DOEIRCB

08-June-2000

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF

100% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 797.5342							
	BINDER TO PELLET	0.0000	(MM kWhr/yr) 0.0000					0.0000	0.0000
	BURNT LIME/DOLOMITE TO PELLET	0.0000	0.0000					0.0000	0.0000
	LIME TO EAF	0.0124	1.1352					0.0047	0.0173
	OXYGEN TO EAF	(MM Nm3/YR) 71.5000	151.5800						
	EAF ELECTRODES	0.0025	22.7050					0.0007	0.0027
	PETROLEUM COKE TO EAF	0.0000						0.0000	0.0000
	COMPONENTS ELEC. POWER REQ'D		(MM kWhr/yr) 175.4202						
	TOTAL ELECTRICAL POWER	(MM kWhr/yr) 972.9543							
	TOTAL CO2 PRODUCED (PROCESS)							0.3508	1.2864
	EQUIVALENT CO2 FROM POWER GEN.								0.8874
	TOTAL CO2 FROM ALL SOURCES								2.1738

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF
IRON CARBIDE/SAF MELTER/EAF
40% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

BASIS:

1.000	MM MT/YEAR LIQUID STEEL PRODUCT
0.977	MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

0.680	MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
0.492	MM MT/YEAR NET IC TO SAF

13.40	FUEL TO IRON CARBIDE - (GJ/mt IC)
268.86	FUEL TO IC - (kg/mt IC)
206.24	IC ELEC. POWER REQ'D - (kWhr/mt IC)
0.150%	STEEL PERCENT CARBON - (wt.% C)
2.20	AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
267.5	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

ASSUMPTIONS:

3,000	ASSUMED FINE ORE SHIPMENT DISTANCE (km)
0.3333	FUEL REQUIREMENT SHIPPING (kg/km)
65,000	SHIPPING TONNAGE (MT FINE ORE/SHIP NET)
0.0154	TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
6.50%	EFFECTIVE IC PERCENT CARBON - (WT.% C)
67.20%	ORE FINES PERCENT IRON - (WT.% Fe DRY)
0.0696	FLUX CHARGED (B. LIME) TO SAF+LRF - (MT/mt HM)
0.1742	TOTAL SLAG PRODUCED IN SAF+LRF - (MT/mt HM)
0.0367	SILICA FLUX TO SAF - (MT/mt HM)
0.0050	DESULFURIZING ADDITIVES TO LRF - (MT/mt HM)
0.0000	CARBON (AS COAL) CHARGE TO SAF - (MT/mt HM)
0.00225	ELECTRODES TO SAF - (MT/mt HM)
0.05613	TOTAL DUST LOSSES (SAF + LT) - (MT/mt HM)
69.71%	PERCENT IRON IN DUST
18.6200	ELECTRIC POWER CONSUMMED IN SAF - (kWhr/mt GB)
0.9301	NET IRON RECOVERY IN SAF + LTF
6.50%	PERCENT CARBON IN IC
	TOTAL OFF-GASES FROM SAF FURNACE -(Nm3/mt HM)
1.977	DENSITY OF OFF-GASES - (kg/Nm3)
3.60%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN SAF SLAG
96.11%	PERCENT IRON IN HM
350.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.9301	NET IRON RECOVERY IN SAF + LTF

	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF
40% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	ORE FINES DELIVERED TO PLANT SITE	0.6804		0.6804	67.20%	0.4573	0.00%	0.0000	
	FUEL OIL FOR ORE FINES DELIVERY		AS LIQUID 0.0105				85.00%	0.0089	0.0326
	NET IRON CARBIDE TO SAF (6.5% C)	0.4916		0.4916	90.00%	0.4424	6.50%	0.0320	
	FUEL TO IRON CARBIDE REACTOR		AS N.G. 0.1322				72.00%	0.0952	
	IRON CARBIDE OFF GASES	0.0170			87.50%	0.0149			0.3489
	IRON CARBIDE ELEC. POWER REQ'D	(MM kWhr/yr) 101.3784							
	NET IC CHARGE TO SAF	0.4916	0.0000	0.4916	90.00%	0.4424	6.50%	0.0320	
	LIME FLUX TO SAF	0.0298							
	SILICA FLUX TO SAF	0.0157							
	ELECTRODES TO SAF	0.0010					96.00%	0.0009	
	SAF CHARGE CARBON	0.0000					80.00%	0.0000	
	SLAG/WIRE DESULFURIZER TO LTF	0.0021							
	SAF FCE. SCRAP, SKULLS	0.0128			95.91%	0.0123	3.60%	0.0005	
	SAF + LADLE TREATMENT DUST	0.0240			6.96%	0.0017			
	MOLTEN SLAG SAF + LTF	0.0746			12.34%	0.0092	0.00%	0.0000	
	NET HOT METAL CHARGE TO EAF	0.4281			96.11%	0.4115	3.60%	0.0154	
	ELECTRIC POWER CONSUMP. SAF	(MM kWhr/yr) 149.8423							

OVERALL SUMMARY MASS BALANCES - GENERIC IRON CARBIDE PROCESS/EAF
40% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	SAF OFF GASES							0.0170	0.0623
409	TOTAL STEEL SCRAP TO EAF	0.6375		0.1544	99.59%	0.1537	0.15%	0.00110	
403	MISC. ADDITIVES	0.0155		0.0155	40.72%	0.0063			
404	STEEL C (CHARGE+SLAG INJ)	0.0000	AS GAS	0.0130			94.00%	0.01218	
405	EAF ELECTRODES	0.0005		0.0005	99.70%	0.0000	94.00%	0.00043	
401	LIME CHARGED	0.0243		0.0243					
415	O2 GAS TO EAF (MM Nm3/YR)		44.48						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032	99.70%	1.0002	0.15%	0.00150	
	TOTAL CARBON INTO EAF	0.0000			48.50%	0.000		0.0465	
	TOT. C IN OFF GASES (INCL. LRF)	(MM kWhr/yr) 0.0000						0.0450	
417	AUX. FUEL TO EAF	0.0053	AS N.G. 0.0023	0.0053			72.00%	0.0017	
418	EAF/LRF OFF GASES	0.0185		0.0004	48.50%	0.009		0.0467	0.1712
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 268.3688	0.063						
417	LIME TO LADLE REF. FCE.	(MM kWhr/yr) 0.0053		0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004	26.97%	0.4175			
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0000	AS GAS 0.063	0.0000	99.70%	0.000	0.15%	0.00000	
510	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.0950	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.0410		0.0410	26.97%	0.0111			
421	REFINED STEEL TO CASTING	0.0000	1.0032	1.0032	99.70%	1.000	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

OTHER PROCESSES

APPENDIX C-21

SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF

OVERALL SUMMARY MASS BALANCES - SL/RN PROCESS TO PRODUCE DRI

MAXIMUM DRI CHARGED -

BASIS:	
0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
0.9365	MM MT/YEAR DRI CHARGED
0.0000	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.0000	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)
SUMMARY:	
1.356	MMM MT/YEAR FINE ORE FEED
3,344.546	MMM Nm3/YEAR AIR
12.643	MMM Nm3/YEAR OXYGEN
55.455	MMM Nm3/YEAR NATURAL GAS
0.702	MMM MT/YEAR COAL
0.052	MMM MT/YEAR FLUX ADDED
2.014	MMM MT/YEAR NET G.B. PELLETS PRODUCED
3,442.330	MMM Nm3/YEAR WASTE FLUE GASES SAF
0.000	MM MT/YEAR NET SLAG PRODUCED
ASSUMPTIONS:	
51.38	ELECTRIC POWER CONSUMPTION IN RK - (kWhr/mt DRI)
1.356	FINE IRON ORE FEED - (MM MT/YR)
63.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
1.448	ORE/DRI RATIO - (MT/mt DRI)
0.750	COAL TO DRI RATIO - (MT/mt DRI)
0.100	BINDER TO DRI RATIO - (MT/mt DRI)
59.215	NATURAL GAS TO RK- (Nm3/mt DRI)
3,344.546	TOTAL AIR TO RK - (Nm3/mt DRI)
13.500	OXYGEN TO RK - (Nm3/mt DRI)
80.00%	PERCENT C IN COAL
3,442.33	GAS VOLUME LEAVING RK - (Nm3/mt HM)
0.0000	FLUX CHARGED (B. LIME) TO SAF+LRF - (MT/mt HM)
0.0000	TOTAL SLAG PRODUCED IN SAF+LRF - (MT/mt HM)
0.0000	SILICA FLUX TO SAF - (MT/mt HM)
0.0000	DESULFURIZING ADDITIVES TO LRF - (MT/mt HM)
0.0000	CARBON (AS COAL) CHARGE TO SAF - (MT/mt HM)
0.00000	ELECTRODES TO SAF - (MT/mt HM)
0.00000	TOTAL DUST LOSSES (SAF + LT) - (MT/mt HM)
69.71%	PERCENT IRON IN DUST
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
1.0000	NET IRON RECOVERY IN SAF + LTF

4.00%	PERCENT CARBON IN DRI
3,442.3	TOTAL OFF-GASES FROM SAF FURNACE -(Nm3/mt HM)
1.977	DENSITY OF OFF-GASES - (kg/Nm3)
3.60%	PERCENT CARBON IN HOT METAL
3.42%	PERCENT Fe IN SAF SLAG
96.11%	PERCENT IRON IN HM
0.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
686.2	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
30	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.
2.00%	PERCENT C IN SAF SLAG
90.51%	PERCENT IRON IN DRI
	POWER & CO2 EMMISSIONS FOR COMPONENTS:
	FINE ORE DELIVERED
25.246	ELECTRIC POWER REQ'D - (kWhr/mt)
0.00805	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	FINE COAL DELIVERED
5.533	ELECTRIC POWER REQ'D - (kWhr/mt)
0.01601	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BINDER FOR PELLETIZING
20.19	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0364	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	BURNT LIME/DOLOMITE
91.84	ELECTRIC POWER REQ'D - (kWhr/mt)
1.4002	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRODES
9,000.00	ELECTRIC POWER REQ'D - (kWhr/mt)
1.0763	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	PETROLEUM COKE (CARBON)
16.936	ELECTRIC POWER REQ'D - (kWhr/mt)
0.0156	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	OXYGEN
2.12	ELECTRIC POWER REQ'D - (kWhr/Nm3)
NONE	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	CO-PRODUCT COKE
15.5435	ELECTRIC POWER REQ'D - (kWhr/Nm3)
0.9975	CUMULATIVE CO2 EMMISSIONS - (MT/mt)
	ELECTRICAL POWER GENERATION (NET)
0.000604	CUMULATIVE CO2 EMMISSIONS - N.G. - (MT/kWhr NET)
0.001448	CUMULATIVE CO2 EMMISSIONS - COAL - (MT/kWhr NET)
0.000871	CUMULATIVE CO2 EMMISSIONS - FUEL OIL - (MT/kWhr NET)
0.000912	CUM. CO2 EMMISSIONS - U.S.A. WTD. AVG. - (MT/kWhr NET)

OVERALL SUMMARY MASS BALANCES - SL/RN PROCESS TO PRODUCE DRI

MAXIMUM DRI CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	IRON ORE FINES TO PELLETIZING	1.3560	0.000	1.3560	64.50%	0.875	0.00%	0.000	
	COAL FINES TO PELLETIZING	0.7024	0.0000	0.7024	0.00%	0.000	80.00%	0.562	
	BINDER TO PELLETIZING	0.0937	0.0015	0.0951	2.15%	0.002	0.00%	0.000	
	RECYCLE DUST TO PELLETIZING	0.2046	0.2046	0.4092	69.71%	0.143	2.00%	0.004	
	RECYCLE PELLETS TO PELLETIZING	0.0516	0.0070	0.0587	1.00%	0.001	28.11%	0.015	
	GROSS PELLETS	2.0653	0.2816	2.3469	0.00%	0.000	28.11%	0.581	
	PELLETS FEED TO RK	2.0137	0.2746	2.2883	3.42%	0.069	28.11%	0.566	
	ELEC. POWER IN G-B PELLETIZING	(MM kWhr/yr) 38.4559869							
	NATURAL GAS FUEL TO RK	(MM Nm3/yr) 59.2147	(MM MT/yr) 0.04396				72.00%	0.032	
	COMBUSTION AIR TO RK	(MM Nm3/yr) 3,344.5459	(MM MT/yr) 4.32383				0.00%	0.000	
	TOTAL WASTE GAS LEAVING RK	(MM Nm3/yr) 3,442.3299	(MM MT/yr) 5.49991				37.11%	0.557	2.041
	DRI LEAVING RK	1.0261	0.000	1.0261	90.51%	0.9287	4.00%	0.041	
	ELECT. POWER CONSUMMED IN RK	(MM kWhr/yr) 52.7222							

DOESLRNVB

OVERALL SUMMARY MASS BALANCES - SL/RN PROCESS TO PRODUCE DRI

21-June-2000

MAXIMUM DRI CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	NET DRI CHARGE	1.0261	0.0000	1.0261	90.51%	0.9287	4.00%	0.0410	
	LIME FLUX TO SAF	0.0000							
	SILICA FLUX TO SAF	0.0000							
	ELECTRODES TO SAF	0.0000					96.00%	0.0000	
	SAF CHARGE CARBON	0.0000					80.00%	0.0000	
	SLAG/WIRE DESULFURIZER TO LTF	0.0000							
	SAF FCE. SCRAP, SKULLS	0.0000			95.91%	0.0000	3.60%	0.0000	
	SAF + LADLE TREATMENT DUST	0.0000			69.71%	0.0000			
	MOLTEN SLAG SAF + LTF	0.0000			12.34%	0.0000	2.00%	0.0000	
	NET DRI CHARGE TO EAF	1.0261			96.11%	0.9287	3.60%	0.0369	
	ELECTRIC POWER CONSUMP. SAF	(MM kWhr/yr) 0.0000							
	SAF OFF GASES							0.0041	0.0150
409	TOTAL STEEL SCRAP TO EAF	0.1544		0.1544	99.59%	0.1537	0.15%	0.00110	
403	MISC. ADDITIVES	0.0155		0.0155	40.72%	0.0063			
404	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130			94.00%	0.01218	
405	EAF ELECTRODES	0.0045		0.0045			94.00%	0.00423	
401	LIME CHARGED	0.0243		0.0243					
415	O2 GAS TO EAF (MM Nm3/YR)		AS GAS 52.60						
416	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032	99.70%	1.0002	0.15%	0.00150	

OVERALL SUMMARY MASS BALANCES - SL/RN PROCESS TO PRODUCE DRI

MAXIMUM DRI CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CO2 (MM T/YR)
	TOTAL CARBON INTO EAF							0.0545	
	TOT. C IN OFF GASES (INCL. LRF)							0.0530	
	AUX. FUEL TO EAF		AS N.G. 0.0023				72.00%	0.0017	
	EAF/LRF OFF GASES	0.0185			48.50%	0.009		0.0546	0.2003
	EAF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 686.2000							
417	LIME TO LADLE REF. FCE.	0.0053		0.0053					
418	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004					
419	ARGON GAS TO LRF (MM Nm3/YR)		AS GAS 0.063						
	LRF ELECTRICAL POWER REQ'D	(MM kWhr/yr) 30.0950							
425	TOTAL SLAG OUTPUT (EAF+LRF)	0.0410		0.0410	26.97%	0.0111			
421	REFINED STEEL TO CASTING	0.0000	1.0032	1.0032	99.70%	1.000	0.15%	0.00150	
510	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770	99.70%	0.974	0.15%	0.00147	

DOESLRNVB

21-June-2000

OVERALL SUMMARY MASS BALANCES - SL/RN PROCESS TO PRODUCE DRI
MAXIMUM DRI CHARGED -

STREAM NUMBER	STREAM LABLE	DRY SOLIDS (MM T/YR)	ELEC. POW. (MM kWhr/yr)	TOTAL (MM T/YR)	%Fe (DRY)	Fe UNITS (MM T/YR)	%C (DRY)	C UNITS (MM T/YR)	CUM. CO2 (MM T/YR)
	PROCESS ELECTRIC POWER REQ'D	(MM kWhr/yr) 807.4732							
	IRON ORE FINES TO G.B. PEL. FEED	1.3560	34.2336					0.0030	0.0109
	COAL FINES TO G.B. PEL. FEED	0.7024	3.8860					0.0031	0.0112
	BINDER TO G.B. PELLET.	0.0951	1.9203					0.0009	0.0035
	FLUX TO SAF	0.0000	0.0000					0.0000	0.0000
	CARBON TO SAF	0.0000	0.0000					0.0000	0.0000
	ELECTRODES TO SAF	0.0000	0.0000					0.0000	0.0000
	OXYGEN GAS TO EAF	(MM Nm3/YR) 52.5985	111.5088						
	EAF ELECTRODES	0.0045	40.5000					0.0013	0.0048
	PETROLEUM COKE TO EAF	0.0130	0.2195					0.0001	0.0002
	COMPONENTS ELEC. POWER REQ'D		192.2682						
	TOTAL ELECTRICAL POWER REQ'D	(MM kWhr/yr) 999.7413							
	TOTAL ELECTRIC POWER PROD.	0.0000							
	TOTAL NET ELEC. ADDITIONAL	999.7413							
	TOTAL CO2 PRODUCED (PROCESS)							0.6237	2.2869
	EQUIV. CO2 FROM EXTR. POWER GEN								0.9119
	TOTAL CO2 FROM ALL SOURCES								3.1987

APPENDIX D

LISTINGS OF DETAILED PROCESS SPREADSHEETS

D-1: 100% DRI CHARGED TO EAF - 1.0% CARBON

D-2: 100% DRI CHARGED TO EAF - 2.5% CARBON

D-3: 30% DRI CHARGED TO EAF - 1.0% CARBON

D-4: 100% SCRAP CHARGED TO EAF

APPENDIX D-1

100% DRI CHARGED TO EAF - 1.0% CARBON

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: OREBODY ASSUMPTIONS

BASIS:

7,940	HRS/YR CONCENTRATOR/PELLET/DRI OPERATION				
8,000	HRS/YR EAF/LMF/CASTING OPERATION				
					TARGET
184.5	T/HR ORE1 CONC. NET FEED	68.559%	IRON UNITS	IN CONC.	68.560%
0.0	T/HR ORE2	0.000%	IRON UNITS		
0.0	T/HR ORE3	0.000%	IRON UNITS		
184.5	T/HR NET DRI ORE FEED	68.559%	IRON UNITS	89.36%	AS FE304
122.1	T/HR SLAB PRODUCED	8,000	HRS/YR BASIS	10.64%	AS FE2O3

				TARGET			BALANCE
1.089	DRI PROD.	1.636	ORE/P TO DRI	79.932%	Fe RECOV		80.763%
0.977	SLAB PROD.	1.114	DRI TO SLAB	60.000%	Wt.% RECOV		58.900%

TOTAL PLANT PRODUCTION (DRY BASIS):

6.294	MM TONNES/YEAR AS-MINED ROCK
2.488	MM TONNES/YEAR NET ORE TO CONCENTRATOR
1.465	MM TONNES/YEAR NET CONCENTRATE
0.000	MM TONNES/YEAR LUMP ORE3
1.940	MM TONNES/YEAR GREEN BALL PELLET (+6mm)
1.968	MM TONNES/YEAR TOTAL INDURATED PELLET
1.836	MM TONNES/YEAR NET INDURATED PELLET (+6mm)
1.781	MM TONNES/YEAR FEED TO DRI FCE.
1.089	MM TONNES/YEAR DRI
0.977	MM TONNES/YEAR NET SLAB PRODUCT (BALANCE)
0.000	MM TONNES/YEAR HOT BAND SLAB
0.977	MM TONNES/YEAR NET SLAB PRODUCT
1.000	MM TONNES/YEAR LIQUID STEEL (TARGET)
0.977	MM TONNES/YEAR NET SLAB PRODUCT (TARGET)

CONCENTRATOR

60.474%	WASTE ROCK - % OF MINED
3.000%	AS-MINED ROCK MOISTURE - %
30.000%	AS-MINED ROCK IRON UNITS - WT.% IRON
50.000%	ORE ROCK IRON UNITS - WT.% IRON
70.0%	GRIZZLY SCREEN O/S - % OF FEED
200.0%	CIRCULATING LOAD - +10 mm TO TERTIARY (% FEED)
0.0%	PERCENT FEED TO SECONDARY 2 (%)
0.0%	PERCENT FEED TO TERTIARY 4 (%)
300.0%	BALL MILL CIRCULATING LOAD (% OF FEED)
65.0%	BALL MILL PERCENT SOLIDS (% OF FEED)
35.0%	B.M. CYCLONE O/F PERCENT SOLIDS (%)
4.60%	GROUND ORE LOSSES TO SLIMES - WT.%
5.00%	DESLIME CYCLONE O/F PERCENT SOLIDS (%)
68.21%	STG.1 MAG. CONC. RECOVERY - WT.% OF FEED
86.39%	STG. 1 IRON UNIT RECOVERY - WT.% OF IRON UNITS
95.30%	STG. 2 MAG. CONC. WT. RECOVERY - WT.% OF FEED
98.50%	STG. 2 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
98.60%	STG. 3 MAG. CONC. RECOV. - WT.% OF FEED
99.50%	STG. 3 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
200.00%	REGRIND MILL CIRCULATING LOAD (% OF FEED)
65.00%	REGRIND MILL % SOLIDS (WT.%)
99.00%	S-FLOTATION IRON CONC - WT.% OF FEED
99.50%	S-FLOTATION IRON UNIT RECOV. - WT.% OF IU
97.30%	GAN. REJECT. MAG. SEP. - WT.% OF FEED
98.57%	GAN. REJECT. MAG. SEP. - WT.% OF IU

CONCENTRATOR DEWATERING

65.0%	WT.% SOLIDS IN CONC. THICK. U/F
35.0%	WT.% SOLIDS IN TAILS. THICK. U/F
0.0%	FEED DIVER. TO THICK. - % OF FEED
10.0%	FILTER FEED O/F - % OF FEED

DRI PLANT

3.0%	PERCENT OF PELLET FINES - WT.% PEL.
10.0%	PERCENT OF LUMP FINES - WT.% LUMP
4.0%	PERCENT DUST - WT.% OF OXIDE FEED
3.0%	PERCENT -6 mm DRI FINES - WT.% DRI
0.0%	PERCENT REMET CHARGED - WT.% OF FD
0.22%	PERC. LIME FOR COATING - WT.% OF FD
9.33%	SOLIDS IN OFF-GASS - WT.% OF DRI FD
1.69%	SOLIDS IN FCE GAS - WT.% OF DRI FD
28.83%	COARSE SOL. IN CLASS - % OF CLASS FD
0.57%	SOLIDS IN SILO DUST - % OF DRI PROD.
0.45%	SOLIDS IN OXIDE SCRN DUST - %DRI FD
1.38%	SOLIDS IN DRI SCRN DUST - %DRI PROD
93.00%	METALLIZATION - WT.% Fet IN DRI

PELLET PLANT

6.7%	PERCENT DUST/FINES - WT.% OF G.B.
2.0%	PERCENT U/S GREEN BALL PELLETS
2.0%	PERCENT O/S GREEN BALL PELLETS
0.0%	PERCENT U/S INDURATED PELLETS
0.0%	PERCENT O/S INDURATED PELLETS
25.0%	PERCENT O/S P.P. DUST - % DUST/FINES
0.0%	COKE TO PELLET - % OF FEED
0.6%	BINDER TO PELLET - % OF FEED
2.0%	DOLOMITE TO PELLET - % OF FEED
0.0%	LIMESTONE TO PELLET - % OF FEED
0.0%	HYDRATED LIME TO PELLET - % OF FEED
0.0%	EXCESS PELLETS TO SALES - % OF TOTAL

4.5%	L.O.I.
1.014	RATIO INDUR./G.B. PELLET

EAF/LMF/CASTING

2.0%	EAF DUST - WT. % OF SLAB
4.0%	DRI TO EAF INJ. - WT.% DRI
1.1%	DOLOMITE ADDITION
0.00%	SILICA FLUX - % DRI FD
0.65%	MISC. ADDIT. - % DRI FD
0.83%	C CHARGED - % DRI FD
0.35%	ELECTRODES - % DRI FD
3.87%	PUL. LIME EAF - % DRI FD
1.34%	REFRACTORIES - % DRI FD
14.34%	EAF SLAG - % DRI FD
2.26%	LADLE SCRAP - % M. STL
0.60%	TUND. SCRAP - % M. STL
99.00%	YIELD TO SLAB - % MS
98.00%	YIELD TO T.SLAB - % MS
98.00%	YIELD HOT BAND - % TS
1.74%	CROP ENDS - % M. STL
4.60%	TOTAL REVERT - %M. STL
1.56%	PURC. SCRAP - % M. STL.
0.50%	PUL. LIME LMF - %M. STL
0.04%	SLG TO LMF - % M. STL
0.64%	SLG FR. LMF - %MS
0.060	ARGON TO LMF - NM3/T MS
0.50%	SLAB SCALE - %MS
0.06%	MOLD POWDER - % M. STL.
0.03%	TUND. POWDER - % M. STL.
100.00%	SLAB PROD. - % OF PROD.
0.27%	SLAG C INJ. - WT% M. STL
25.60%	%Fe IN EAF SLAG

RED = ASSUMPTION INPUT (DATA OR EXPERIENCE) BLUE = DERIVED VARIABLE

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
1001	AS-MINED ROCK	97.0%	6.294	0.195	6.488	353.4%	30.00%	1.888
1002	WASTE ROCK	97.0%	3.806	0.118	3.924	213.7%	16.93%	0.644
1	IRON ORE TO CONCENTRATOR (CRUSHING)	97.0%	2.488	0.077	2.564	139.7%	50.00%	1.244
2	PRODUCT FROM PRIMARY CRUSHER (80% -130 mm)	97.0%	2.488	0.077	2.564	139.7%	50.00%	1.244
3	FEED TO GRIZZLY (Secondary 1)	97.0%	2.488	0.077	2.564	139.7%	50.00%	1.244
3 a	FEED TO GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
4	OS FROM GRIZZLY (Secondary 1)	97.0%	1.741	0.054	1.795	97.8%	50.00%	0.871
4 a	OS FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
5	US FROM GRIZZLY (Secondary 1)	97.0%	0.746	0.023	0.769	41.9%	50.00%	0.373
5 a	US FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
6	US FROM SECONDARY 1 (80% -37 mm)	97.0%	1.741	0.054	1.795	97.8%	50.00%	0.871
6 a	US FROM SECONDARY 2 (80% -37 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
7	TOTAL FEED TO TERTIARY CRUSHERS (+10 mm)	97.0%	4.975	0.154	5.129	279.4%	50.00%	2.488
7 a	US FROM TERTIARY 1 (80% -10 mm)	97.0%	1.658	0.051	1.710	93.1%	50.00%	0.829
7 b	US FROM TERTIARY 2 (80% -10 mm)	97.0%	1.658	0.051	1.710	93.1%	50.00%	0.829
7 c	US FROM TERTIARY 3 (80% -10 mm)	97.0%	1.658	0.051	1.710	93.1%	50.00%	0.829
7 d	US FROM TERTIARY 4 (80% -10 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
8	TOTAL FEED TO TERTIARY SCREENS	97.0%	7.463	0.231	7.693	419.1%	50.00%	3.731
9	UNDERSIZE FROM TERTIARY SCREENS (-10 mm)	97.0%	2.488	0.077	2.564	139.7%	50.00%	1.244
10	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	2.488	0.077	2.564	139.7%	50.00%	1.244

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
10 a	FEED TO BALL MILLS 1&2 (-10 mm)	97.0%	1.244	0.038	1.282	69.8%	50.00%	0.622
10 b	FEED TO BALL MILLS 3&4 (-10 mm)	97.0%	1.244	0.038	1.282	69.8%	50.00%	0.622
11	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	1.244	0.038	1.282	69.8%	50.00%	0.622
11 a	FEED TO BALL MILL 1 (-10 mm)	97.0%	0.622	0.019	0.641	34.9%	50.00%	0.311
11 b	FEED TO BALL MILL 2 (-10 mm)	97.0%	0.622	0.019	0.641	34.9%	50.00%	0.311
11 c	FEED TO BALL MILL 3 (-10 mm)	97.0%	0.622	0.019	0.641	34.9%	50.00%	0.311
11 d	FEED TO BALL MILL 4 (-10 mm)	97.0%	0.622	0.019	0.641	34.9%	50.00%	0.311
12	TOTAL FEED TO BALL MILL CYCLONES	65.0%	6.219	3.349	9.568	349.2%	50.00%	3.109
13	TOTAL B.M. CYCLONE UNDERFLOW	21.4%	3.731	13.679	17.410	209.5%	50.00%	1.866
14	TOTAL B.M. MAKEUP WATER	0.0%	0.000	14.950	14.950			
15	TOTAL B.M. CYCLONE OVERFLOW	35.0%	2.488	4.620	7.107	139.7%	50.00%	1.244
21	ORE SLIMES TO TAILINGS	5.0%	0.114	2.174	2.289	6.4%	29.80%	0.034
22	DE-SLIMED ORE TO MAG. SEP.	49.3%	2.373	2.446	4.819	133.3%	50.97%	1.210
23	MAG. SEP. 1 DILUTION WATER	0.0%	0.000	31.600	31.600			
24	NET FEED TO MAG. SEP. 1	6.5%	2.373	34.046	36.419	133.3%	50.97%	1.210
25	MAG. SEP 1 TAILS	11.9%	0.754	5.585	6.339	42.4%	21.70%	0.164
26	MAG. SEP. 1 CONC.	5.4%	1.619	28.461	30.080	90.9%	64.62%	1.046
27	MAG. SEP. 2 DILUTION WATER	0.0%	0.000	14.300	14.300			
28	NET FEED TO MAG. SEP. 2	3.6%	1.619	42.761	44.380	90.9%	64.62%	1.046
29	MAG. SEP 2 TAILS	1.5%	0.076	4.996	5.072	4.3%	21.94%	0.017
30	MAG. SEP. 2 CONC.	3.9%	1.543	37.765	39.308	86.6%	66.72%	1.029

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
31	MAG. SEP. 3 DILUTION WATER	0.0%	0.000	13.900	13.900			
32	NET FEED TO MAG. SEP. 3	2.9%	1.543	51.665	53.208	86.6%	66.72%	1.029
33	MAG. SEP 3 TAILS	1.5%	0.022	1.418	1.440	1.2%	23.83%	0.005
34	MAG. SEP. 3 CONC.	2.9%	1.521	50.247	51.768	85.4%	67.33%	1.024
35	REGRIND MILL DISCHARGE	65.0%	3.042	1.638	4.680	170.8%	0.00%	0.000
36	NET FEED TO REGRIND MILL CYCLONE	8.1%	4.563	51.885	56.448	256.3%	67.33%	3.073
37	REGRIND MILL CYCLONE O/F PRODUCT TO FLOTATION	2.9%	1.521	50.247	51.768	85.4%	67.33%	1.024
38	REGRIND MILL CYCLONE U/F TO MILL	65.0%	3.042	1.638	4.680	170.8%	67.33%	2.048
39	REGRIND MILL DILUTION WATER	0.0%	0.000	0.000	0.000			
40	FLOTATION DILUTION WATER	0.0%	0.000	5.100	5.100			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
41	FLOTATION CHEMICALS	0.0%	0.000	0.050	0.050			
42	NET FLOTATION FEED	2.7%	1.521	55.397	56.918	85.4%	67.33%	1.024
43	FLOAT TAILS - Fe CONC. TO MAG. IV	2.6%	1.506	55.355	56.861	84.6%	67.67%	1.019
44	SULFUR FLOAT REJECTS TO TAILS	27.0%	0.015	0.041	0.056	0.9%	33.67%	0.005
45	MAG. SEP. 4 CONC.	2.7%	1.465	52.682	54.147	82.3%	68.56%	1.005
46	MAG. SEP. 4 GANGUE REJECT TO TAILS	1.5%	0.041	2.674	2.715	2.3%	35.69%	0.015
47	CONCENTRATE TO PIPELINE FEED	65.0%	1.465	0.789	2.254	82.3%	68.56%	1.005
48	EXCESS WATER FROM CONC. THICK. TO P.W. POND	0.0%	0.000	51.893	51.893			
49	TOTAL REJECTS TO TAILS	5.7%	1.022	16.888	17.911	57.4%	23.40%	0.239
50	DEWATERED TAILINGS TO DISPOSAL	35.0%	1.022	1.899	2.921	57.4%	23.40%	0.239
51	TAILS THICKENER DECANT TO P.W. POND	0.0%	0.000	14.990	14.990			
52	EXCESS WATER FROM TAILS POND	0.0%	0.000	1.388	1.388			
53	FRESH WATER MAKEUP TO P.W. POND	0.0%	0.000	5.232	5.232			
54	EVAPORATION FROM P.W. POND	0.0%	0.000	3.675	3.675			
	TOTAL INPUTS TO P.W. POND	0.0%	0.000	73.502	73.502			
55	TOTAL CONCENTRATOR WATER INPUTS	0.0%	0.000	79.900	79.900			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORPIPELINE & ORE RECEIVING (PFD-003)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
43	CONCENTRATE SLURRY FROM PIPELINE	65.0%	1.465	0.789	2.254	82.3%	68.56%	1.005
101	CONCENTRATE FEED TO DEWATERING	65.0%	1.465	0.789	2.254	82.3%	68.56%	1.005
102	NET FILTER FEED	60.0%	2.098	1.399	3.497	117.8%	70.54%	1.480
103	FEED SLURRY DIVERSION TO THICKENERS	65.0%	0.000	0.000	0.000	0.0%	68.56%	0.000
104	FILTER CAKE	92.0%	1.888	0.164	2.053	106.0%	70.54%	1.332
105	FILTRATE	0.0%	0.000	1.095	1.095			
106	FILTER O/F	60.0%	0.210	0.140	0.350	11.8%	70.54%	0.148
107	LAUNDER WASH-DOWN WATER	0.0%	0.000	0.699	0.699			
108	NET FILTER O/F RETURN	20.0%	0.210	0.839	1.049	11.8%	70.54%	0.148
109	THICKENER FEED	50.6%	2.098	2.052	4.150	117.8%	70.54%	1.480
110	THICKENER DECANT	0.0%	0.000	0.653	0.653			
111	THICKENER U/F	60.0%	2.098	1.399	3.497	117.8%	70.54%	1.480
112	EXCESS WATER TO PROCESS WATER	0.0%	0.000	1.747	1.747			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORSTOCKPILE, PELLET PLANT SLURRY/FINES HANDLING (BFD-004)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
201	RECYCLE EAF DUST SLURRY	15.0%	0.020	0.112	0.132	1.1%	48.50%	0.010
202	RECYCLE DRI DUST SLURRY	15.0%	0.169	0.957	1.125	9.5%	87.47%	0.148
203	P.P. DUST/FINES SLURRY	15.0%	0.123	0.697	0.820	6.9%	67.81%	0.083
204	P.P. DUST SYSTEMS O.S.	80.0%	0.047	0.012	0.059	2.6%	67.81%	0.032
205	FEED TO P.P. THICKENER	18.5%	0.423	1.860	2.283	23.8%	77.42%	0.328
206	DECANT FROM P.P. THICKENER	0.0%	0.000	1.437	1.437			
207	U/F FROM P.P. THICKENER TO FEED THICK.	50.0%	0.423	0.423	0.847	23.8%	77.42%	0.328
208	DRI CLASSIFIER O/S	75.0%	0.057	0.019	0.075	3.2%	87.80%	0.050
209	-6 mm ORE/PELLET FINES	100.0%	0.055	0.000	0.055	3.1%	67.81%	0.037
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	67.81%	0.000
211	TOTAL FEED TO MILLING	83.8%	0.159	0.031	0.189	8.9%	74.93%	0.119
212	MILL MAKE-UP WATER	0.0%	0.000	0.075	0.075	0.0%		
213	GROUND FINES SLURRY TO P.P. THICKENER	60.0%	0.159	0.106	0.265	8.9%	74.93%	0.119
232	INDURATED PELLETS TO STOCKPILE	100.0%	1.836	0.000	1.836	103.1%	67.81%	1.245
250	RECLAIMED PELLETS	100.0%	1.836	0.000	1.836	103.1%	67.81%	1.245
251	LUMP ORE3 TO STOCKPILE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
252	RECLAIMED LUMP ORE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
253	PELLET/LUMP ORE TO FEED SILOS	100.0%	1.836	0.000	1.836	103.1%	67.81%	1.245
254	EXCESS PELLETS TO SALES	0.0%	0.000	0.000	0.000	0.0%	67.81%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORGREEN BALL PELLET PRODUCTION: (BFD-005)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
104	FILTER CAKE TO PELLET PLANT	92.0%	1.888	0.164	2.053	106.0%	70.54%	1.332
218	NET OXIDE FEED TO PELLETIZING	91.9%	1.969	0.173	2.142	110.6%	70.47%	1.388
219	PELLETIZING WATER	0.0%	0.000	0.027	0.027	0.0%		
220	COKE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
221	BINDER TO PELLETIZING	100.0%	0.012	0.000	0.012	0.7%	11.60%	0.001
222	DOLOMITE TO PELLETIZING	100.0%	0.040	0.000	0.040	2.3%	1.61%	0.001
223	LIMESTONE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
224	HYDRATED LIME TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
225	PELLET FEED MIXTURE	91.0%	2.021	0.200	2.221	113.5%	68.76%	1.390
226	DISC DRESSING MOISTURE	0.0%	0.000	0.012	0.012	0.0%		
227	GREEN BALL PELLETS	90.5%	2.021	0.212	2.233	113.5%	68.76%	1.390
228	COMBINED GREEN BALL O/S & U/S	90.5%	0.081	0.008	0.089	4.5%	68.76%	0.056
229	SIZED GREEN BALL PELLETS	90.5%	1.940	0.204	2.144	109.0%	68.76%	1.334

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORINDURATED PELLET PRODUCTION: (BFD-006)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
229	SIZED GREEN BALL PELLETS	90.5%	1.940	0.204	2.144	109.0%	68.76%	1.334
230	INDURATED PELLETS (GROSS)	100.0%	1.968	0.000	1.968	110.5%	67.81%	1.334
231	INDURATED PELLETS (NET)	100.0%	1.836	0.000	1.836	103.1%	67.81%	1.245
232	CRUSHED OVERSIZE PELLETS	100.0%	0.000	0.000	0.000	0.0%	67.81%	0.000
233	UNDERSIZE INDURATED PELLETS	100.0%	0.000	0.000	0.000	0.0%	67.81%	0.000
234	RECYCLED INDURATED PELLET DUST/FINES	100.0%	0.132	0.000	0.132	7.4%	67.81%	0.089
235	P.P. DUST SLURRY WATER	0.0%	0.000	0.697	0.697			
203	P.P. DUST SLURRY TO PELLET FEED	15.0%	0.123	0.697	0.820	6.9%	67.81%	0.089
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	67.81%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORDRI SYSTEMS, 1 OF 2 (PFD-007)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (T/HR)
253	RECLAIMED PELLETS/LUMP ORE	100.0%	1.8358	0.0000	1.8358	103.1%	67.81%	1.2448
209	-6 mm OXIDE TO PELLETIZING (ORE/PELLETS)	100.0%	0.0551	0.0000	0.0551	3.1%	67.81%	0.0373
299	REMET (OTHER) CHARGED TO SHAFT FCE.	100.0%	0.0000	0.0000	0.0000	0.0%	67.81%	0.0000
300	NET ORE/PELLETS, ETC. TO SHAFT FCE.	100.0%	1.7807	0.0000	1.7807	100.0%	67.81%	1.2075
301	COATING LIME	100.0%	0.0095	0.0000	0.0095	0.5%		
302	LIME COATING WATER	0.0%	0.0000	0.0284	0.0284	0.0%		
303	NET FURNACE FEED	98.4%	1.7902	0.0284	1.8186	100.5%	67.45%	1.2075
304	OFF-GASSES (INCL. DUST/WV)	24.5%	0.1661	0.5121	0.6783	9.3%	87.80%	0.1459
305	GAS QUENCH SCRUB WATER (MM TPY)	0.0%	0.0000	73.6071	73.6071	0.0%		
306	FURNACE DUST TO DUST SCRUBBERS	100.0%	0.0302	0.0000	0.0300	1.7%	87.80%	0.0264
307	FURNACE DUST SCRUB WATER	0.0%	0.0000	2.3448	2.3448	0.0%		
308	FCE DUST SLURRY TO CLASSIFIER	1.3%	0.0300	2.3448	2.3748	1.7%	87.80%	0.0264
309	GAS QUENCH SCRUBBER BLOWDOWN	6.6%	0.1661	2.3448	2.5109	9.3%	87.80%	0.1459
208	COARSE SOLIDS FROM CLASSIFIER	75.0%	0.0565	0.0188	0.0754	3.2%	87.80%	0.0496
310	DE-GRITTED FCE. SCRUB BLOW-DOWN	97.0%	0.1396	4.6707	4.8103	7.8%	87.80%	0.1226
311	PRODUCT SILO SCRUBBER BLOW-DOWN	0.4%	0.0062	1.6079	1.6140	0.3%	92.80%	0.0057
312	OXIDE SCREEN SCRUBBER BLOW-DOWN	100.0%	0.0080	1.6079	1.6159	0.5%	67.81%	0.0055
313	COMPRESSOR COOLING WATER	0.0%	0.0000	6.6994	6.6994	0.0%		
314	PRODUCT SCREEN SCRUBBER	0.6%	0.0150	2.3448	2.3598	0.8%	92.80%	0.0139
315	NET CLARIFIER FEED	0.2%	0.1688	91.0498	91.2186	9.5%	87.47%	0.1477

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: ORDRI SYSTEMS, 2 OF 2 (PFD-008)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
316	CLAR. DECANT TO COOLING SYSTEMS	0.0%	0.0000	90.093	90.093	0.0%		
317	DRI TO SCREENS	100.0%	1.0886	0.000	1.089	61.1%	92.80%	1.0102
318	DRI WITH FINES REMOVED	100.0%	1.0450	0.000	1.045	58.7%	92.80%	0.9698
319	DRI FROM SILOS	100.0%	1.0450	0.000	1.045	58.7%	92.80%	0.9698
320	EXCESS DRI TO SALES	100.0%	0.0000	0.000	0.000	0.0%	92.80%	0.0000
321	DRI TO EAF STORAGE HOPPERS	100.0%	1.0450	0.000	1.045	58.7%	92.80%	0.9698
322	GAS QUENCH O/F WATER TO CLARIFIER	0.0%	0.0000	74.119	74.119	0.0%		
323	INERT GAS (MM Nm3/YR)	0.0%	0.0000	43.000	43.000	0.0%		
324	DRI SCREEN FINES TO EAF INJECTION	100.0%	0.0435	0.000	0.044	2.4%	92.80%	0.0404

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: OREAF STEELMAKING/LMF (PFD-009) BASIS: 8,000 HRS/YR EAF/LMF/CASTING OPERATION

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL DRI FEED TO EAF	100.0%	1.089	0.000	1.089	61.1%	92.80%	1.010
401	LUMP LIME FLUX TO EAF	100.0%	0.012	0.000	0.012	0.7%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	1.8%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.012	0.000	0.012	3.0%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	0.5%		
406	TOTAL EAF COOLING WATER CIRC. (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
407	REVERT SCRAP	100.0%	0.048	0.000	0.048	2.7%	99.70%	0.048
408	PURCHASED SCRAP	100.0%	0.016	0.000	0.016	0.9%	99.70%	0.016
409	NET SCRAP CHARGED	100.0%	0.065	0.000	0.065	3.6%	99.70%	0.065
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.031	0.000	0.031	1.8%	41.32%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.015	0.000	0.015	0.8%		
412	PROCESS/COOLING WATER OUT OF EAF (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.156	0.156	0.0%	25.60%	0.040
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	1.1%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR)	0.0%	0.000	11.000	11.000	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.054	1.054	0.0%	99.70%	1.051
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.3%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.2%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE)

Revision A: OREAF STLMAKING/LMF (PFD-009), CASTING (PFD-010) BASIS: 0 (MM T/YR)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.052	1.052	0.0%	99.70%	1.049
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.042	0.000	0.012	0.7%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.156	0.000	0.156	8.8%	26.97%	0.042
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.3%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	1.3%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.4%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	1.0%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	4.8%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	1.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR)	0.0%	0.161	9.600	9.761	9.1%		
509	NET STEEL TO CASTING	0.0%	0.000	0.999	0.999	0.0%	99.70%	0.996
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	54.9%	99.70%	0.974
511	THIN SLAB TO HOT BAND	#DIV/0!	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	54.9%	99.70%	0.974
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX D-2

100% DRI CHARGED TO EAF - 2.5% CARBON

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: OREBODY ASSUMPTIONS

BASIS:

7,940	HRS/YR CONCENTRATOR/PELLET/DRI OPERATION
8,000	HRS/YR EAF/LMF/CASTING OPERATION

							TARGET
184.8	T/HR ORE1 CONC. NET FEED		68.559%	IRON UNITS	IN CONC.		68.560%
0.0	T/HR ORE2		0.000%	IRON UNITS			
0.0	T/HR ORE3		0.000%	IRON UNITS			
184.8	T/HR NET DRI ORE FEED		68.559%	IRON UNITS		89.36%	AS FE304
122.2	T/HR SLAB PRODUCED		8,000	HRS/YR BASIS		10.64%	AS FE2O3
				TARGET			BALANCE
1.107	DRI PROD.	1.611	ORE/P TO DRI	79.932%	Fe RECOV		80.763%
0.977	SLAB PROD.	1.132	DRI TO SLAB	60.000%	Wt.% RECOV		58.900%

TOTAL PLANT PRODUCTION (DRY BASIS):	
6.301	MM TONNES/YEAR AS-MINED ROCK
2.491	MM TONNES/YEAR NET ORE TO CONCENTRATOR
1.467	MM TONNES/YEAR NET CONCENTRATE
0.000	MM TONNES/YEAR LUMP ORE3
1.943	MM TONNES/YEAR GREEN BALL PELLET (+6mm)
1.970	MM TONNES/YEAR TOTAL INDURATED PELLET
1.838	MM TONNES/YEAR NET INDURATED PELLET (+6mm)
1.783	MM TONNES/YEAR FEED TO DRI FCE.
1.107	MM TONNES/YEAR DRI
0.977	MM TONNES/YEAR NET SLAB PRODUCT (BALANCE)
0.000	MM TONNES/YEAR HOT BAND SLAB
0.977	MM TONNES/YEAR NET SLAB PRODUCT
1.000	MM TONNES/YEAR LIQUID STEEL (TARGET)
0.977	MM TONNES/YEAR NET SLAB PRODUCT (TARGET)

CONCENTRATOR	
60.474%	WASTE ROCK - % OF MINED
3.000%	AS-MINED ROCK MOISTURE - %
30.000%	AS-MINED ROCK IRON UNITS - WT.% IRON
50.000%	ORE ROCK IRON UNITS - WT.% IRON
70.0%	GRIZZLY SCREEN O/S - % OF FEED
200.0%	CIRCULATING LOAD - +10 mm TO TERTIARY (% FEED)
0.0%	PERCENT FEED TO SECONDARY 2 (%)
0.0%	PERCENT FEED TO TERTIARY 4 (%)
300.0%	BALL MILL CIRCULATING LOAD (% OF FEED)
65.0%	BALL MILL PERCENT SOLIDS (% OF FEED)
35.0%	B.M. CYCLONE O/F PERCENT SOLIDS (%)
4.60%	GROUND ORE LOSSES TO SLIMES - WT.%
5.00%	DESLIME CYCLONE O/F PERCENT SOLIDS (%)
68.21%	STG.1 MAG. CONC. RECOVERY - WT.% OF FEED
86.39%	STG. 1 IRON UNIT RECOVERY - WT.% OF IRON UNITS
95.30%	STG. 2 MAG. CONC. WT. RECOVERY - WT.% OF FEED
98.50%	STG. 2 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
98.60%	STG. 3 MAG. CONC. RECOV. - WT.% OF FEED
99.50%	STG. 3 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
200.00%	REGRIND MILL CIRCULATING LOAD (% OF FEED)
65.00%	REGRIND MILL % SOLIDS (WT.%)
99.00%	S-FLOTATION IRON CONC - WT.% OF FEED
99.50%	S-FLOTATION IRON UNIT RECOV. - WT.% OF IU
97.30%	GAN. REJECT. MAG. SEP. - WT.% OF FEED
98.57%	GAN. REJECT. MAG. SEP. - WT.% OF IU

CONCENTRATOR DEWATERING	
65.0%	WT.% SOLIDS IN CONC. THICK. U/F
35.0%	WT.% SOLIDS IN TAILS. THICK. U/F
0.0%	FEED DIVER. TO THICK. - % OF FEED
10.0%	FILTER FEED O/F - % OF FEED

DRI PLANT	
3.0%	PERCENT OF PELLET FINES - WT.% PEL.
10.0%	PERCENT OF LUMP FINES - WT.% LUMP
4.0%	PERCENT DUST - WT.% OF OXIDE FEED
3.0%	PERCENT -6 mm DRI FINES - WT.% DRI
0.0%	PERCENT REMET CHARGED - WT.% OF FD
0.22%	PERC. LIME FOR COATING - WT.% OF FD
9.32%	SOLIDS IN OFF-GASS - WT.% OF DRI FD
1.68%	SOLIDS IN FCE GAS - WT.% OF DRI FD
28.83%	COARSE SOL. IN CLASS - % OF CLASS FD
0.56%	SOLIDS IN SILO DUST - % OF DRI PROD.
0.45%	SOLIDS IN OXIDE SCRN DUST - %DRI FD
1.36%	SOLIDS IN DRI SCRN DUST - %DRI PROD
91.59%	METALLIZATION - WT.% Fet IN DRI

PELLET PLANT	
6.7%	PERCENT DUST/FINES - WT.% OF G.B.
2.0%	PERCENT U/S GREEN BALL PELLETS
2.0%	PERCENT O/S GREEN BALL PELLETS
0.0%	PERCENT U/S INDURATED PELLETS
0.0%	PERCENT O/S INDURATED PELLETS
25.0%	PERCENT O/S P.P. DUST - % DUST/FINES
0.0%	COKE TO PELLET - % OF FEED
0.6%	BINDER TO PELLET - % OF FEED
2.0%	DOLOMITE TO PELLET - % OF FEED
0.0%	LIMESTONE TO PELLET - % OF FEED
0.0%	HYDRATED LIME TO PELLET - % OF FEED
0.0%	EXCESS PELLETS TO SALES - % OF TOTAL

4.5%	L.O.I.
1.014	RATIO INDUR./G.B. PELLET

EAF/LMF/CASTING	
2.0%	EAF DUST - WT. % OF SLAB
4.0%	DRI TO EAF INJ. - WT.% DRI
1.1%	DOLOMITE ADDITION
0.00%	SILICA FLUX - % DRI FD
0.65%	MISC. ADDIT. - % DRI FD
0.62%	C CHARGED - % DRI FD
0.40%	ELECTRODES - % DRI FD
3.87%	PUL. LIME EAF - % DRI FD
1.34%	REFRACTORIES - % DRI FD
14.34%	EAF SLAG - % DRI FD
2.26%	LADLE SCRAP - % M. STL
0.60%	TUND. SCRAP - % M. STL
99.00%	YIELD TO SLAB - % MS
98.00%	YIELD TO T.SLAB - % MS
98.00%	YIELD HOT BAND - % TS
1.74%	CROP ENDS - % M. STL
4.60%	TOTAL REVERT - %M. STL
1.56%	PURC. SCRAP - % M. STL.
0.50%	PUL. LIME LMF - %M. STL
0.04%	SLG TO LMF - % M. STL
0.64%	SLG FR. LMF - %MS
0.060	ARGON TO LMF - NM3/T MS
0.50%	SLAB SCALE - %MS
0.06%	MOLD POWDER - % M. STL.
0.03%	TUND. POWDER - % M. STL.
100.00%	SLAB PROD. - % OF PROD.
0.27%	SLAG C INJ. - WT% M. STL
25.60%	%Fe IN EAF SLAG

RED = ASSUMPTION INPUT (DATA OR EXPERIENCE) BLUE = DERIVED VARIABLE

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
1001	AS-MINED ROCK	97.0%	6.301	0.195	6.496	353.5%	30.00%	1.890
1002	WASTE ROCK	97.0%	3.811	0.118	3.929	213.8%	16.93%	0.645
1	IRON ORE TO CONCENTRATOR (CRUSHING)	97.0%	2.491	0.077	2.568	139.7%	50.00%	1.245
2	PRODUCT FROM PRIMARY CRUSHER (80% -130 mm)	97.0%	2.491	0.077	2.568	139.7%	50.00%	1.245
3	FEED TO GRIZZLY (Secondary 1)	97.0%	2.491	0.077	2.568	139.7%	50.00%	1.245
3 a	FEED TO GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
4	OS FROM GRIZZLY (Secondary 1)	97.0%	1.743	0.054	1.797	97.8%	50.00%	0.872
4 a	OS FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
5	US FROM GRIZZLY (Secondary 1)	97.0%	0.747	0.023	0.770	41.9%	50.00%	0.374
5 a	US FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
6	US FROM SECONDARY 1 (80% -37 mm)	97.0%	1.743	0.054	1.797	97.8%	50.00%	0.872
6 a	US FROM SECONDARY 2 (80% -37 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
7	TOTAL FEED TO TERTIARY CRUSHERS (+10 mm)	97.0%	4.981	0.154	5.135	279.4%	50.00%	2.491
7 a	US FROM TERTIARY 1 (80% -10 mm)	97.0%	1.660	0.051	1.712	93.1%	50.00%	0.830
7 b	US FROM TERTIARY 2 (80% -10 mm)	97.0%	1.660	0.051	1.712	93.1%	50.00%	0.830
7 c	US FROM TERTIARY 3 (80% -10 mm)	97.0%	1.660	0.051	1.712	93.1%	50.00%	0.830
7 d	US FROM TERTIARY 4 (80% -10 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
8	TOTAL FEED TO TERTIARY SCREENS	97.0%	7.472	0.231	7.703	419.2%	50.00%	3.736
9	UNDERSIZE FROM TERTIARY SCREENS (-10 mm)	97.0%	2.491	0.077	2.568	139.7%	50.00%	1.245
10	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	2.491	0.077	2.568	139.7%	50.00%	1.245

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

08-June-2000 IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
10 a	FEED TO BALL MILLS 1&2 (-10 mm)	97.0%	1.245	0.039	1.284	69.9%	50.00%	0.623
10 b	FEED TO BALL MILLS 3&4 (-10 mm)	97.0%	1.245	0.039	1.284	69.9%	50.00%	0.623
11	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	1.245	0.039	1.284	69.9%	50.00%	0.623
11 a	FEED TO BALL MILL 1 (-10 mm)	97.0%	0.623	0.019	0.642	34.9%	50.00%	0.311
11 b	FEED TO BALL MILL 2 (-10 mm)	97.0%	0.623	0.019	0.642	34.9%	50.00%	0.311
11 c	FEED TO BALL MILL 3 (-10 mm)	97.0%	0.623	0.019	0.642	34.9%	50.00%	0.311
11 d	FEED TO BALL MILL 4 (-10 mm)	97.0%	0.623	0.019	0.642	34.9%	50.00%	0.311
12	TOTAL FEED TO BALL MILL CYCLONES	65.0%	6.227	3.353	9.579	349.3%	50.00%	3.113
13	TOTAL B.M. CYCLONE UNDERFLOW	21.5%	3.736	13.677	17.413	209.6%	50.00%	1.868
14	TOTAL B.M. MAKEUP WATER	0.0%	0.000	14.950	14.950			
15	TOTAL B.M. CYCLONE OVERFLOW	35.0%	2.491	4.626	7.116	139.7%	50.00%	1.245
21	ORE SLIMES TO TAILINGS	5.0%	0.115	2.177	2.291	6.4%	29.80%	0.034
22	DE-SLIMED ORE TO MAG. SEP.	49.3%	2.376	2.449	4.825	133.3%	50.97%	1.211
23	MAG. SEP. 1 DILUTION WATER	0.0%	0.000	31.600	31.600			
24	NET FEED TO MAG. SEP. 1	6.5%	2.376	34.049	36.425	133.3%	50.97%	1.211
25	MAG. SEP 1 TAILS	11.9%	0.755	5.592	6.347	42.4%	21.70%	0.164
26	MAG. SEP. 1 CONC.	5.4%	1.621	28.457	30.078	90.9%	64.62%	1.047
27	MAG. SEP. 2 DILUTION WATER	0.0%	0.000	14.300	14.300			
28	NET FEED TO MAG. SEP. 2	3.7%	1.621	42.757	44.378	90.9%	64.62%	1.047
29	MAG. SEP 2 TAILS	1.5%	0.076	5.002	5.079	4.3%	21.94%	0.017
30	MAG. SEP. 2 CONC.	3.9%	1.545	37.755	39.299	86.6%	66.72%	1.031

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

08-June-2000 IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
31	MAG. SEP. 3 DILUTION WATER	0.0%	0.000	13.900	13.900			
32	NET FEED TO MAG. SEP. 3	2.9%	1.545	51.655	53.199	86.6%	66.72%	1.031
33	MAG. SEP 3 TAILS	1.5%	0.022	1.420	1.442	1.2%	23.83%	0.005
34	MAG. SEP. 3 CONC.	2.9%	1.523	50.235	51.758	85.4%	67.33%	1.025
35	REGRIND MILL DISCHARGE	65.0%	3.046	1.640	4.686	170.9%	0.00%	0.000
36	NET FEED TO REGRIND MILL CYCLONE	8.1%	4.569	51.875	56.444	256.3%	67.33%	3.076
37	REGRIND MILL CYCLONE O/F PRODUCT TO FLOTATION	2.9%	1.523	50.235	51.758	85.4%	67.33%	1.025
38	REGRIND MILL CYCLONE U/F TO MILL	65.0%	3.046	1.640	4.686	170.9%	67.33%	2.051
39	REGRIND MILL DILUTION WATER	0.0%	0.000	0.000	0.000			
40	FLOTATION DILUTION WATER	0.0%	0.000	5.100	5.100			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
41	FLOTATION CHEMICALS	0.0%	0.000	0.050	0.050			
42	NET FLOTATION FEED	2.7%	1.523	55.385	56.908	85.4%	67.33%	1.025
43	FLOAT TAILS - Fe CONC. TO MAG. IV	2.7%	1.508	55.343	56.851	84.6%	67.67%	1.020
44	SULFUR FLOAT REJECTS TO TAILS	27.0%	0.015	0.041	0.056	0.9%	33.67%	0.005
45	MAG. SEP. 4 CONC.	2.7%	1.467	52.666	54.133	82.3%	68.56%	1.006
46	MAG. SEP. 4 GANGUE REJECT TO TAILS	1.5%	0.041	2.677	2.718	2.3%	35.69%	0.015
47	CONCENTRATE TO PIPELINE FEED	65.0%	1.467	0.790	2.257	82.3%	68.56%	1.006
48	EXCESS WATER FROM CONC. THICK. TO P.W. POND	0.0%	0.000	51.876	51.876			
49	TOTAL REJECTS TO TAILS	5.7%	1.024	16.909	17.933	57.4%	23.40%	0.240
50	DEWATERED TAILINGS TO DISPOSAL	35.0%	1.024	1.901	2.925	57.4%	23.40%	0.240
51	TAILS THICKENER DECANT TO P.W. POND	0.0%	0.000	15.008	15.008			
52	EXCESS WATER FROM TAILS POND	0.0%	0.000	1.389	1.389			
53	FRESH WATER MAKEUP TO P.W. POND	0.0%	0.000	5.232	5.232			
54	EVAPORATION FROM P.W. POND	0.0%	0.000	3.675	3.675			
	TOTAL INPUTS TO P.W. POND	0.0%	0.000	73.506	73.506			
55	TOTAL CONCENTRATOR WATER INPUTS	0.0%	0.000	79.900	79.900			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORPIPELINE & ORE RECEIVING (PFD-003)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
43	CONCENTRATE SLURRY FROM PIPELINE	65.0%	1.467	0.790	2.257	82.3%	68.56%	1.006
101	CONCENTRATE FEED TO DEWATERING	65.0%	1.467	0.790	2.257	82.3%	68.56%	1.006
102	NET FILTER FEED	60.0%	2.101	1.400	3.501	117.8%	70.36%	1.478
103	FEED SLURRY DIVERSION TO THICKENERS	65.0%	0.000	0.000	0.000	0.0%	68.56%	0.000
104	FILTER CAKE	92.0%	1.890	0.164	2.055	106.0%	70.36%	1.330
105	FILTRATE	0.0%	0.000	1.096	1.096			
106	FILTER O/F	60.0%	0.210	0.140	0.350	11.8%	70.36%	0.148
107	LAUNDER WASH-DOWN WATER	0.0%	0.000	0.700	0.700			
108	NET FILTER O/F RETURN	20.0%	0.210	0.840	1.050	11.8%	70.36%	0.148
109	THICKENER FEED	50.6%	2.101	2.054	4.154	117.8%	70.36%	1.478
110	THICKENER DECANT	0.0%	0.000	0.653	0.653			
111	THICKENER U/F	60.0%	2.101	1.400	3.501	117.8%	70.36%	1.478
112	EXCESS WATER TO PROCESS WATER	0.0%	0.000	1.749	1.749			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORSTOCKPILE, PELLET PLANT SLURRY/FINES HANDLING (BFD-004)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
201	RECYCLE EAF DUST SLURRY	15.0%	0.020	0.112	0.132	1.1%	48.50%	0.010
202	RECYCLE DRI DUST SLURRY	15.0%	0.169	0.957	1.125	9.5%	86.13%	0.145
203	P.P. DUST/FINES SLURRY	15.0%	0.123	0.698	0.821	6.9%	67.64%	0.083
204	P.P. DUST SYSTEMS O.S.	80.0%	0.047	0.012	0.059	2.6%	67.64%	0.032
205	FEED TO P.P. THICKENER	18.5%	0.423	1.861	2.284	23.8%	76.61%	0.324
206	DECANT FROM P.P. THICKENER	0.0%	0.000	1.437	1.437			
207	U/F FROM P.P. THICKENER TO FEED THICK.	50.0%	0.423	0.423	0.847	23.8%	76.61%	0.324
208	DRI CLASSIFIER O/S	75.0%	0.057	0.019	0.075	3.2%	86.39%	0.049
209	-6 mm ORE/PELLET FINES	100.0%	0.055	0.000	0.055	3.1%	67.64%	0.037
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	67.64%	0.000
211	TOTAL FEED TO MILLING	83.8%	0.159	0.031	0.189	8.9%	74.31%	0.118
212	MILL MAKE-UP WATER	0.0%	0.000	0.075	0.075	0.0%		
213	GROUND FINES SLURRY TO P.P. THICKENER	60.0%	0.159	0.106	0.265	8.9%	74.31%	0.118
232	INDURATED PELLETS TO STOCKPILE	100.0%	1.838	0.000	1.838	103.1%	67.64%	1.243
250	RECLAIMED PELLETS	100.0%	1.838	0.000	1.838	103.1%	67.64%	1.243
251	LUMP ORE3 TO STOCKPILE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
252	RECLAIMED LUMP ORE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
253	PELLET/LUMP ORE TO FEED SILOS	100.0%	1.838	0.000	1.838	103.1%	67.64%	1.243
254	EXCESS PELLETS TO SALES	0.0%	0.000	0.000	0.000	0.0%	67.64%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORGREEN BALL PELLET PRODUCTION: (BFD-005)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
104	FILTER CAKE TO PELLET PLANT	92.0%	1.890	0.164	2.055	106.0%	70.36%	1.330
218	NET OXIDE FEED TO PELLETIZING	91.9%	1.971	0.173	2.144	110.6%	70.29%	1.386
219	PELLETIZING WATER	0.0%	0.000	0.027	0.027	0.0%		
220	COKE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
221	BINDER TO PELLETIZING	100.0%	0.012	0.000	0.012	0.7%	11.60%	0.001
222	DOLOMITE TO PELLETIZING	100.0%	0.040	0.000	0.040	2.3%	1.61%	0.001
223	LIMESTONE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
224	HYDRATED LIME TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
225	PELLET FEED MIXTURE	91.0%	2.023	0.200	2.224	113.5%	68.58%	1.388
226	DISC DRESSING MOISTURE	0.0%	0.000	0.012	0.012	0.0%		
227	GREEN BALL PELLETS	90.5%	2.023	0.212	2.236	113.5%	68.58%	1.388
228	COMBINED GREEN BALL O/S & U/S	90.5%	0.081	0.008	0.089	4.5%	68.58%	0.056
229	SIZED GREEN BALL PELLETS	90.5%	1.943	0.204	2.146	109.0%	68.58%	1.332

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORINDURATED PELLET PRODUCTION: (BFD-006)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
229	SIZED GREEN BALL PELLETS	90.5%	1.943	0.204	2.146	109.0%	68.58%	1.332
230	INDURATED PELLETS (GROSS)	100.0%	1.970	0.000	1.970	110.5%	67.64%	1.332
231	INDURATED PELLETS (NET)	100.0%	1.838	0.000	1.838	103.1%	67.64%	1.243
232	CRUSHED OVERSIZE PELLETS	100.0%	0.000	0.000	0.000	0.0%	67.64%	0.000
233	UNDERSIZE INDURATED PELLETS	100.0%	0.000	0.000	0.000	0.0%	67.64%	0.000
234	RECYCLED INDURATED PELLET DUST/FINES	100.0%	0.132	0.000	0.132	7.4%	67.64%	0.089
235	P.P. DUST SLURRY WATER	0.0%	0.000	0.698	0.698			
203	P.P. DUST SLURRY TO PELLET FEED	15.0%	0.123	0.698	0.821	6.9%	67.64%	0.089
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	67.64%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORDRI SYSTEMS, 1 OF 2 (PFD-007)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (T/HR)
253	RECLAIMED PELLETS/LUMP ORE	100.0%	1.8378	0.0000	1.8378	103.1%	67.64%	1.2430
209	-6 mm OXIDE TO PELLETIZING (ORE/PELLETS)	100.0%	0.0551	0.0000	0.0551	3.1%	67.64%	0.0373
299	REMET (OTHER) CHARGED TO SHAFT FCE.	100.0%	0.0000	0.0000	0.0000	0.0%	67.64%	0.0000
300	NET ORE/PELLETS, ETC. TO SHAFT FCE.	100.0%	1.7826	0.0000	1.7826	100.0%	67.64%	1.2057
301	COATING LIME	100.0%	0.0095	0.0000	0.0095	0.5%		
302	LIME COATING WATER	0.0%	0.0000	0.0284	0.0284	0.0%		
303	NET FURNACE FEED	98.4%	1.7921	0.0284	1.8205	100.5%	67.28%	1.2057
304	OFF-GASSES (INCL. DUST/WV)	24.5%	0.1661	0.5127	0.6788	9.3%	86.39%	0.1435
305	GAS QUENCH SCRUB WATER (MM TPY)	0.0%	0.0000	73.6065	73.6065	0.0%		
306	FURNACE DUST TO DUST SCRUBBERS	100.0%	0.0302	0.0000	0.0300	1.7%	86.39%	0.0259
307	FURNACE DUST SCRUB WATER	0.0%	0.0000	2.3448	2.3448	0.0%		
308	FCE DUST SLURRY TO CLASSIFIER	1.3%	0.0300	2.3448	2.3748	1.7%	86.39%	0.0259
309	GAS QUENCH SCRUBBER BLOWDOWN	6.6%	0.1661	2.3448	2.5109	9.3%	86.39%	0.1435
208	COARSE SOLIDS FROM CLASSIFIER	75.0%	0.0565	0.0188	0.0754	3.2%	86.39%	0.0488
310	DE-GRITTED FCE. SCRUB BLOW-DOWN	97.0%	0.1396	4.6707	4.8103	7.8%	86.39%	0.1206
311	PRODUCT SILO SCRUBBER BLOW-DOWN	0.4%	0.0062	1.6079	1.6140	0.3%	91.39%	0.0056
312	OXIDE SCREEN SCRUBBER BLOW-DOWN	100.0%	0.0080	1.6079	1.6159	0.5%	67.64%	0.0054
313	COMPRESSOR COOLING WATER	0.0%	0.0000	6.6994	6.6994	0.0%		
314	PRODUCT SCREEN SCRUBBER	0.6%	0.0150	2.3448	2.3598	0.8%	91.39%	0.0137
315	NET CLARIFIER FEED	0.2%	0.1688	91.0498	91.2186	9.5%	86.13%	0.1454

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: ORDRI SYSTEMS, 2 OF 2 (PFD-008)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
316	CLAR. DECANT TO COOLING SYSTEMS	0.0%	0.0000	90.093	90.093	0.0%		
317	DRI TO SCREENS	100.0%	1.1067	0.000	1.107	62.1%	91.39%	1.0114
318	DRI WITH FINES REMOVED	100.0%	1.0624	0.000	1.062	59.6%	91.39%	0.9710
319	DRI FROM SILOS	100.0%	1.0624	0.000	1.062	59.6%	91.39%	0.9710
320	EXCESS DRI TO SALES	100.0%	0.0000	0.000	0.000	0.0%	91.39%	0.0000
321	DRI TO EAF STORAGE HOPPERS	100.0%	1.0624	0.000	1.062	59.6%	91.39%	0.9710
322	GAS QUENCH O/F WATER TO CLARIFIER	0.0%	0.0000	74.119	74.119	0.0%		
323	INERT GAS (MM Nm3/YR)	0.0%	0.0000	43.000	43.000	0.0%		
324	DRI SCREEN FINES TO EAF INJECTION	100.0%	0.0443	0.000	0.044	2.5%	91.39%	0.0405

Revision A: OREAF STEELMAKING/LMF (PFD-009)

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

BASIS: 8,000 HRS/YR EAF/LMF/CASTING OPERATION

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL DRI FEED TO EAF	100.0%	1.107	0.000	1.107	62.1%	91.39%	1.011
401	LUMP LIME FLUX TO EAF	100.0%	0.013	0.000	0.013	0.7%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	1.8%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.010	0.000	0.010	3.0%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	0.5%		
406	TOTAL EAF COOLING WATER CIRC. (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
407	REVERT SCRAP	100.0%	0.048	0.000	0.048	2.7%	99.70%	0.048
408	PURCHASED SCRAP	100.0%	0.016	0.000	0.016	0.9%	99.70%	0.016
409	NET SCRAP CHARGED	100.0%	0.065	0.000	0.065	3.6%	99.70%	0.065
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.030	0.000	0.030	1.7%	43.80%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.015	0.000	0.015	0.8%		
412	PROCESS/COOLING WATER OUT OF EAF (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.159	0.159	0.0%	25.60%	0.041
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	1.1%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR)	0.0%	0.000	19.250	19.250	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.055	1.055	0.0%	99.70%	1.052
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.3%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.2%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(BASE CASE: MIDREX SHAFT FURNACE - 100% DRI CHARGE - 2.5% C)

Revision A: OREAF STLMAKING/LMF (PFD-009), CASTING (PFD-010) BASIS: 0 (MM T/YR)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.053	1.053	0.0%	99.70%	1.050
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.043	0.000	0.012	0.7%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.159	0.000	0.159	8.9%	26.95%	0.043
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.3%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	1.3%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.4%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	1.0%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	4.8%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	1.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR)	0.0%	0.164	9.600	9.764	9.2%		
509	NET STEEL TO CASTING	0.0%	0.000	1.000	1.000	0.0%	99.70%	0.997
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	54.8%	99.70%	0.975
511	THIN SLAB TO HOT BAND	#DIV/0!	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	54.8%	99.70%	0.975
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX D-3

30% DRI CHARGED TO EAF - 1.0% CARBON

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: OREBODY ASSUMPTIONS

BASIS:

7,940	HRS/YR CONCENTRATOR/PELLET/DRI OPERATION					
8,000	HRS/YR EAF/LMF/CASTING OPERATION					
						TARGET
61.2	T/HR ORE1 CONC. NET FEED	68.557%	IRON UNITS	IN CONC.		68.560%
0.0	T/HR ORE2	0.000%	IRON UNITS			
0.0	T/HR ORE3	0.000%	IRON UNITS			
61.2	T/HR NET DRI ORE FEED	68.557%	IRON UNITS		89.36%	AS FE304
122.1	T/HR SLAB PRODUCED	8,000	HRS/YR BASIS		10.64%	AS FE2O3
		TARGET				BALANCE
0.367	DRI PROD. 2.072 ORE/P TO DRI	79.932%	Fe RECOV			80.761%
0.977	SLAB PROD. 0.376 DRI TO SLAB	60.000%	Wt.% RECOV			58.900%

TOTAL PLANT PRODUCTION (DRY BASIS):	
2.087	MM TONNES/YEAR AS-MINED ROCK
0.825	MM TONNES/YEAR NET ORE TO CONCENTRATOR
0.486	MM TONNES/YEAR NET CONCENTRATE
0.000	MM TONNES/YEAR LUMP ORE3
0.830	MM TONNES/YEAR GREEN BALL PELLET (+6mm)
0.841	MM TONNES/YEAR TOTAL INDURATED PELLET
0.785	MM TONNES/YEAR NET INDURATED PELLET (+6mm)
0.761	MM TONNES/YEAR FEED TO DRI FCE.
0.367	MM TONNES/YEAR DRI
0.977	MM TONNES/YEAR NET SLAB PRODUCT (BALANCE)
0.000	MM TONNES/YEAR HOT BAND SLAB
0.977	MM TONNES/YEAR NET SLAB PRODUCT
1.000	MM TONNES/YEAR LIQUID STEEL (TARGET)
0.977	MM TONNES/YEAR NET SLAB PRODUCT (TARGET)

CONCENTRATOR	
60.474%	WASTE ROCK - % OF MINED
3.000%	AS-MINED ROCK MOISTURE - %
30.000%	AS-MINED ROCK IRON UNITS - WT.% IRON
50.000%	ORE ROCK IRON UNITS - WT.% IRON
70.0%	GRIZZLY SCREEN O/S - % OF FEED
200.0%	CIRCULATING LOAD - +10 mm TO TERTIARY (% FEED)
0.0%	PERCENT FEED TO SECONDARY 2 (%)
0.0%	PERCENT FEED TO TERTIARY 4 (%)
300.0%	BALL MILL CIRCULATING LOAD (% OF FEED)
65.0%	BALL MILL PERCENT SOLIDS (% OF FEED)
35.0%	B.M. CYCLONE O/F PERCENT SOLIDS (%)
4.60%	GROUND ORE LOSSES TO SLIMES - WT.%
5.00%	DESLIME CYCLONE O/F PERCENT SOLIDS (%)
68.21%	STG.1 MAG. CONC. RECOVERY - WT.% OF FEED
86.39%	STG. 1 IRON UNIT RECOVERY - WT.% OF IRON UNITS
95.30%	STG. 2 MAG. CONC. WT. RECOVERY - WT.% OF FEED
98.50%	STG. 2 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
98.60%	STG. 3 MAG. CONC. RECOV. - WT.% OF FEED
99.50%	STG. 3 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
200.00%	REGRIND MILL CIRCULATING LOAD (% OF FEED)
65.00%	REGRIND MILL % SOLIDS (WT.%)
99.00%	S-FLOTATION IRON CONC - WT.% OF FEED
99.50%	S-FLOTATION IRON UNIT RECOV. - WT.% OF IU
97.30%	GAN. REJECT. MAG. SEP. - WT.% OF FEED
98.57%	GAN. REJECT. MAG. SEP. - WT.% OF IU

CONCENTRATOR DEWATERING	
65.0%	WT.% SOLIDS IN CONC. THICK. U/F
35.0%	WT.% SOLIDS IN TAILS. THICK. U/F
0.0%	FEED DIVER. TO THICK. - % OF FEED
10.0%	FILTER FEED O/F - % OF FEED

DRI PLANT	
3.0%	PERCENT OF PELLET FINES - WT.% PEL.
10.0%	PERCENT OF LUMP FINES - WT.% LUMP
4.0%	PERCENT DUST - WT.% OF OXIDE FEED
3.0%	PERCENT -6 mm DRI FINES - WT.% DRI
0.0%	PERCENT REMET CHARGED - WT.% OF FD
0.22%	PERC. LIME FOR COATING - WT.% OF FD
21.83%	SOLIDS IN OFF-GASS - WT.% OF DRI FD
3.94%	SOLIDS IN FCE GAS - WT.% OF DRI FD
28.83%	COARSE SOL. IN CLASS - % OF CLASS FD
1.68%	SOLIDS IN SILO DUST - % OF DRI PROD.
1.06%	SOLIDS IN OXIDE SCRN DUST - %DRI FD
4.08%	SOLIDS IN DRI SCRN DUST - %DRI PROD
93.00%	METALLIZATION - WT.% Fet IN DRI

PELLET PLANT	
6.7%	PERCENT DUST/FINES - WT.% OF G.B.
2.0%	PERCENT U/S GREEN BALL PELLETS
2.0%	PERCENT O/S GREEN BALL PELLETS
0.0%	PERCENT U/S INDURATED PELLETS
0.0%	PERCENT O/S INDURATED PELLETS
25.0%	PERCENT O/S P.P. DUST - % DUST/FINES
0.0%	COKE TO PELLET - % OF FEED
0.6%	BINDER TO PELLET - % OF FEED
2.0%	DOLOMITE TO PELLET - % OF FEED
0.0%	LIMESTONE TO PELLET - % OF FEED
0.0%	HYDRATED LIME TO PELLET - % OF FEED
0.0%	EXCESS PELLETS TO SALES - % OF TOTAL

4.5%	L.O.I.
1.014	RATIO INDUR./G.B. PELLET

EAF/LMF/CASTING	
2.0%	EAF DUST - WT. % OF SLAB
4.0%	DRI TO EAF INJ. - WT.% DRI
1.1%	DOLOMITE ADDITION
0.00%	SILICA FLUX - % EAF FD
0.65%	MISC. ADDIT. - % EAF FD
0.83%	C CHARGED - % EAF FD
0.35%	ELECTRODES - % EAF FD
3.87%	PUL. LIME EAF - % EAF FD
1.34%	REFRACTORIES - % EAF FD
14.34%	EAF SLAG - % EAF FD
2.26%	LADLE SCRAP - % M. STL
0.60%	TUND. SCRAP - % M. STL
99.00%	YIELD TO SLAB - % MS
98.00%	YIELD TO T.SLAB - % MS
98.00%	YIELD HOT BAND - % TS
1.74%	CROP ENDS - % M. STL
4.60%	TOTAL REVERT - %M. STL
65.40%	PURC. SCRAP - % M. STL.
0.50%	PUL. LIME LMF - %M. STL
0.04%	SLG TO LMF - % M. STL
0.64%	SLG FR. LMF - %MS
0.060	ARGON TO LMF - NM3/T MS
0.50%	SLAB SCALE - %MS
0.06%	MOLD POWDER - % M. STL.
0.03%	TUND. POWDER - % M. STL.
100.00%	SLAB PROD. - % OF PROD.
0.27%	SLAG C INJ. - WT% M. STL
25.60%	%Fe IN EAF SLAG

RED = ASSUMPTION INPUT (DATA OR EXPERIENCE) BLUE = DERIVED VARIABLE

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
1001	AS-MINED ROCK	97.0%	2.087	0.065	2.152	274.2%	30.00%	0.626
1002	WASTE ROCK	97.0%	1.262	0.039	1.301	165.8%	16.93%	0.214
1	IRON ORE TO CONCENTRATOR (CRUSHING)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
2	PRODUCT FROM PRIMARY CRUSHER (80% -130 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
3	FEED TO GRIZZLY (Secondary 1)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
3 a	FEED TO GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
4	OS FROM GRIZZLY (Secondary 1)	97.0%	0.578	0.018	0.595	75.9%	50.00%	0.289
4 a	OS FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
5	US FROM GRIZZLY (Secondary 1)	97.0%	0.248	0.008	0.255	32.5%	50.00%	0.124
5 a	US FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
6	US FROM SECONDARY 1 (80% -37 mm)	97.0%	0.578	0.018	0.595	75.9%	50.00%	0.289
6 a	US FROM SECONDARY 2 (80% -37 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
7	TOTAL FEED TO TERTIARY CRUSHERS (+10 mm)	97.0%	1.650	0.051	1.701	216.8%	50.00%	0.825
7 a	US FROM TERTIARY 1 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 b	US FROM TERTIARY 2 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 c	US FROM TERTIARY 3 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 d	US FROM TERTIARY 4 (80% -10 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
8	TOTAL FEED TO TERTIARY SCREENS	97.0%	2.475	0.077	2.552	325.2%	50.00%	1.238
9	UNDERSIZE FROM TERTIARY SCREENS (-10 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
10	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
10 a	FEED TO BALL MILLS 1&2 (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
10 b	FEED TO BALL MILLS 3&4 (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
11	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
11 a	FEED TO BALL MILL 1 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 b	FEED TO BALL MILL 2 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 c	FEED TO BALL MILL 3 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 d	FEED TO BALL MILL 4 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
12	TOTAL FEED TO BALL MILL CYCLONES	65.0%	2.063	1.111	3.173	271.0%	50.00%	1.031
13	TOTAL B.M. CYCLONE UNDERFLOW	7.8%	1.238	14.528	15.766	162.6%	50.00%	0.619
14	TOTAL B.M. MAKEUP WATER	0.0%	0.000	14.950	14.950			
15	TOTAL B.M. CYCLONE OVERFLOW	35.0%	0.825	1.532	2.357	108.4%	50.00%	0.413
21	ORE SLIMES TO TAILINGS	5.0%	0.038	0.721	0.759	5.0%	29.80%	0.011
22	DE-SLIMED ORE TO MAG. SEP.	49.3%	0.787	0.811	1.598	103.4%	50.97%	0.401
23	MAG. SEP. 1 DILUTION WATER	0.0%	0.000	31.600	31.600			
24	NET FEED TO MAG. SEP. 1	2.4%	0.787	32.411	33.198	103.4%	50.97%	0.401
25	MAG. SEP 1 TAILS	11.9%	0.250	1.852	2.103	32.9%	21.43%	0.054
26	MAG. SEP. 1 CONC.	1.7%	0.537	30.559	31.096	70.5%	64.74%	0.348
27	MAG. SEP. 2 DILUTION WATER	0.0%	0.000	14.300	14.300			
28	NET FEED TO MAG. SEP. 2	1.2%	0.537	44.859	45.396	70.5%	64.74%	0.348
29	MAG. SEP 2 TAILS	1.5%	0.025	1.657	1.682	3.3%	24.62%	0.006
30	MAG. SEP. 2 CONC.	1.2%	0.512	43.202	43.713	67.2%	66.72%	0.341

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
31	MAG. SEP. 3 DILUTION WATER	0.0%	0.000	13.900	13.900			
32	NET FEED TO MAG. SEP. 3	0.9%	0.512	57.102	57.613	67.2%	66.72%	0.341
33	MAG. SEP 3 TAILS	1.5%	0.007	0.470	0.478	0.9%	23.83%	0.002
34	MAG. SEP. 3 CONC.	0.9%	0.505	56.631	57.136	66.3%	67.33%	0.340
35	REGRIND MILL DISCHARGE	65.0%	1.009	0.543	1.552	132.6%	0.00%	0.000
36	NET FEED TO REGRIND MILL CYCLONE	2.6%	1.514	57.175	58.688	198.8%	67.33%	1.019
37	REGRIND MILL CYCLONE O/F PRODUCT TO FLOTATION	0.9%	0.505	56.631	57.136	66.3%	67.33%	0.340
38	REGRIND MILL CYCLONE U/F TO MILL	65.0%	1.009	0.543	1.552	132.6%	67.33%	0.679
39	REGRIND MILL DILUTION WATER	0.0%	0.000	0.000	0.000			
40	FLOTATION DILUTION WATER	0.0%	0.000	5.100	5.100			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
41	FLOTATION CHEMICALS	0.0%	0.000	0.050	0.050			
42	NET FLOTATION FEED	0.8%	0.505	61.781	62.286	66.3%	67.33%	0.340
43	FLOAT TAILS - Fe CONC. TO MAG. IV	0.8%	0.499	61.768	62.267	65.6%	67.67%	0.338
44	SULFUR FLOAT REJECTS TO TAILS	27.0%	0.005	0.014	0.019	0.7%	33.66%	0.002
45	MAG. SEP. 4 CONC.	0.8%	0.486	60.881	61.367	63.8%	68.56%	0.333
46	MAG. SEP. 4 GANGUE REJECT TO TAILS	1.5%	0.014	0.887	0.900	1.8%	35.69%	0.005
47	CONCENTRATE TO PIPELINE FEED	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
48	EXCESS WATER FROM CONC. THICK. TO P.W. POND	0.0%	0.000	60.619	60.619			
49	TOTAL REJECTS TO TAILS	5.7%	0.339	5.601	5.941	44.5%	23.41%	0.079
50	DEWATERED TAILINGS TO DISPOSAL	35.0%	0.339	0.630	0.969	44.5%	23.41%	0.079
51	TAILS THICKENER DECANT TO P.W. POND	0.0%	0.000	4.972	4.972			
52	EXCESS WATER FROM TAILS POND	0.0%	0.000	0.460	0.460			
53	FRESH WATER MAKEUP TO P.W. POND	0.0%	0.000	5.232	5.232			
54	EVAPORATION FROM P.W. POND	0.0%	0.000	3.564	3.564			
	TOTAL INPUTS TO P.W. POND	0.0%	0.000	71.283	71.283			
55	TOTAL CONCENTRATOR WATER INPUTS	0.0%	0.000	79.900	79.900			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORPIPELINE & ORE RECEIVING (PFD-003)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
43	CONCENTRATE SLURRY FROM PIPELINE	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
101	CONCENTRATE FEED TO DEWATERING	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
102	NET FILTER FEED	60.0%	0.897	0.598	1.495	117.8%	73.60%	0.660
103	FEED SLURRY DIVERSION TO THICKENERS	65.0%	0.000	0.000	0.000	0.0%	68.56%	0.000
104	FILTER CAKE	92.0%	0.807	0.070	0.877	106.0%	73.60%	0.594
105	FILTRATE	0.0%	0.000	0.468	0.468			
106	FILTER O/F	60.0%	0.090	0.060	0.149	11.8%	73.60%	0.066
107	LAUNDER WASH-DOWN WATER	0.0%	0.000	0.299	0.299			
108	NET FILTER O/F RETURN	20.0%	0.090	0.359	0.448	11.8%	73.60%	0.066
109	THICKENER FEED	48.8%	0.897	0.942	1.839	117.8%	73.60%	0.660
110	THICKENER DECANT	0.0%	0.000	0.344	0.344			
111	THICKENER U/F	60.0%	0.897	0.598	1.495	117.8%	73.60%	0.660
112	EXCESS WATER TO PROCESS WATER	0.0%	0.000	0.812	0.812			

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORSTOCKPILE, PELLET PLANT SLURRY/FINES HANDLING (BFD-004)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
201	RECYCLE EAF DUST SLURRY	15.0%	0.020	0.112	0.132	2.6%	48.50%	0.010
202	RECYCLE DRI DUST SLURRY	15.0%	0.169	0.957	1.125	22.2%	87.61%	0.148
203	P.P. DUST/FINES SLURRY	15.0%	0.053	0.298	0.351	6.9%	70.74%	0.037
204	P.P. DUST SYSTEMS O.S.	80.0%	0.047	0.012	0.059	6.2%	70.74%	0.033
205	FEED TO P.P. THICKENER	18.2%	0.321	1.440	1.761	42.2%	81.23%	0.261
206	DECANT FROM P.P. THICKENER	0.0%	0.000	1.119	1.119			
207	U/F FROM P.P. THICKENER TO FEED THICK.	50.0%	0.321	0.321	0.643	42.2%	81.23%	0.261
208	DRI CLASSIFIER O/S	75.0%	0.057	0.019	0.075	7.4%	87.80%	0.050
209	-6 mm ORE/PELLET FINES	100.0%	0.024	0.000	0.024	3.1%	70.74%	0.017
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
211	TOTAL FEED TO MILLING	80.6%	0.127	0.031	0.158	16.7%	78.32%	0.100
212	MILL MAKE-UP WATER	0.0%	0.000	0.054	0.054	0.0%		
213	GROUND FINES SLURRY TO P.P. THICKENER	60.0%	0.127	0.085	0.212	16.7%	78.32%	0.100
232	INDURATED PELLETS TO STOCKPILE	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
250	RECLAIMED PELLETS	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
251	LUMP ORE3 TO STOCKPILE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
252	RECLAIMED LUMP ORE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
253	PELLET/LUMP ORE TO FEED SILOS	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
254	EXCESS PELLETS TO SALES	0.0%	0.000	0.000	0.000	0.0%	70.74%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORGREEN BALL PELLET PRODUCTION: (BFD-005)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
104	FILTER CAKE TO PELLET PLANT	92.0%	0.807	0.070	0.877	106.0%	73.60%	0.594
218	NET OXIDE FEED TO PELLETIZING	91.9%	0.842	0.074	0.916	110.6%	73.53%	0.619
219	PELLETIZING WATER	0.0%	0.000	0.012	0.012	0.0%		
220	COKE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
221	BINDER TO PELLETIZING	100.0%	0.005	0.000	0.005	0.7%	11.60%	0.001
222	DOLOMITE TO PELLETIZING	100.0%	0.017	0.000	0.017	2.3%	1.61%	0.000
223	LIMESTONE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
224	HYDRATED LIME TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
225	PELLET FEED MIXTURE	91.0%	0.864	0.085	0.950	113.5%	71.73%	0.620
226	DISC DRESSING MOISTURE	0.0%	0.000	0.005	0.005	0.0%		
227	GREEN BALL PELLETS	90.5%	0.864	0.091	0.955	113.5%	71.73%	0.620
228	COMBINED GREEN BALL O/S & U/S	90.5%	0.035	0.004	0.038	4.5%	71.73%	0.025
229	SIZED GREEN BALL PELLETS	90.5%	0.830	0.087	0.917	109.0%	71.73%	0.595

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORINDURATED PELLET PRODUCTION: (BFD-006)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
229	SIZED GREEN BALL PELLETS	90.5%	0.830	0.087	0.917	109.0%	71.73%	0.595
230	INDURATED PELLETS (GROSS)	100.0%	0.841	0.000	0.841	110.5%	70.74%	0.595
231	INDURATED PELLETS (NET)	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
232	CRUSHED OVERSIZE PELLETS	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
233	UNDERSIZE INDURATED PELLETS	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
234	RECYCLED INDURATED PELLET DUST/FINES	100.0%	0.056	0.000	0.056	7.4%	70.74%	0.040
235	P.P. DUST SLURRY WATER	0.0%	0.000	0.298	0.298			
203	P.P. DUST SLURRY TO PELLET FEED	15.0%	0.053	0.298	0.351	6.9%	70.74%	0.040
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORDRI SYSTEMS, 1 OF 2 (PFD-007)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (T/HR)
253	RECLAIMED PELLETS/LUMP ORE	100.0%	0.7848	0.0000	0.7848	103.1%	70.74%	0.5552
209	-6 mm OXIDE TO PELLETIZING (ORE/PELLETS)	100.0%	0.0235	0.0000	0.0235	3.1%	70.74%	0.0167
299	REMET (OTHER) CHARGED TO SHAFT FCE.	100.0%	0.0000	0.0000	0.0000	0.0%	70.74%	0.0000
300	NET ORE/PELLETS, ETC. TO SHAFT FCE.	100.0%	0.7612	0.0000	0.7612	100.0%	70.74%	0.5385
301	COATING LIME	100.0%	0.0095	0.0000	0.0095	1.2%		
302	LIME COATING WATER	0.0%	0.0000	0.0284	0.0284	0.0%		
303	NET FURNACE FEED	96.4%	0.7707	0.0284	0.7991	101.2%	69.88%	0.5385
304	OFF-GASSES (INCL. DUST/WV)	43.0%	0.1661	0.2205	0.3866	21.8%	87.80%	0.1459
305	GAS QUENCH SCRUB WATER (MM TPY)	0.0%	0.0000	73.8987	73.8987	0.0%		
306	FURNACE DUST TO DUST SCRUBBERS	100.0%	0.0304	0.0000	0.0300	3.9%	87.80%	0.0264
307	FURNACE DUST SCRUB WATER	0.0%	0.0000	2.3448	2.3448	0.0%		
308	FCE DUST SLURRY TO CLASSIFIER	1.3%	0.0300	2.3448	2.3748	3.9%	87.80%	0.0264
309	GAS QUENCH SCRUBBER BLOWDOWN	6.6%	0.1661	2.3448	2.5109	21.8%	87.80%	0.1459
208	COARSE SOLIDS FROM CLASSIFIER	75.0%	0.0565	0.0188	0.0754	7.4%	87.80%	0.0496
310	DE-GRITTED FCE. SCRUB BLOW-DOWN	97.0%	0.1396	4.6707	4.8103	18.3%	87.80%	0.1226
311	PRODUCT SILO SCRUBBER BLOW-DOWN	0.4%	0.0062	1.6079	1.6140	0.8%	92.80%	0.0057
312	OXIDE SCREEN SCRUBBER BLOW-DOWN	100.0%	0.0080	1.6079	1.6159	1.1%	70.74%	0.0057
313	COMPRESSOR COOLING WATER	0.0%	0.0000	6.6994	6.6994	0.0%		
314	PRODUCT SCREEN SCRUBBER	0.6%	0.0150	2.3448	2.3598	2.0%	92.80%	0.0139
315	NET CLARIFIER FEED	0.2%	0.1688	91.0498	91.2186	22.2%	87.61%	0.1479

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: ORDRI SYSTEMS, 2 OF 2 (PFD-008)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
316	CLAR. DECANT TO COOLING SYSTEMS	0.0%	0.0000	90.093	90.093	0.0%		
317	DRI TO SCREENS	100.0%	0.3674	0.000	0.367	48.3%	92.80%	0.3410
318	DRI WITH FINES REMOVED	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
319	DRI FROM SILOS	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
320	EXCESS DRI TO SALES	100.0%	0.0000	0.000	0.000	0.0%	92.80%	0.0000
321	DRI TO EAF STORAGE HOPPERS	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
322	GAS QUENCH O/F WATER TO CLARIFIER	0.0%	0.0000	74.119	74.119	0.0%		
323	INERT GAS (MM Nm3/YR)	0.0%	0.0000	43.000	43.000	0.0%		
324	DRI SCREEN FINES TO EAF INJECTION	100.0%	0.0147	0.000	0.015	1.9%	92.80%	0.0136

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: OREAF STEELMAKING/LMF (PFD-009) BASIS: 8,000 HRS/YR EAF/LMF/CASTING OPERATION

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL DRI FEED TO EAF	100.0%	0.367	0.000	0.367	48.3%	92.80%	0.341
401	LUMP LIME FLUX TO EAF	100.0%	0.013	0.000	0.013	1.6%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	4.2%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.012	0.000	0.012	7.1%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	1.1%		
406	TOTAL EAF COOLING WATER CIRC. (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
407	REVERT SCRAP	100.0%	0.048	0.000	0.048	6.4%	99.70%	0.048
408	PURCHASED SCRAP	100.0%	0.688	0.000	0.688	90.4%	99.70%	0.686
409	NET SCRAP CHARGED	100.0%	0.736	0.000	0.736	96.7%	99.70%	0.734
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.032	0.000	0.032	4.2%	40.75%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.015	0.000	0.015	1.9%		
412	PROCESS/COOLING WATER OUT OF EAF (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.158	0.158	0.0%	25.60%	0.041
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	2.6%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR)	0.0%	0.000	11.812	11.812	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.054	1.054	0.0%	99.70%	1.051
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.7%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.4%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(MIDREX SHAFT FURNACE - 30% DRI CHARGE)

Revision A: OREAF STLMAKING/LMF (PFD-009), CASTING (PFD-010) BASIS: 0 (MM T/YR)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.052	1.052	0.0%	99.70%	1.049
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.014	0.000	0.012	1.5%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.158	0.000	0.158	20.8%	26.96%	0.043
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.7%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	3.1%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.8%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	2.4%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	11.3%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	3.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR)	0.0%	0.164	9.600	9.764	21.5%		
509	NET STEEL TO CASTING	0.0%	0.000	0.999	0.999	0.0%	99.70%	0.996
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
511	THIN SLAB TO HOT BAND	#DIV/0!	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX D-4

100% SCRAP CHARGED TO EAF

16-Sept-1999

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: OREBODY ASSUMPTIONS

BASIS:

7,940	HRS/YR CONCENTRATOR/PELLET/DRI OPERATION					
8,000	HRS/YR EAF/LMF/CASTING OPERATION					TARGET
61.2	T/HR ORE1 CONC. NET FEED	68.557%	IRON UNITS	IN CONC.		68.560%
0.0	T/HR ORE2	0.000%	IRON UNITS			
0.0	T/HR ORE3	0.000%	IRON UNITS			
61.2	T/HR NET DRI ORE FEED	68.557%	IRON UNITS		89.36%	AS FE304
122.1	T/HR SLAB PRODUCED	8,000	HRS/YR BASIS		10.64%	AS FE2O3

				TARGET		BALANCE
0.000	DRI PROD.	2.072	ORE/P TO DRI	79.932%	Fe RECOV	80.761%
0.977	SLAB PROD.	0.000	DRI TO SLAB	60.000%	Wt.% RECOV	58.900%

TOTAL PLANT PRODUCTION (DRY BASIS):

2.087	MM TONNES/YEAR AS-MINED ROCK
0.825	MM TONNES/YEAR NET ORE TO CONCENTRATOR
0.486	MM TONNES/YEAR NET CONCENTRATE
0.000	MM TONNES/YEAR LUMP ORE3
0.830	MM TONNES/YEAR GREEN BALL PELLET (+6mm)
0.841	MM TONNES/YEAR TOTAL INDURATED PELLET
0.785	MM TONNES/YEAR NET INDURATED PELLET (+6mm)
0.761	MM TONNES/YEAR FEED TO DRI FCE.
0.000	MM TONNES/YEAR DRI
0.977	MM TONNES/YEAR NET SLAB PRODUCT (BALANCE)
0.000	MM TONNES/YEAR HOT BAND SLAB
0.977	MM TONNES/YEAR NET SLAB PRODUCT
1.000	MM TONNES/YEAR LIQUID STEEL (TARGET)
0.977	MM TONNES/YEAR NET SLAB PRODUCT (TARGET)

CONCENTRATOR

60.474%	WASTE ROCK - % OF MINED
3.000%	AS-MINED ROCK MOISTURE - %
30.000%	AS-MINED ROCK IRON UNITS - WT.% IRON
50.000%	ORE ROCK IRON UNITS - WT.% IRON
70.0%	GRIZZLY SCREEN O/S - % OF FEED
200.0%	CIRCULATING LOAD - +10 mm TO TERTIARY (% FEED)
0.0%	PERCENT FEED TO SECONDARY 2 (%)
0.0%	PERCENT FEED TO TERTIARY 4 (%)
300.0%	BALL MILL CIRCULATING LOAD (% OF FEED)
65.0%	BALL MILL PERCENT SOLIDS (% OF FEED)
35.0%	B.M. CYCLONE O/F PERCENT SOLIDS (%)
4.60%	GROUND ORE LOSSES TO SLIMES - WT.%
5.00%	DESLIME CYCLONE O/F PERCENT SOLIDS (%)
68.21%	STG.1 MAG. CONC. RECOVERY - WT.% OF FEED
86.39%	STG. 1 IRON UNIT RECOVERY - WT.% OF IRON UNITS
95.30%	STG. 2 MAG. CONC. WT. RECOVERY - WT.% OF FEED
98.50%	STG. 2 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
98.60%	STG. 3 MAG. CONC. RECOV. - WT.% OF FEED
99.50%	STG. 3 MAG. CONC. IRON UNIT RECOV. - WT.% OF IU
200.00%	REGRIND MILL CIRCULATING LOAD (% OF FEED)
65.00%	REGRIND MILL % SOLIDS (WT.%)
99.00%	S-FLOTATION IRON CONC - WT.% OF FEED
99.50%	S-FLOTATION IRON UNIT RECOV. - WT.% OF IU
97.30%	GAN. REJECT. MAG. SEP. - WT.% OF FEED
98.57%	GAN. REJECT. MAG. SEP. - WT.% OF IU

CONCENTRATOR DEWATERING

65.0%	WT.% SOLIDS IN CONC. THICK. U/F
35.0%	WT.% SOLIDS IN TAILS. THICK. U/F
0.0%	FEED DIVER. TO THICK. - % OF FEED
10.0%	FILTER FEED O/F - % OF FEED

DRI PLANT

3.0%	PERCENT OF PELLET FINES - WT.% PEL.
10.0%	PERCENT OF LUMP FINES - WT.% LUMP
4.0%	PERCENT DUST - WT.% OF OXIDE FEED
3.0%	PERCENT -6 mm DRI FINES - WT.% DRI
0.0%	PERCENT REMET CHARGED - WT.% OF FD
0.22%	PERC. LIME FOR COATING - WT.% OF FD
21.83%	SOLIDS IN OFF-GASS - WT.% OF DRI FD
3.94%	SOLIDS IN FCE GAS - WT.% OF DRI FD
28.83%	COARSE SOL. IN CLASS - % OF CLASS FD
1.68%	SOLIDS IN SILO DUST - % OF DRI PROD.
1.06%	SOLIDS IN OXIDE SCRN DUST - %DRI FD
4.08%	SOLIDS IN DRI SCRN DUST - %DRI PROD
93.00%	METALLIZATION - WT.% Fet IN DRI

PELLET PLANT

6.7%	PERCENT DUST/FINES - WT.% OF G.B.
2.0%	PERCENT U/S GREEN BALL PELLETS
2.0%	PERCENT O/S GREEN BALL PELLETS
0.0%	PERCENT U/S INDURATED PELLETS
0.0%	PERCENT O/S INDURATED PELLETS
25.0%	PERCENT O/S P.P. DUST - % DUST/FINES
0.0%	COKE TO PELLET - % OF FEED
0.6%	BINDER TO PELLET - % OF FEED
2.0%	DOLOMITE TO PELLET - % OF FEED
0.0%	LIMESTONE TO PELLET - % OF FEED
0.0%	HYDRATED LIME TO PELLET - % OF FEED
0.0%	EXCESS PELLETS TO SALES - % OF TOTAL

4.5%	L.O.I.
1.014	RATIO INDUR./G.B. PELLET

EAF/LMF/CASTING

2.0%	EAF DUST - WT. % OF SLAB
4.0%	DRI TO EAF INJ. - WT.% DRI
1.1%	DOLOMITE ADDITION
0.00%	SILICA FLUX - % EAF FD
0.65%	MISC. ADDIT. - % EAF FD
0.83%	C CHARGED - % EAF FD
0.35%	ELECTRODES - % EAF FD
3.87%	PUL. LIME EAF - % EAF FD
1.34%	REFRACTORIES - % EAF FD
14.34%	EAF SLAG - % EAF FD
2.26%	LADLE SCRAP - % M. STL
0.60%	TUND. SCRAP - % M. STL
99.00%	YIELD TO SLAB - % MS
98.00%	YIELD TO T.SLAB - % MS
98.00%	YIELD HOT BAND - % TS
1.74%	CROP ENDS - % M. STL
4.60%	TOTAL REVERT - %M. STL
95.40%	PURC. SCRAP - % M. STL.
0.50%	PUL. LIME LMF - %M. STL
0.04%	SLG TO LMF - % M. STL
0.64%	SLG FR. LMF - %MS
0.060	ARGON TO LMF - NM3/T MS
0.50%	SLAB SCALE - %MS
0.06%	MOLD POWDER - % M. STL.
0.03%	TUND. POWDER - % M. STL.
100.00%	SLAB PROD. - % OF PROD.
0.27%	SLAG C INJ. - WT% M. STL
25.60%	%Fe IN EAF SLAG

RED = ASSUMPTION INPUT (DATA OR EXPERIENCE) BLUE = DERIVED VARIABLE

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
1001	AS-MINED ROCK	97.0%	2.087	0.065	2.152	274.2%	30.00%	0.626
1002	WASTE ROCK	97.0%	1.262	0.039	1.301	165.8%	16.93%	0.214
1	IRON ORE TO CONCENTRATOR (CRUSHING)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
2	PRODUCT FROM PRIMARY CRUSHER (80% -130 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
3	FEED TO GRIZZLY (Secondary 1)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
3 a	FEED TO GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
4	OS FROM GRIZZLY (Secondary 1)	97.0%	0.578	0.018	0.595	75.9%	50.00%	0.289
4 a	OS FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
5	US FROM GRIZZLY (Secondary 1)	97.0%	0.248	0.008	0.255	32.5%	50.00%	0.124
5 a	US FROM GRIZZLY (Secondary 2)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
6	US FROM SECONDARY 1 (80% -37 mm)	97.0%	0.578	0.018	0.595	75.9%	50.00%	0.289
6 a	US FROM SECONDARY 2 (80% -37 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
7	TOTAL FEED TO TERTIARY CRUSHERS (+10 mm)	97.0%	1.650	0.051	1.701	216.8%	50.00%	0.825
7 a	US FROM TERTIARY 1 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 b	US FROM TERTIARY 2 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 c	US FROM TERTIARY 3 (80% -10 mm)	97.0%	0.550	0.017	0.567	72.3%	50.00%	0.275
7 d	US FROM TERTIARY 4 (80% -10 mm)	97.0%	0.000	0.000	0.000	0.0%	50.00%	0.000
8	TOTAL FEED TO TERTIARY SCREENS	97.0%	2.475	0.077	2.552	325.2%	50.00%	1.238
9	UNDERSIZE FROM TERTIARY SCREENS (-10 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413
10	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	0.825	0.026	0.851	108.4%	50.00%	0.413

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

16-Sept-1999 IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
10 a	FEED TO BALL MILLS 1&2 (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
10 b	FEED TO BALL MILLS 3&4 (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
11	TOTAL FEED TO BALL MILLS (-10 mm)	97.0%	0.413	0.013	0.425	54.2%	50.00%	0.206
11 a	FEED TO BALL MILL 1 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 b	FEED TO BALL MILL 2 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 c	FEED TO BALL MILL 3 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
11 d	FEED TO BALL MILL 4 (-10 mm)	97.0%	0.206	0.006	0.213	27.1%	50.00%	0.103
12	TOTAL FEED TO BALL MILL CYCLONES	65.0%	2.063	1.111	3.173	271.0%	50.00%	1.031
13	TOTAL B.M. CYCLONE UNDERFLOW	7.8%	1.238	14.528	15.766	162.6%	50.00%	0.619
14	TOTAL B.M. MAKEUP WATER	0.0%	0.000	14.950	14.950			
15	TOTAL B.M. CYCLONE OVERFLOW	35.0%	0.825	1.532	2.357	108.4%	50.00%	0.413
21	ORE SLIMES TO TAILINGS	5.0%	0.038	0.721	0.759	5.0%	29.80%	0.011
22	DE-SLIMED ORE TO MAG. SEP.	49.3%	0.787	0.811	1.598	103.4%	50.97%	0.401
23	MAG. SEP. 1 DILUTION WATER	0.0%	0.000	31.600	31.600			
24	NET FEED TO MAG. SEP. 1	2.4%	0.787	32.411	33.198	103.4%	50.97%	0.401
25	MAG. SEP 1 TAILS	11.9%	0.250	1.852	2.103	32.9%	21.43%	0.054
26	MAG. SEP. 1 CONC.	1.7%	0.537	30.559	31.096	70.5%	64.74%	0.348
27	MAG. SEP. 2 DILUTION WATER	0.0%	0.000	14.300	14.300			
28	NET FEED TO MAG. SEP. 2	1.2%	0.537	44.859	45.396	70.5%	64.74%	0.348
29	MAG. SEP 2 TAILS	1.5%	0.025	1.657	1.682	3.3%	24.62%	0.006
30	MAG. SEP. 2 CONC.	1.2%	0.512	43.202	43.713	67.2%	66.72%	0.341

BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE

16-Sept-1999 IRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
31	MAG. SEP. 3 DILUTION WATER	0.0%	0.000	13.900	13.900			
32	NET FEED TO MAG. SEP. 3	0.9%	0.512	57.102	57.613	67.2%	66.72%	0.341
33	MAG. SEP 3 TAILS	1.5%	0.007	0.470	0.478	0.9%	23.83%	0.002
34	MAG. SEP. 3 CONC.	0.9%	0.505	56.631	57.136	66.3%	67.33%	0.340
35	REGRIND MILL DISCHARGE	65.0%	1.009	0.543	1.552	132.6%	0.00%	0.000
36	NET FEED TO REGRIND MILL CYCLONE	2.6%	1.514	57.175	58.688	198.8%	67.33%	1.019
37	REGRIND MILL CYCLONE O/F PRODUCT TO FLOTATION	0.9%	0.505	56.631	57.136	66.3%	67.33%	0.340
38	REGRIND MILL CYCLONE U/F TO MILL	65.0%	1.009	0.543	1.552	132.6%	67.33%	0.679
39	REGRIND MILL DILUTION WATER	0.0%	0.000	0.000	0.000			
40	FLOTATION DILUTION WATER	0.0%	0.000	5.100	5.100			

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORIRON ORE CONCENTRATOR (PFD-002)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
41	FLOTATION CHEMICALS	0.0%	0.000	0.050	0.050			
42	NET FLOTATION FEED	0.8%	0.505	61.781	62.286	66.3%	67.33%	0.340
43	FLOAT TAILS - Fe CONC. TO MAG. IV	0.8%	0.499	61.768	62.267	65.6%	67.67%	0.338
44	SULFUR FLOAT REJECTS TO TAILS	27.0%	0.005	0.014	0.019	0.7%	33.66%	0.002
45	MAG. SEP. 4 CONC.	0.8%	0.486	60.881	61.367	63.8%	68.56%	0.333
46	MAG. SEP. 4 GANGUE REJECT TO TAILS	1.5%	0.014	0.887	0.900	1.8%	35.69%	0.005
47	CONCENTRATE TO PIPELINE FEED	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
48	EXCESS WATER FROM CONC. THICK. TO P.W. POND	0.0%	0.000	60.619	60.619			
49	TOTAL REJECTS TO TAILS	5.7%	0.339	5.601	5.941	44.5%	23.41%	0.079
50	DEWATERED TAILINGS TO DISPOSAL	35.0%	0.339	0.630	0.969	44.5%	23.41%	0.079
51	TAILS THICKENER DECANT TO P.W. POND	0.0%	0.000	4.972	4.972			
52	EXCESS WATER FROM TAILS POND	0.0%	0.000	0.460	0.460			
53	FRESH WATER MAKEUP TO P.W. POND	0.0%	0.000	5.232	5.232			
54	EVAPORATION FROM P.W. POND	0.0%	0.000	3.564	3.564			
	TOTAL INPUTS TO P.W. POND	0.0%	0.000	71.283	71.283			
55	TOTAL CONCENTRATOR WATER INPUTS	0.0%	0.000	79.900	79.900			

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORPIPELINE & ORE RECEIVING (PFD-003)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
43	CONCENTRATE SLURRY FROM PIPELINE	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
101	CONCENTRATE FEED TO DEWATERING	65.0%	0.486	0.262	0.748	63.8%	68.56%	0.333
102	NET FILTER FEED	60.0%	0.897	0.598	1.495	117.8%	73.60%	0.660
103	FEED SLURRY DIVERSION TO THICKENERS	65.0%	0.000	0.000	0.000	0.0%	68.56%	0.000
104	FILTER CAKE	92.0%	0.807	0.070	0.877	106.0%	73.60%	0.594
105	FILTRATE	0.0%	0.000	0.468	0.468			
106	FILTER O/F	60.0%	0.090	0.060	0.149	11.8%	73.60%	0.066
107	LAUNDER WASH-DOWN WATER	0.0%	0.000	0.299	0.299			
108	NET FILTER O/F RETURN	20.0%	0.090	0.359	0.448	11.8%	73.60%	0.066
109	THICKENER FEED	48.8%	0.897	0.942	1.839	117.8%	73.60%	0.660
110	THICKENER DECANT	0.0%	0.000	0.344	0.344			
111	THICKENER U/F	60.0%	0.897	0.598	1.495	117.8%	73.60%	0.660
112	EXCESS WATER TO PROCESS WATER	0.0%	0.000	0.812	0.812			

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORSTOCKPILE, PELLET PLANT SLURRY/FINES HANDLING (BFD-004)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
201	RECYCLE EAF DUST SLURRY	15.0%	0.020	0.112	0.132	2.6%	48.50%	0.010
202	RECYCLE DRI DUST SLURRY	15.0%	0.169	0.957	1.125	22.2%	87.61%	0.148
203	P.P. DUST/FINES SLURRY	15.0%	0.053	0.298	0.351	6.9%	70.74%	0.037
204	P.P. DUST SYSTEMS O.S.	80.0%	0.047	0.012	0.059	6.2%	70.74%	0.033
205	FEED TO P.P. THICKENER	18.2%	0.321	1.440	1.761	42.2%	81.23%	0.261
206	DECANT FROM P.P. THICKENER	0.0%	0.000	1.119	1.119			
207	U/F FROM P.P. THICKENER TO FEED THICK.	50.0%	0.321	0.321	0.643	42.2%	81.23%	0.261
208	DRI CLASSIFIER O/S	75.0%	0.057	0.019	0.075	7.4%	87.80%	0.050
209	-6 mm ORE/PELLET FINES	100.0%	0.024	0.000	0.024	3.1%	70.74%	0.017
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
211	TOTAL FEED TO MILLING	80.6%	0.127	0.031	0.158	16.7%	78.32%	0.100
212	MILL MAKE-UP WATER	0.0%	0.000	0.054	0.054	0.0%		
213	GROUND FINES SLURRY TO P.P. THICKENER	60.0%	0.127	0.085	0.212	16.7%	78.32%	0.100
232	INDURATED PELLETS TO STOCKPILE	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
250	RECLAIMED PELLETS	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
251	LUMP ORE3 TO STOCKPILE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
252	RECLAIMED LUMP ORE	97.0%	0.000	0.000	0.000	0.0%	0.00%	0.000
253	PELLET/LUMP ORE TO FEED SILOS	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
254	EXCESS PELLETS TO SALES	0.0%	0.000	0.000	0.000	0.0%	70.74%	0.000

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORGREEN BALL PELLET PRODUCTION: (BFD-005)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
104	FILTER CAKE TO PELLET PLANT	92.0%	0.807	0.070	0.877	106.0%	73.60%	0.594
218	NET OXIDE FEED TO PELLETIZING	91.9%	0.842	0.074	0.916	110.6%	73.53%	0.619
219	PELLETIZING WATER	0.0%	0.000	0.012	0.012	0.0%		
220	COKE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
221	BINDER TO PELLETIZING	100.0%	0.005	0.000	0.005	0.7%	11.60%	0.001
222	DOLOMITE TO PELLETIZING	100.0%	0.017	0.000	0.017	2.3%	1.61%	0.000
223	LIMESTONE TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
224	HYDRATED LIME TO PELLETIZING	100.0%	0.000	0.000	0.000	0.0%		
225	PELLET FEED MIXTURE	91.0%	0.864	0.085	0.950	113.5%	71.73%	0.620
226	DISC DRESSING MOISTURE	0.0%	0.000	0.005	0.005	0.0%		
227	GREEN BALL PELLETS	90.5%	0.864	0.091	0.955	113.5%	71.73%	0.620
228	COMBINED GREEN BALL O/S & U/S	90.5%	0.035	0.004	0.038	4.5%	71.73%	0.025
229	SIZED GREEN BALL PELLETS	90.5%	0.830	0.087	0.917	109.0%	71.73%	0.595

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORINDURATED PELLET PRODUCTION: (BFD-006)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
229	SIZED GREEN BALL PELLETS	90.5%	0.830	0.087	0.917	109.0%	71.73%	0.595
230	INDURATED PELLETS (GROSS)	100.0%	0.841	0.000	0.841	110.5%	70.74%	0.595
231	INDURATED PELLETS (NET)	100.0%	0.785	0.000	0.785	103.1%	70.74%	0.555
232	CRUSHED OVERSIZE PELLETS	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
233	UNDERSIZE INDURATED PELLETS	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000
234	RECYCLED INDURATED PELLET DUST/FINES	100.0%	0.056	0.000	0.056	7.4%	70.74%	0.040
235	P.P. DUST SLURRY WATER	0.0%	0.000	0.298	0.298			
203	P.P. DUST SLURRY TO PELLET FEED	15.0%	0.053	0.298	0.351	6.9%	70.74%	0.040
210	INDURATED PELLET RECYCLE O/S & U/S	100.0%	0.000	0.000	0.000	0.0%	70.74%	0.000

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORDRI SYSTEMS, 1 OF 2 (PFD-007)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (T/HR)
253	RECLAIMED PELLETS/LUMP ORE	100.0%	0.7848	0.0000	0.7848	103.1%	70.74%	0.5552
209	-6 mm OXIDE TO PELLETIZING (ORE/PELLETS)	100.0%	0.0235	0.0000	0.0235	3.1%	70.74%	0.0167
299	REMET (OTHER) CHARGED TO SHAFT FCE.	100.0%	0.0000	0.0000	0.0000	0.0%	70.74%	0.0000
300	NET ORE/PELLETS, ETC. TO SHAFT FCE.	100.0%	0.7612	0.0000	0.7612	100.0%	70.74%	0.5385
301	COATING LIME	100.0%	0.0095	0.0000	0.0095	1.2%		
302	LIME COATING WATER	0.0%	0.0000	0.0284	0.0284	0.0%		
303	NET FURNACE FEED	96.4%	0.7707	0.0284	0.7991	101.2%	69.88%	0.5385
304	OFF-GASSES (INCL. DUST/WV)	43.0%	0.1661	0.2205	0.3866	21.8%	87.80%	0.1459
305	GAS QUENCH SCRUB WATER (MM TPY)	0.0%	0.0000	73.8987	73.8987	0.0%		
306	FURNACE DUST TO DUST SCRUBBERS	100.0%	0.0304	0.0000	0.0300	3.9%	87.80%	0.0264
307	FURNACE DUST SCRUB WATER	0.0%	0.0000	2.3448	2.3448	0.0%		
308	FCE DUST SLURRY TO CLASSIFIER	1.3%	0.0300	2.3448	2.3748	3.9%	87.80%	0.0264
309	GAS QUENCH SCRUBBER BLOWDOWN	6.6%	0.1661	2.3448	2.5109	21.8%	87.80%	0.1459
208	COARSE SOLIDS FROM CLASSIFIER	75.0%	0.0565	0.0188	0.0754	7.4%	87.80%	0.0496
310	DE-GRITTED FCE. SCRUB BLOW-DOWN	97.0%	0.1396	4.6707	4.8103	18.3%	87.80%	0.1226
311	PRODUCT SILO SCRUBBER BLOW-DOWN	0.4%	0.0062	1.6079	1.6140	0.8%	92.80%	0.0057
312	OXIDE SCREEN SCRUBBER BLOW-DOWN	100.0%	0.0080	1.6079	1.6159	1.1%	70.74%	0.0057
313	COMPRESSOR COOLING WATER	0.0%	0.0000	6.6994	6.6994	0.0%		
314	PRODUCT SCREEN SCRUBBER	0.6%	0.0150	2.3448	2.3598	2.0%	92.80%	0.0139
315	NET CLARIFIER FEED	0.2%	0.1688	91.0498	91.2186	22.2%	87.61%	0.1479

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: ORDRI SYSTEMS, 2 OF 2 (PFD-008)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	SOLIDS % OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
316	CLAR. DECANT TO COOLING SYSTEMS	0.0%	0.0000	90.093	90.093	0.0%		
317	DRI TO SCREENS	100.0%	0.3674	0.000	0.367	48.3%	92.80%	0.3410
318	DRI WITH FINES REMOVED	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
319	DRI FROM SILOS	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
320	EXCESS DRI TO SALES	100.0%	0.0000	0.000	0.000	0.0%	92.80%	0.0000
321	DRI TO EAF STORAGE HOPPERS	100.0%	0.3527	0.000	0.353	46.3%	92.80%	0.3273
322	GAS QUENCH O/F WATER TO CLARIFIER	0.0%	0.0000	74.119	74.119	0.0%		
323	INERT GAS (MM Nm3/YR)	0.0%	0.0000	43.000	43.000	0.0%		
324	DRI SCREEN FINES TO EAF INJECTION	100.0%	0.0147	0.000	0.015	1.9%	92.80%	0.0136

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: OREAF STEELMAKING/LMF (PFD-009)

BASIS: 8,000 HRS/YR EAF/LMF/CASTING OPERATION

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
400	TOTAL DRI FEED TO EAF	100.0%	0.000	0.000	0.000	0.0%	92.80%	0.000
401	LUMP LIME FLUX TO EAF	100.0%	0.012	0.000	0.012	1.6%		
402	SILICA FLUX	100.0%	0.000	0.000	0.000	0.0%		
403	MISC. ADDITIVES (Al, FeMn, FeSi, etc.)	100.0%	0.007	0.000	0.007	4.2%	40.72%	0.013
404	STEEL CARBON (CHARGED+SLAG INJ.)	100.0%	0.012	0.000	0.012	7.1%		
405	EAF ELECTRODES	100.0%	0.004	0.000	0.004	1.1%		
406	TOTAL EAF COOLING WATER CIRC. (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
407	REVERT SCRAP	100.0%	0.050	0.000	0.050	6.5%	99.70%	0.049
408	PURCHASED SCRAP	100.0%	1.028	0.000	1.028	135.0%	99.70%	1.025
409	NET SCRAP CHARGED	100.0%	1.078	0.000	1.078	141.6%	99.70%	1.074
410	TOTAL FLUX & ADDITIVES CHARGED	100.0%	0.031	0.000	0.031	4.1%	41.75%	0.013
411	REFRACTORIES CONSUMMED	100.0%	0.014	0.000	0.014	1.9%		
412	PROCESS/COOLING WATER OUT OF EAF (MM NM3/YR)	0.0%	0.000	70.627	70.627	0.0%		
413	EAF SLAG (LIQUID)	0.0%	0.000	0.155	0.155	0.0%	25.60%	0.040
414	EAF DUST TO EAF DUST COLLECTION	100.0%	0.020	0.000	0.020	2.6%	48.50%	0.010
415	OXYGEN GAS TO FURNACE (MM Nm3/YR)	0.0%	0.000	11.913	11.913	0.0%		
416	LIQUID EAF STEEL TO LADLE REFINING	0.0%	0.000	1.054	1.054	0.0%	99.70%	1.051
417	PULVERIZED LIME TO LADLE REF. FCE.	100.0%	0.005	0.000	0.005	0.7%		
418	SLAG/WIRE DESULFURIZER TO LRF	100.0%	0.0004	0.0000	0.0034	0.4%		
419	ARGON GAS TO LRF (MM Nm3/YR)	0.0%	0.000	0.063	0.063	0.0%		

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BASE CASE IRON/STEELMAKING WATER & SOLIDS BALANCE
(100% SCRAP CHARGE TO EAF - NO OTHER IRON UNITS CHARGED)

Revision A: OREAF STLMAKING/LMF (PFD-009), CASTING (PFD-010) BASIS: 0 (MM T/YR)

STREAM NUMBER	STREAM LABLE	% SOLIDS	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)	% OF SLAB OF DRI FD	%Fe (DRY)	Fe UNITS (MM T/YR)
420	SLAG & LOSSES FROM LRF	0.0%	0.000	0.007	0.007	0.0%	31.80%	0.002
421	REFINED STEEL TO CASTING	0.0%	0.000	1.052	1.052	0.0%	99.70%	1.049
422	PULVERIZED LIME FLUX TO EAF	100.0%	0.000	0.000	0.012	1.5%		
423	WATER FOR EAF DUST TRANSPORT	0.0%	0.000	0.112	0.112	0.0%		
424	PROC. COOLING WATER LMF	0.0%	0.000	14.125	14.125	0.0%		
425	TOTAL SLAG OUTPUT (AS SOLID)	100.0%	0.155	0.000	0.155	20.3%	26.99%	0.042
501	SLAB SCALE	0.0%	0.005	0.000	0.005	0.7%	80.00%	0.004
502	LADLE SCRAP	0.0%	0.024	0.000	0.024	3.1%	99.70%	0.024
503	TUNDISH SCRAP	100.0%	0.006	0.000	0.006	0.8%	99.70%	0.006
504	CROP END SCRAP	0.0%	0.018	0.000	0.018	2.4%	99.70%	0.018
505	MOLD POWDER TO CASTING	100.0%	0.0006	0.000	0.001	11.3%		
506	TUNDISH POWDER TO CASTING	100.0%	0.0003	0.000	0.000	3.5%		
507	MOLD COOLING WATER (MM NM3/YR)	0.0%	0.000	29.206	29.206	0.0%		
508	CONTACT COOLING WATER (MM NM3/YR)	0.0%	0.160	9.600	9.760	21.0%		
509	NET STEEL TO CASTING	0.0%	0.000	0.999	0.999	0.0%	99.70%	0.996
510	TOTAL CAST SLAB PRODUCT	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
511	THIN SLAB TO HOT BAND	#DIV/0!	0.000	0.000	0.000	0.0%	99.70%	0.000
512	SLABS TO SALES	100.0%	0.977	0.000	0.977	128.3%	99.70%	0.974
513	HOT BAND TO SALES	100.0%	0.000	0.000	0.000	0.0%	99.70%	0.000

APPENDIX E

METSIM® IRONMAKING PROCESS SIMULATIONS

E-1: BASE CASE MIDREX SHAFT FURNACE

E-2: HYLSA IVM (REFORMERLESS WITH HOT DRI CHARGE TO EAF)

E-3: TECNORED SHAFT MELTER

E-4: HISMELT OXYGEN REACTOR

E-5: REDSMELT ROTARY HEARTH FURNACE

E-6: CIRCORED FLUID-BED REDUCTION PROCESS (NATURAL GAS REDUCTANT)

E-7: CIRCOFER FLUID-BED REDUCTION PROCESS (COAL REDUCTANT)

E-8: GENERIC IRON CARBIDE PROCESS

APPENDIX E-1:

BASE CASE MIDREX SHAFT FURNACE

IRONMAKING PROCESS DESCRIPTION

MIDREX® SHAFT FURNACE

PROCESS BACKGROUND:

The Midrex ™ Direct Reduction process is based upon a low pressure, moving bed shaft furnace where the reducing gas moves counter-current to the lump iron oxide ore or iron oxide pellet solids in the bed. The reducing gas (from 10-20% CO and 80-90% H_2) is produced from natural gas using Midrex's CO_2 reforming process and their proprietary catalyst (instead of steam reforming).

A single reformer is utilized instead of a reformer/heater combination. The reformed gas does not need to be cooled before introduction to the process. There is also no need for a separate CO_2 removal system.

The process can produce cold or hot DRI as well as HBI for subsequent use as a scrap substitute feed to a steelmaking melting furnace (SAF, EAF or oxygen steelmaking process).

Over 50 Midrex™ Modules have been built worldwide since 1969. They have supplied over 60% of the worlds DRI since 1989.

Standard sizes:

MIDREX™ MINIMOD Plant	(0.25-0.5 MM mt/year)
MIDREX™ Series 500 Module	(0.5-0.8 MM mt/year)
MIDREX™ Series 750 Module	(0.8-1.0 MM mt/year)
MIDREX MEGAMOD™	(1.0-1.6 MM mt/year)
MIDREX SUPER MEGAMOD™	(1.6-2.7 MM mt/year)

PROCESS DESCRIPTION:

The iron oxide feed to a Midrex ® shaft furnace can be in the form of pellets, lump ore or a mixture of the two (in 0 to 100% proportions). The solid feed is discharged into a feed hopper on top of a proportioning hopper that evenly distributes the solids into the shaft furnace.

A dynamic seal leg keeps the reducing gas inside the furnace. The shaft furnace operates at low pressure, under 1 bar gauge, which allows dynamic seals to be used on the furnace inlet and discharge. The iron ore burden in the shaft furnace is first heated, then reduced by the upward flowing, counter-current reducing gas that is injected through tuyeres located in a bustle distributor at the bottom of the cylindrical section of the shaft. The ore is reduced to a metallization typically in the range of 93% to 94% by the time it reaches the bustle area.

Below the bustle area, it goes through a transition zone (with design to reduce agglomeration or lumping) and then reaches the lower conical section of the furnace. Lower carbon reduced iron (<1.5% C) is cooled using a circulating stream of cooled exhaust gas that is introduced in the conical section for cold DRI discharge. Higher carbon DRI (up to 4.0% C) can be produced by introduction of natural gas into this cooling gas. It readily reacts (and cracks) with the highly reactive metallic DRI.

For hot discharge of DRI to be used for hot charging of EAF's (i.e. Midrex's Hotlink™ Process) or for feed to hot briquetting presses (to produce HBI), the lower part of the furnace is modified to allow handling of hot burden.

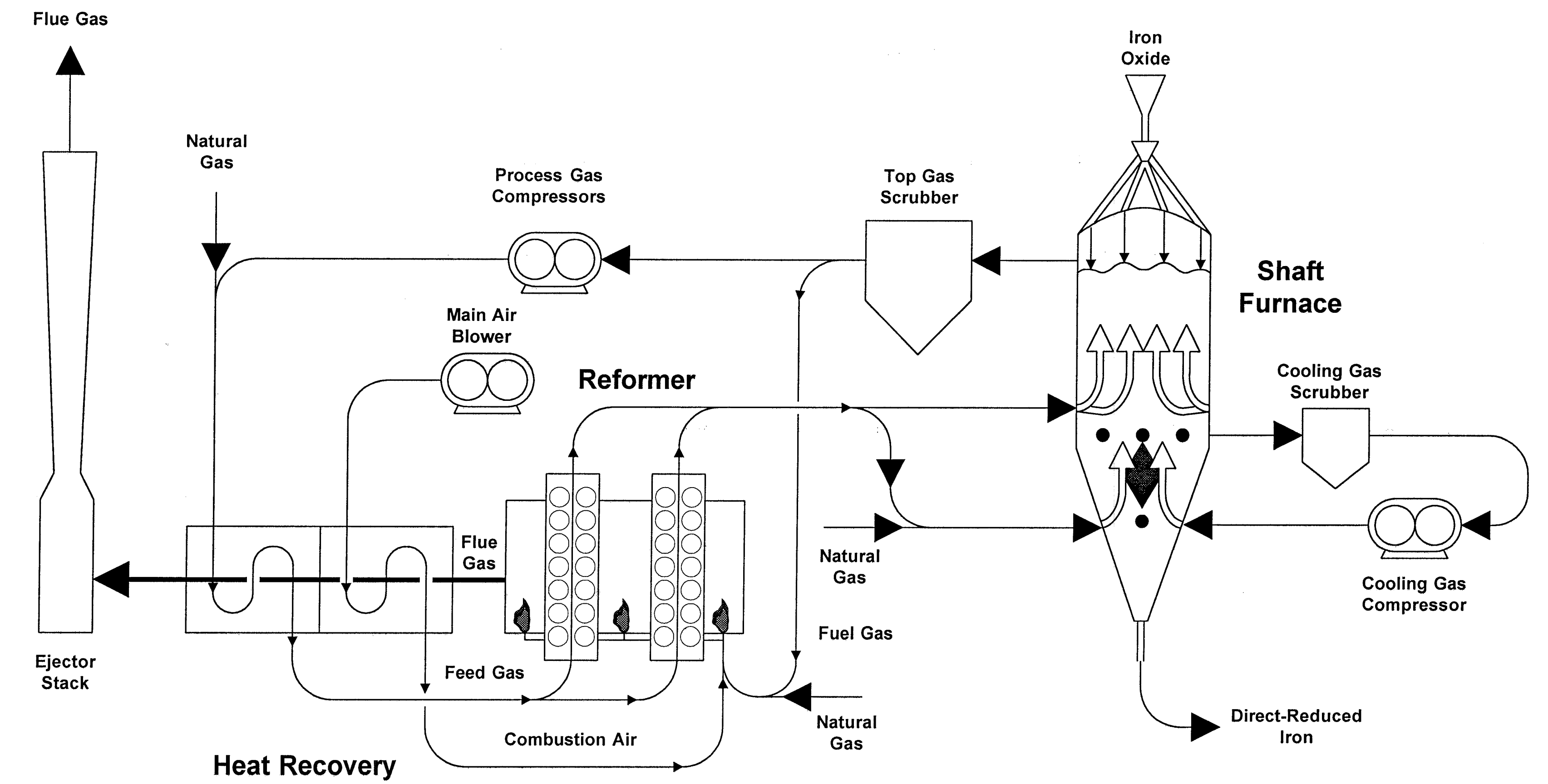
The Midrex gas generation system consists of a CO_2 reformer using their own catalyst. The feed to the reformer is a mixture of process gas recycled from the furnace and makeup natural gas. The top gas leaving the shaft furnace at a temperature of 400 to 450C is cooled and dust is removed in a top gas scrubber. About two-thirds of the gas is recycled back to the process (process gas) and the rest is used as a fuel. The process gas is compressed, mixed with natural gas and is preheated in the reformer recuperator before entering the tubes of the reformer.

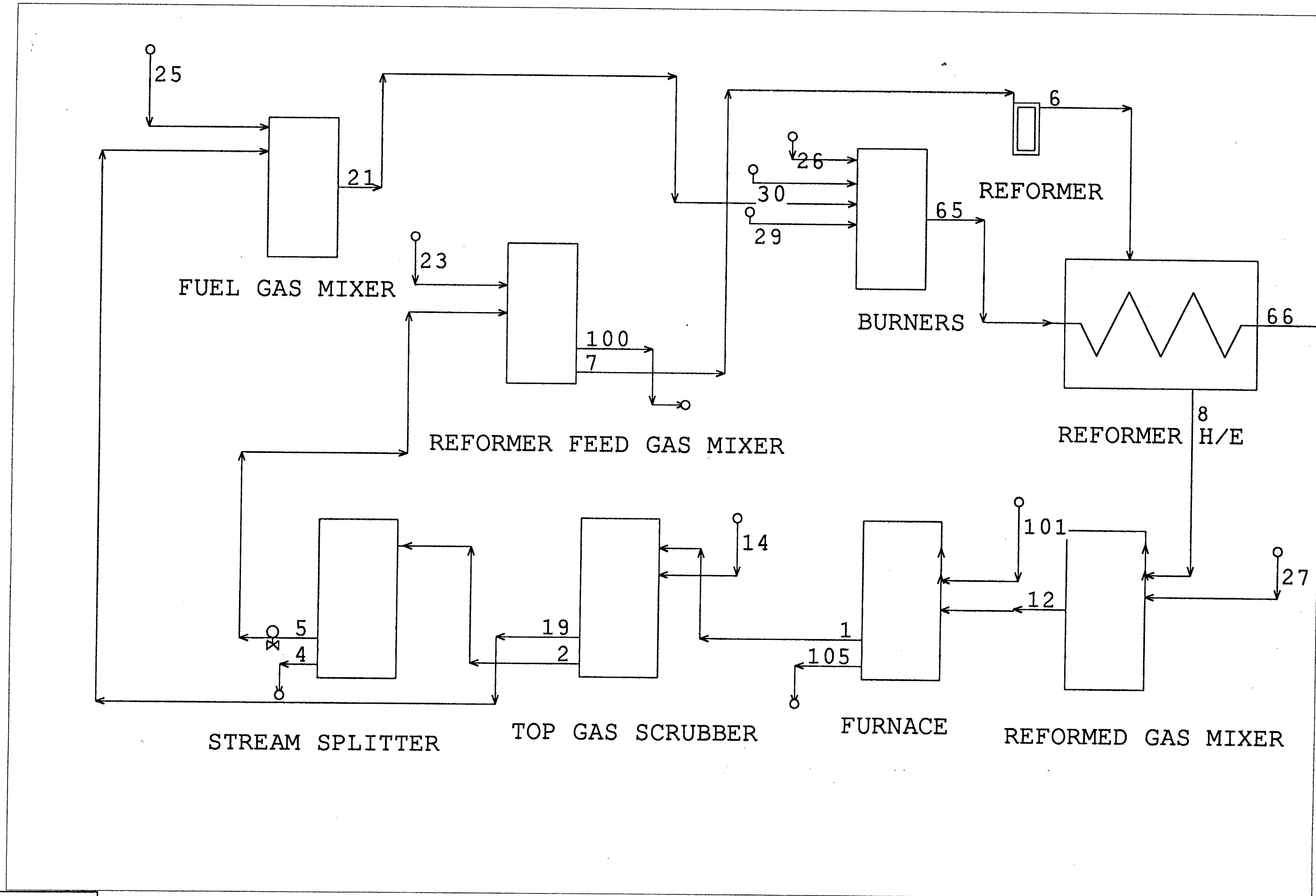
The reformed gas comprising of mostly CO and H_2 exits the reformer at about 850 °C and passes through collection headers to the reformed gas line. The ratio of H_2 to CO is controlled at about 1.5 to 1.8, and reducing quality at 11 to 12 for best operation.

PROCESS ADVANTAGES:

World-wide commercial use
Proven performance
"Relatively-forgiving" operation
Raw material flexibility
CO_2 reformer eliminates need for steam system, reformed gas quench, reducing gas heating and CO_2 removal system.

MIDREX PROCESS FLOWSHEET





MIDREX PROCESS

Midrex Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a basic flowsheet for a Midrex Megamod reactor for Tondu Corporation by Midrex Direct Reduction Corporation, Charlatte, USA.

Flowsheet Description

Stream 101 representing the lump ore feed consists of 82% Fe_2O_3, 12% Fe_3O_4 and 6% SiO_2. In the Reduction furnace, this feed is heated and reduced by the upcoming reducing gases or Bustle gas (Stream 12) into DRI (Stream 105). Stream 1 representing the Top gas is passed through a Gas Scrubber and a stream splitter to divide the Top gas into Process gas and Fuel gas. The Process gas is mixed with some natural gas and passed through a Mist Eliminator (Both unit operations performed by one MetSim unit operation called Reformed feed gas mixer). Stream 7 representing the process gas to reformer undergoes reforming reactions in the Reformer. Fuel gas (Stream 19) is mixed with some natural gas (Stream 25) and burned in the main Burner. Also additional natural gas (Stream 26) is burned with air (Stream 30) in the auxiliary Burner. This leads to hot flue gases (Stream 65). This stream is used to keep the reformer hot. The hot reformed gases (Stream 8) are again mixed with some natural gas (Stream 27) to yield the Bustle gas (Stream 12).

Model Assumptions:

Reduction Furnace: The temperature of hot bustle gas is 840C. The top gas comes out at 402C. Complete reduction of iron ore takes place along with some reaction between metallic Fe and natural gas to give Fe_3C. No carry-over of solid particles in the Top gas is assumed.

Top Gas Scrubber: The hot Top gases are mixed with some recycle stream and divided into two parts: Process gas and Fuel gas.

Stream Splitter: Only a MetSim unit operation; does not exist in reality. Process gas is divided into the portion required to carry out complete reduction. Rest goes back as recycle stream.

Reformed Feed Gas Mixer: All liquid water is separated.

Reformer: The reactions reach equilibrium.

Reformer H/E: The temperature of hot reformed gases is 940C.

Results

It was decided to achieve same operating conditions as were outlined in the Tondu proposal by Midrex. In the absence of information on gas compositions and amounts for certain feed streams, a few assumptions were made. These led to some differences between the MetSim Model results and the data by Midrex.

It was observed that although complete metallization took place in the furnace, the amount of gases flowing in and around the reduction furnace were higher than those outlined in the proposal by Midrex. This is partly due to the unknowns about the bustle gas composition.

MIDREX PROCESS --- STREAM SUMMARY

Stream Number	1	2	4	5	6	7	8	12
Stream Names	TOP GAS	PROCESS G	TO COOLIN	TOP GAS F	GAS FROM	GAS TO RE	REFORMED	GAS FOR R
MT/HR SOLIDS	0	0	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0
MT/HR GASEOUS	254.14	213.63	28.356	185.28	190.6	190.6	190.82	195.04
MT/HR TOTAL	254.14	213.63	28.356	185.28	190.6	190.6	190.82	195.04
Percent Solids	0	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.00033391	0.00035009	0.00035009	0.00035009	0.0007686	0.00026588	0.00018939	0.00017045
Sp.Gr.TOTAL	0.00033391	0.00035009	0.00035009	0.00035009	0.0007686	0.00026588	0.00018939	0.00017045
Temperature C	402	369.31	369.31	369.31	25	560	940	840
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	3.08E+05	2.59E+05	34437	2.25E+05	2.27E+05	2.35E+05	2.27E+05	2.81E+05
Component Mass Flow Rates								
1 Fe2O3 MT/HR	0	0	0	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0
5 H2O MT/HR	0	0	0	0	0	0	0	0
6 H2O MT/HR	27.852	22.103	2.9339	19.17	16.076	2.3003	15.919	15.919
7 C1H4 MT/HR	6.7962	5.6683	0.75238	4.916	29.908	27.105	30.156	17.189
8 C2H6 MT/HR	0.0017397	0.0013048	0.00017319	0.0011316	0.0017077	0.0011316	0.0017397	0.0017397
10 C1O1 MT/HR	69.897	61.505	8.1637	53.341	64.969	53.341	65.03	125.05
11 C1O2 MT/HR	136.22	112.74	14.965	97.78	71.818	97.78	71.936	24.781
12 H2 MT/HR	12.383	10.476	1.3906	9.0859	6.8397	9.0859	6.7862	11.106
13 N2 MT/HR	0.989	1.1336	0.15046	0.98311	0.98311	0.98311	0.989	0.989
14 O2 MT/HR	0	0	0	0	0	0	0	0
17 SiO2 MT/HR	0	0	0	0	0	0	0	0
18 Fe3C MT/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	17.208	14.375	1.908	12.467	16.155	16.155	16.147	17.208
2 C 6	72.24	61.389	8.1483	53.24	69.853	69.853	70.096	73.258
3 N 7	0.989	1.1336	0.15046	0.98311	0.98311	0.98311	0.989	0.989
4 O 8	163.71	136.74	18.149	118.59	103.6	103.6	103.59	103.59
5 Si 14	0	0	0	0	0	0	0	0
7 Fe 26	0	0	0	0	0	0	0	0

MIDREX PROCESS --- STREAM SUMMARY

Stream Number	14	19	21	23	25	26	27	29
Stream Names	RECYCLE P	FUEL GAS	FUEL TO MA	NATURAL G	NATURAL G	N.G. TO AU	NATURAL G	HOT AIR
MT/HR SOLIDS	0	0	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0
MT/HR GASEOUS	30.7	71.211	74.289	22.189	3.0778	0.35788	4.223	258.56
MT/HR TOTAL	30.7	71.211	74.289	22.189	3.0778	0.35788	4.223	258.56
Percent Solids	0	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.00063023	0.00035009	0.00039692	0.00065574	0.00063446	0.00063446	0.00063446	0.00037077
Sp.Gr.TOTAL	0.00063023	0.00035009	0.00039692	0.00065574	0.00063446	0.00063446	0.00063446	0.00037077
Temperature C	77	369.31	290	25	35	35	35	675
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	38000	86482	90782	31000	4300	500	5900	2.01E+05
Component Mass Flow Rates								
1 Fe2O3 MT/HR	0	0	0	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0
5 H2O MT/HR	0	0	0	0	0	0	0	0
6 H2O MT/HR	1.6188	7.3678	7.3678	0	0	0	0	0
7 C1H4 MT/HR	0.76157	1.8894	4.9672	22.189	3.0778	0.35788	4.223	0
8 C2H6 MT/HR	0	0.00043492	0.00043492	0	0	0	0	0
10 C1O1 MT/HR	12.109	20.502	20.502	0	0	0	0	0
11 C1O2 MT/HR	14.102	37.582	37.582	0	0	0	0	0
12 H2 MT/HR	1.5858	3.4921	3.4921	0	0	0	0	0
13 N2 MT/HR	0.52242	0.37786	0.37786	0	0	0	0	198.57
14 O2 MT/HR	0	0	0	0	0	0	0	59.986
17 SiO2 MT/HR	0	0	0	0	0	0	0	0
18 Fe3C MT/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	1.9584	4.7916	5.565	5.5763	0.77349	0.089941	1.0613	0
2 C 6	9.6115	20.463	22.767	16.612	2.3043	0.26794	3.1617	0
3 N 7	0.52242	0.37786	0.37786	0	0	0	0	198.57
4 O 8	18.608	45.579	45.579	0	0	0	0	59.986
5 Si 14	0	0	0	0	0	0	0	0
7 Fe 26	0	0	0	0	0	0	0	0

MIDREX PROCESS --- STREAM SUMMARY

Stream Number	30	65	66	100	101	105
Stream Names	AIR	HOT FLUE G	COOLED FL	MIST	IRON ORE	REDUCED IRON
MT/HR SOLIDS	0	0	0	0	215	155.9
MT/HR AQUEOUS	0	0	0	16.869	0	0
MT/HR GASEOUS	7.0785	340.28	340.28	0	0	0
MT/HR TOTAL	7.0785	340.28	340.28	16.869	215	155.9
Percent Solids	0	0	0	0	100	100
Sp.Gr.SOLIDS	0	0	0	0	4.9432	4.2899
Sp.Gr.AQUEOUS	0	0	0	0.9581	0	0
Sp.Gr.GASEOUS	0.0011408	0.00013292	0.00020363	0	0	0
Sp.Gr.TOTAL	0.0011408	0.00013292	0.00020363	0.9581	4.9432	4.2899
Temperature C	35	2316.2	1417	100	35	300
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	5500	2.70E+05	2.70E+05	0	0	0
Component Mass Flow Rates						
1 Fe2O3 MT/HR	0	0	0	0	176.3	0
2 Fe3O4 MT/HR	0	0	0	0	25.8	0
4 Fe1 MT/HR	0	0	0	0	0	127.78
5 H2O MT/HR	0	0	0	16.869	0	0
6 H2O MT/HR	0	50.535	50.535	0	0	0
7 C1H4 MT/HR	0	0	0	0	0	0
8 C2H6 MT/HR	0	0.00043492	0.00043492	0	0	0
10 C1O1 MT/HR	0	0	0	0	0	0
11 C1O2 MT/HR	0	84.402	84.402	0	0	0
12 H2 MT/HR	0	0	0	0	0	0
13 N2 MT/HR	5.4363	204.39	204.39	0	0	0
14 O2 MT/HR	1.6422	0.95997	0.95997	0	0	0
17 SiO2 MT/HR	0	0	0	0	12.9	12.9
18 Fe3C MT/HR	0	0	0	0	0	15.216
Element Mass Flow Rates						
1 H 1	0	5.655	5.655	1.8877	0	0
2 C 6	0	23.035	23.035	0	0	1.0179
3 N 7	5.4363	204.39	204.39	0	0	0
4 O 8	1.6422	107.21	107.21	14.982	66.991	6.87
5 Si 14	0	0	0	0	6.03	6.03
7 Fe 26	0	0	0	0	141.98	141.98

MIDREX PROCESS

INPUT DATA

TITLE : MIDREX PROCESS
CASE :
DATA STORAGE FILE NAME : midrex6.sfw
HEAT BALANCE OPTION : ON
UNITS OF MASS/TIME : MT/HR

ROW	CNM	CHF			PHC	CMW	SGF
1	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
2	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
3	Fe1O1	Fe1O1	SI1	71.8464	5.7000	0.0000	0.0000
4	Fe1	Fe1	SI1	55.8470	7.8600	0.0000	0.0000
5	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
6	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
7	C1H4	C1H4	GC8	16.0430	0.0007	0.0000	0.0000
8	C2H6	C2H6	GC8	30.0701	0.0013	0.0000	0.0000
9	C4H10	C4H10	GC8	58.1243	0.0026	0.0000	0.0000
10	C1O1	C1O1	GC8	28.0106	0.0012	0.0000	0.0000
11	C1O2	C1O2	GC8	44.0100	0.0020	0.0000	0.0000
12	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
13	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
14	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
15	H2S1	H2S1	GC8	34.0799	0.0015	0.0000	0.0000
16	S1O2	S1O2	GC8	64.0628	0.0029	0.0000	0.0000
17	SiO2	SiO2	SI1	60.0848	2.6500	0.0000	0.0000
18	Fe3C	Fe3C	SI1	179.5521	1.0000	0.0000	0.0000

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
2	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
3	Fe1O1	B672157	-65000	-3998	12.1207	1.0479	0.8685
4	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
5	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
6	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
7	C1H4	B6772217	-17880	-6424	11.8424	2.9907	8.0422
8	C2H6	B6772223	-20240	-5819	11.3274	9.4527	4.7951
9	C4H10	BAK1126	-29800	-17099	32.8367	11.3643	18.9320
10	C1O1	B672093	-26417	-2962	7.7460	0.2285	1.9749
11	C1O2	B672094	-94051	-5911	12.9357	0.3891	6.1869
12	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
13	N2	B672244	0	-2846	7.5728	0.2525	1.7794
14	O2	B672277	0	-2979	7.9696	0.2720	1.7697
15	H2S1	B689140	-4930	-3383	8.6760	1.2152	2.1081
16	S1O2	B672348	-70940	-5603	13.1364	0.2172	5.0762
17	SiO2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
18	Fe3C	B6771332	5985	-5013	21.1456	4.1225	-5.0322

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
2	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
3	Fe1O1	298.2	1600.0	-60048	-19.0598	-5.9536	-9.2221
4	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
5	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
6	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
7	C1H4	298.2	2000.0	-14673	-45.4106	-7.1789	-6.9854
8	C2H6	298.2	1000.0	-19821	-48.2326	-15.8609	-2.9266
9	C4H10	298.2	1500.0	-24334	-69.8380	-25.6515	-13.3922
10	C1O1	298.2	3000.0	-21272	-52.8075	-2.2569	-10.0674
11	C1O2	298.2	3000.0	-86430	-58.7976	-3.7771	-15.3476
12	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
13	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
14	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
15	H2S1	298.2	2000.0	-1229	-52.4032	-4.2869	-7.0969
16	S1O2	298.2	3000.0	-62759	-67.8617	-3.6510	-16.3249
17	SiO2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
18	Fe3C	298.2	1400.0	15085	-32.7885	-13.6625	-16.6593

MIDREX PROCESS

INPUT DATA

NO	FLOL TYP OPR	LABEL UNIT PROCESS	FLO 1 IS1	2 IS2	3 IS3	4 IS4	5 IS5	6 IS6	7 INV	8 OS1	9 OS2	10 OS3	11 OS4	12 OS5	13 OS6
1	SEC	MIDREX PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	MIX	FUEL GAS MIXER	25	19	0	0	0	0	0	21	0	0	0	0	0
3	SPP	REFORMER FEED GAS MIXER	5	23	0	0	0	0	0	7	100	0	0	0	0
4	MIX	BURNERS	26	30	21	29	0	0	0	65	0	0	0	0	0
5	HTX	REFORMER H/E	65	0	0	6	0	0	0	66	8	0	0	0	0
6	MIX	REFORMED GAS MIXER	8	27	0	0	0	0	0	12	0	0	0	0	0
7	SPP	FURNACE	101	12	0	0	0	0	0	105	1	0	0	0	0
8	SPS	TOP GAS SCRUBBER	1	14	0	0	0	0	0	2	19	0	0	0	0
9	SUB	STREAM SPLITTER	2	0	0	0	0	0	0	4	5	0	0	0	0
10	FEM	REFORMER	7	0	0	0	0	0	0	6	0	0	0	0	0

MIDREX PROCESS

HEAT BALANCE SUMMARY - 1000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	MIDREX PROCESS	0	0	0	0	0	0	0	0
2	FUEL GAS MIXER	10582	0	0	0	0	-2120	-8462	0
3	REFORMER FEED GA	27571	9851	0	0	0	12844	-50265	0
4	BURNERS	51534	213270	0	0	0	0	-264803	0
5	REFORMER H/E	265120	0	0	0	-26512	0	-238608	0
6	REFORMED GAS MIX	87919	-63320	0	0	0	58595	-83194	0
7	FURNACE	83490	-34940	0	0	0	-1473	-47077	0
8	TOP GAS SCRUBBER	42237	0	0	0	0	0	-42237	0
9	STREAM SPLITTER	31678	0	0	0	0	0	-31678	0
10	REFORMER	48999	2805	0	0	0	-51489	-315	0

MIDREX PROCESS

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1	TOP GAS	402.00	755.60	41601545.00	165088272.0	174060864.0
2	PROCESS GAS	369.31	696.77	31677782.00	125707600.0	132539842.0
3		0.00	32.00	29628815.00	117576638.0	123966960.0
4	TO COOLING GAS CYCLE	369.31	696.77	4204697.00	16685584.0	17592450.0
5	TOP GAS FOR REFORMER	369.31	696.77	27473086.00	109022015.0	114947391.0
6	GAS FROM REFORMER	25.00	77.00	315131.00	1250540.0	1318507.0
7	GAS TO REFORMER	560.00	1040.00	48999147.00	194444329.0	205012431.0
8	REFORMED GAS	940.00	1724.00	87887098.00	348764190.0	367719617.0
12	GAS FOR REDUCTION	840.00	1544.00	83193513.00	330138541.0	348081659.0
14	RECYCLE PROCESS GAS	77.00	170.60	635498.00	2521861.0	2658925.0
19	FUEL GAS	369.31	696.77	10559261.00	41902533.0	44179947.0
21	FUEL TO MAIN BURNER	290.00	554.00	8461842.00	33579305.0	35404349.0
23	NATURAL GAS	25.00	77.00	97442.00	386682.0	407698.0
25	NATURAL GAS	35.00	95.00	22921.00	90957.0	95901.0
26	N.G. TO AUX. BURNER	35.00	95.00	2665.00	10576.0	11151.0
27	NATURAL GAS	35.00	95.00	31450.00	124802.0	131585.0
29	HOT AIR	675.00	1247.00	43047939.00	170828027.0	180112576.0
30	AIR	35.00	95.00	21127.00	83837.0	88394.0
35		814.36	1497.85	3712815.00	14733641.0	15534418.0
65	HOT FLUE GAS	2316.15	4201.08	264803304.00	1050824432.0	1107937023.0
66	COOLED FLUE GAS	1417.02	2582.63	150720507.00	598107307.0	630614600.0
67		814.36	1497.85	70543487.00	279939179.0	295153949.0
100	MIST	100.00	212.00	1266320.00	5025165.0	5298284.0
101	IRON ORE	35.00	95.00	296156.00	1175244.0	1239118.0
105	REDUCED IRON	300.00	572.00	5475021.00	21726638.0	22907487.0

MIDREX PROCESS

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
1	TOP GAS	100.0000	447971	181238.7	761108	307926.6
2	PROCESS GAS	100.0000	359167	152703.5	610229	259444.9
3		100.0000	142550	142549.7	242193	242193.5
4	TO COOLING GAS CYCLE	100.0000	47673	20268.8	80998	34437.0
5	TOP GAS FOR REFORMER	100.0000	311494	132434.7	529232	225007.9
6	GAS FROM REFORMER	100.0000	145954	133716.1	247978	227185.1
7	GAS TO REFORMER	100.0000	421920	138327.5	716847	235019.9
8	REFORMED GAS	100.0000	593013	133521.3	1007535	226854.1
12	GAS FOR REDUCTION	100.0000	673489	165263.9	1144265	280785.2
14	RECYCLE PROCESS GAS	100.0000	28671	22366.0	48712	38000.0
19	FUEL GAS	100.0000	119722	50901.2	203410	86481.6
21	FUEL TO MAIN BURNER	100.0000	110160	53432.1	187163	90781.6
23	NATURAL GAS	100.0000	19916	18245.9	33837	31000.0
25	NATURAL GAS	100.0000	2855	2530.9	4851	4300.0
26	N.G. TO AUX. BURNER	100.0000	332	294.3	564	500.0
27	NATURAL GAS	100.0000	3918	3472.6	6656	5900.0
29	HOT AIR	100.0000	410449	118245.3	697358	200900.0
30	AIR	100.0000	3652	3237.2	6205	5500.0
35		100.0000	32736	8222.4	55620	13970.0
65	HOT FLUE GAS	100.0000	1506796	158954.5	2560063	270065.4
66	COOLED FLUE GAS	100.0000	983560	158954.5	1671080	270065.4
67		100.0000	621993	156226.2	1056773	265430.0

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
100	MIST	100.0000	77.5206	4.89082	17.60695	422.567
101	IRON ORE	100.0000	191.4957	12.08157	43.49366	1043.848
105	REDUCED IRON	100.0000	160.0028	10.09467	36.34080	872.179

MASS FLOW RATES - MT/HR

NO.	STREAM	MT/HR-SI	MT/HR-LI	MT/HR-GC	MT/HR-TC
1	TOP GAS	0.0000	0.00000	254.1434	254.1434
2	PROCESS GAS	0.0000	0.00000	213.6325	213.6325
3		0.0000	0.00000	204.7725	204.7725
4	TO COOLING GAS CYCLE	0.0000	0.00000	28.3562	28.3562
5	TOP GAS FOR REFORMER	0.0000	0.00000	185.2764	185.2764
6	GAS FROM REFORMER	0.0000	0.00000	190.5957	190.5957
7	GAS TO REFORMER	0.0000	0.00000	190.5957	190.5957
8	REFORMED GAS	0.0000	0.00000	190.8172	190.8172
12	GAS FOR REDUCTION	0.0000	0.00000	195.0402	195.0402
14	RECYCLE PROCESS GAS	0.0000	0.00000	30.7000	30.7000
19	FUEL GAS	0.0000	0.00000	71.2108	71.2108
21	FUEL TO MAIN BURNER	0.0000	0.00000	74.2886	74.2886
23	NATURAL GAS	0.0000	0.00000	22.1885	22.1885
25	NATURAL GAS	0.0000	0.00000	3.0778	3.0778
26	N.G. TO AUX. BURNER	0.0000	0.00000	0.3579	0.3579
27	NATURAL GAS	0.0000	0.00000	4.2230	4.2230
29	HOT AIR	0.0000	0.00000	258.5594	258.5594
30	AIR	0.0000	0.00000	7.0785	7.0785
35		0.0000	0.00000	14.0495	14.0495
65	HOT FLUE GAS	0.0000	0.00000	340.2844	340.2844
66	COOLED FLUE GAS	0.0000	0.00000	340.2844	340.2844
67		0.0000	0.00000	266.9407	266.9407
100	MIST	0.0000	16.86920	0.0000	16.8692
101	IRON ORE	215.0000	0.00000	0.0000	215.0000
105	REDUCED IRON	155.8967	0.00000	0.0000	155.8967

MIDREX PROCESS

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-GC	SG-TC
1	TOP GAS	0.0000	0.0000	0.0000	0.0003	0.0003
2	PROCESS GAS	0.0000	0.0000	0.0000	0.0004	0.0004
3		0.0000	0.0000	0.0000	0.0008	0.0008
4	TO COOLING GAS CYCLE	0.0000	0.0000	0.0000	0.0004	0.0004
5	TOP GAS FOR REFORMER	0.0000	0.0000	0.0000	0.0004	0.0004
6	GAS FROM REFORMER	0.0000	0.0000	0.0000	0.0008	0.0008
7	GAS TO REFORMER	0.0000	0.0000	0.0000	0.0003	0.0003
8	REFORMED GAS	0.0000	0.0000	0.0000	0.0002	0.0002
12	GAS FOR REDUCTION	0.0000	0.0000	0.0000	0.0002	0.0002
14	RECYCLE PROCESS GAS	0.0000	0.0000	0.0000	0.0006	0.0006
19	FUEL GAS	0.0000	0.0000	0.0000	0.0004	0.0004
21	FUEL TO MAIN BURNER	0.0000	0.0000	0.0000	0.0004	0.0004
23	NATURAL GAS	0.0000	0.0000	0.0000	0.0007	0.0007
25	NATURAL GAS	0.0000	0.0000	0.0000	0.0006	0.0006
26	N.G. TO AUX. BURNER	0.0000	0.0000	0.0000	0.0006	0.0006
27	NATURAL GAS	0.0000	0.0000	0.0000	0.0006	0.0006
29	HOT AIR	0.0000	0.0000	0.0000	0.0004	0.0004
30	AIR	0.0000	0.0000	0.0000	0.0011	0.0011
35		0.0000	0.0000	0.0000	0.0003	0.0003
65	HOT FLUE GAS	0.0000	0.0000	0.0000	0.0001	0.0001
66	COOLED FLUE GAS	0.0000	0.0000	0.0000	0.0002	0.0002
67		0.0000	0.0000	0.0000	0.0003	0.0003
100	MIST	0.0000	0.0000	0.9581	0.0000	0.9581
101	IRON ORE	100.0000	4.9432	0.0000	0.0000	4.9432
105	REDUCED IRON	100.0000	4.2899	0.0000	0.0000	4.2899

MIDREX PROCESS

STREAM DATA

SOLIDS - MT/HR

NO. STREAM	Fe2O3	Fe3O4	Fe1O1	Fe1	SiO2	Fe3C
101 IRON ORE	176.300	25.8000	0.00000	0.000	12.9000	0.0000
105 REDUCED IRON	0.000	0.0000	0.00000	127.781	12.9000	15.2157

SOLIDS - WEIGHT PERCENT

NO. STREAM	Fe2O3	Fe3O4	Fe1O1	Fe1	SiO2	Fe3C
101 IRON ORE	82.0000	12.0000	0.00000	0.0000	6.00000	0.00000
105 REDUCED IRON	0.0000	0.0000	0.00000	81.9651	8.27471	9.76014

AQUEOUS - MT/HR

NO. STREAM	H2O
100 MIST	16.8692

AQUEOUS - WEIGHT PERCENT

NO. STREAM	H2O
100 MIST	100.000

AQUEOUS - GRAMS PER LITER

NO. STREAM	H2O
100 MIST	958.099

GASEOUS - MT/HR

NO. STREAM	H2O	C1H4	C2H6	C4H10	C1O1	C1O2	H2
1 TOP GAS	27.8524	6.7962	0.00174	0.00000	69.897	136.224	12.3828
2 PROCESS GAS	22.1034	5.6683	0.00130	0.00000	61.505	112.745	10.4764
3	28.5421	0.9039	0.00000	0.00000	51.458	113.366	9.5077
4 TO COOLING GAS CYCLE	2.9339	0.7524	0.00017	0.00000	8.164	14.965	1.3906
5 TOP GAS FOR REFORMER	19.1695	4.9160	0.00113	0.00000	53.341	97.780	9.0859
6 GAS FROM REFORMER	16.0763	29.9078	0.00171	0.00000	64.969	71.818	6.8397
7 GAS TO REFORMER	2.3003	27.1045	0.00113	0.00000	53.341	97.780	9.0859
8 REFORMED GAS	15.9191	30.1557	0.00174	0.00000	65.030	71.936	6.7862
12 GAS FOR REDUCTION	15.9191	17.1893	0.00174	0.00000	125.054	24.781	11.1062
14 RECYCLE PROCESS GAS	1.6188	0.7616	0.00000	0.00000	12.109	14.102	1.5858
19 FUEL GAS	7.3678	1.8894	0.00043	0.00000	20.502	37.582	3.4921
21 FUEL TO MAIN BURNER	7.3678	4.9672	0.00043	0.00000	20.502	37.582	3.4921
23 NATURAL GAS	0.0000	22.1885	0.00000	0.00000	0.000	0.000	0.0000
25 NATURAL GAS	0.0000	3.0778	0.00000	0.00000	0.000	0.000	0.0000
26 N.G. TO AUX. BURNER	0.0000	0.3579	0.00000	0.00000	0.000	0.000	0.0000
27 NATURAL GAS	0.0000	4.2230	0.00000	0.00000	0.000	0.000	0.0000
35	0.4453	0.0000	0.00000	0.00000	0.161	0.656	0.2860
65 HOT FLUE GAS	50.5347	0.0000	0.00043	0.00000	0.000	84.402	0.0000
66 COOLED FLUE GAS	50.5347	0.0000	0.00043	0.00000	0.000	84.402	0.0000
67	8.4605	0.0000	0.00000	0.00000	3.057	12.460	5.4340

MIDREX PROCESS

STREAM DATA

GASEOUS - MT/HR

NO.	STREAM	N2	O2	H2S1	S1O2
1	TOP GAS	0.989	0.0000	0.00000	0.00000
2	PROCESS GAS	1.134	0.0000	0.00000	0.00000
3		0.994	0.0000	0.00000	0.00000
4	TO COOLING GAS CYCLE	0.150	0.0000	0.00000	0.00000
5	TOP GAS FOR REFORMER	0.983	0.0000	0.00000	0.00000
6	GAS FROM REFORMER	0.983	0.0000	0.00000	0.00000
7	GAS TO REFORMER	0.983	0.0000	0.00000	0.00000
8	REFORMED GAS	0.989	0.0000	0.00000	0.00000
12	GAS FOR REDUCTION	0.989	0.0000	0.00000	0.00000
14	RECYCLE PROCESS GAS	0.522	0.0000	0.00000	0.00000
19	FUEL GAS	0.378	0.0000	0.00000	0.00000
21	FUEL TO MAIN BURNER	0.378	0.0000	0.00000	0.00000
29	HOT AIR	198.574	59.9858	0.00000	0.00000
30	AIR	5.436	1.6422	0.00000	0.00000
35		10.200	2.3011	0.00000	0.00000
65	HOT FLUE GAS	204.388	0.9600	0.00000	0.00000
66	COOLED FLUE GAS	204.388	0.9600	0.00000	0.00000
67		193.809	43.7202	0.00000	0.00000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2O	C1H4	C2H6	C4H10	C1O1	C1O2	H2
1	TOP GAS	10.9593	2.674	0.00068	0.00000	27.5029	53.6014	4.87235
2	PROCESS GAS	10.3465	2.653	0.00061	0.00000	28.7899	52.7751	4.90396
3		13.9384	0.441	0.00000	0.00000	25.1295	55.3620	4.64307
4	TO COOLING GAS CYCLE	10.3465	2.653	0.00061	0.00000	28.7899	52.7751	4.90396
5	TOP GAS FOR REFORMER	10.3465	2.653	0.00061	0.00000	28.7899	52.7751	4.90396
6	GAS FROM REFORMER	8.4348	15.692	0.00090	0.00000	34.0873	37.6809	3.58859
7	GAS TO REFORMER	1.2069	14.221	0.00059	0.00000	27.9864	51.3022	4.76709
8	REFORMED GAS	8.3426	15.803	0.00091	0.00000	34.0795	37.6988	3.55638
12	GAS FOR REDUCTION	8.1620	8.813	0.00089	0.00000	64.1168	12.7057	5.69429
14	RECYCLE PROCESS GAS	5.2728	2.481	0.00000	0.00000	39.4447	45.9345	5.16561
19	FUEL GAS	10.3465	2.653	0.00061	0.00000	28.7899	52.7751	4.90396
21	FUEL TO MAIN BURNER	9.9178	6.686	0.00059	0.00000	27.5972	50.5886	4.70079
23	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.00000
25	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.00000
26	N.G. TO AUX. BURNER	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.00000
27	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.00000
35		3.1694	0.000	0.00000	0.00000	1.1451	4.6677	2.03566
65	HOT FLUE GAS	14.8507	0.000	0.00013	0.00000	0.0000	24.8032	0.00000
66	COOLED FLUE GAS	14.8507	0.000	0.00013	0.00000	0.0000	24.8032	0.00000
67		3.1694	0.000	0.00000	0.00000	1.1451	4.6677	2.03566

MIDREX PROCESS

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	N2	O2	H2S1	S1O2
1	TOP GAS	0.3892	0.0000	0.00000	0.00000
2	PROCESS GAS	0.5306	0.0000	0.00000	0.00000
3		0.4856	0.0000	0.00000	0.00000
4	TO COOLING GAS CYCLE	0.5306	0.0000	0.00000	0.00000
5	TOP GAS FOR REFORMER	0.5306	0.0000	0.00000	0.00000
6	GAS FROM REFORMER	0.5158	0.0000	0.00000	0.00000
7	GAS TO REFORMER	0.5158	0.0000	0.00000	0.00000
8	REFORMED GAS	0.5183	0.0000	0.00000	0.00000
12	GAS FOR REDUCTION	0.5071	0.0000	0.00000	0.00000
14	RECYCLE PROCESS GAS	1.7017	0.0000	0.00000	0.00000
19	FUEL GAS	0.5306	0.0000	0.00000	0.00000
21	FUEL TO MAIN BURNER	0.5086	0.0000	0.00000	0.00000
29	HOT AIR	76.8000	23.2000	0.00000	0.00000
30	AIR	76.8000	23.2000	0.00000	0.00000
35		72.6039	16.3783	0.00000	0.00000
65	HOT FLUE GAS	60.0638	0.2821	0.00000	0.00000
66	COOLED FLUE GAS	60.0638	0.2821	0.00000	0.00000
67		72.6039	16.3783	0.00000	0.00000

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2O	C1H4	C2H6	C4H10	C1O1	C1O2	H2
1	TOP GAS	11.2536	3.084	0.00042	0.00000	18.1638	22.5308	44.7107
2	PROCESS GAS	10.5996	3.052	0.00037	0.00000	18.9697	22.1320	44.8963
3		14.6622	0.521	0.00000	0.00000	17.0016	23.8391	43.6471
4	TO COOLING GAS CYCLE	10.5996	3.052	0.00037	0.00000	18.9697	22.1320	44.8963
5	TOP GAS FOR REFORMER	10.5996	3.052	0.00037	0.00000	18.9697	22.1320	44.8963
6	GAS FROM REFORMER	8.8041	18.392	0.00056	0.00000	22.8836	16.0999	33.4733
7	GAS TO REFORMER	1.2178	16.113	0.00036	0.00000	18.1616	21.1891	42.9837
8	REFORMED GAS	8.7307	18.572	0.00057	0.00000	22.9384	16.1498	33.2599
12	GAS FOR REDUCTION	7.0538	8.553	0.00046	0.00000	35.6385	4.4949	43.9776
14	RECYCLE PROCESS GAS	5.3000	2.800	0.00000	0.00000	25.5000	18.9000	46.4000
19	FUEL GAS	10.5996	3.052	0.00037	0.00000	18.9697	22.1320	44.8963
21	FUEL TO MAIN BURNER	10.0976	7.644	0.00036	0.00000	18.0712	21.0836	42.7697
23	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.0000
25	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.0000
26	N.G. TO AUX. BURNER	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.0000
27	NATURAL GAS	0.0000	100.000	0.00000	0.00000	0.0000	0.0000	0.0000
35		3.9657	0.000	0.00000	0.00000	0.9215	2.3908	22.7621
65	HOT FLUE GAS	23.2808	0.000	0.00012	0.00000	0.0000	15.9166	0.0000
66	COOLED FLUE GAS	23.2808	0.000	0.00012	0.00000	0.0000	15.9166	0.0000
67		3.9657	0.000	0.00000	0.00000	0.9215	2.3908	22.7621

MIDREX PROCESS

STREAM DATA

GASEOUS - VOLUME PERCENT

NO.	STREAM	N2	O2	H2S1	S1O2
1	TOP GAS	0.2570	0.0000	0.00000	0.00000
2	PROCESS GAS	0.3496	0.0000	0.00000	0.00000
3		0.3285	0.0000	0.00000	0.00000
4	TO COOLING GAS CYCLE	0.3496	0.0000	0.00000	0.00000
5	TOP GAS FOR REFORMER	0.3496	0.0000	0.00000	0.00000
6	GAS FROM REFORMER	0.3462	0.0000	0.00000	0.00000
7	GAS TO REFORMER	0.3347	0.0000	0.00000	0.00000
8	REFORMED GAS	0.3488	0.0000	0.00000	0.00000
12	GAS FOR REDUCTION	0.2818	0.0000	0.00000	0.00000
14	RECYCLE PROCESS GAS	1.1000	0.0000	0.00000	0.00000
19	FUEL GAS	0.3496	0.0000	0.00000	0.00000
21	FUEL TO MAIN BURNER	0.3330	0.0000	0.00000	0.00000
29	HOT AIR	79.0852	20.9148	0.00000	0.00000
30	AIR	79.0852	20.9148	0.00000	0.00000
35		58.4223	11.5377	0.00000	0.00000
65	HOT FLUE GAS	60.5535	0.2490	0.00000	0.00000
66	COOLED FLUE GAS	60.5535	0.2490	0.00000	0.00000
67		58.4223	11.5377	0.00000	0.00000

[redacted]

APPENDIX E-2:

HYLSA IVM (REFORMERLESS WITH HOT DRI CHARGE TO EAF)

HYLSA PROCESS (HYL III)

PROCESS BACKGROUND:

The HYL process uses reducing gases within a moving bed shaft furnace reactor to remove the oxygen from iron ore pellets and lump ore. In comparison to other similar technologies, it operates at slightly higher reduction temperatures (about 50 °C higher) and intermediate reduction pressures (up to 6 bars). The process can produce cold/hot DRI as well as HBI.

The HYL process can utilize higher-sulfur ore and gas feeds since it is equipped with a sulfur removal step (prior to the conventional steam reformer). A more-positive control is obtained for the reducing gas (CO to H_2 ratio) is obtained by utilizing a selective CO_2 removal circuit (typically PSA) in the circulating gas systems. This allows a wide range of CO to H_2 ratios (from 0.1 to 0.3) to be utilized depending on the required degree of metallization and/or carbon content of the final product.

PROCESS DESCRIPTION:

The iron oxide feed to a HYL shaft furnace can be pellets, lump, or a mixture of the two. The solids are fed to the top of the shaft furnace by conveyor. An automatic system of bins and pressure locks receives the ore at atmospheric pressure in an open bin, pressurizes in intermediate bins and charges it continuously to the reactor.

Hylsa divides the process into two independent sections: reducing gas generation and iron ore reduction. The natural gas (makeup to the reducing gas stream) is mixed with reducing gases recycled from the CO_2 removal system. The pressurized reducing gas is passed through a gas heater (where it is heated up to 930 °C) and is introduced to the reactor at up to 6 bar gauge. The higher gas pressure system reduces the tendency for bed fluidization, permits higher capacity from a given-diameter shaft furnace and reduces the effective volumetric flow rates or circulating gases. Higher mole ratios of reducing gas to iron oxide solids can be obtained (as compared to other shaft furnace processes).

The exhaust reducing gas from the reactor (at about 400 °C) is cooled in a quenching/scrubbing system that removes most of the water produced during the reduction process from the gas stream. Also most of the dust in the exhaust gas is also removed. The scrubbed gas is compressed, fed to the CO_2 removal system (and optionally to a SO_2 removal system) before being fed back to the lower part of the shaft furnace.

In the reducing gas generation system, natural gas is passed through a section of the reformer recuperator to preheat it, and is then desulfurized to reduce the sulfur content to less than 1 ppm. This is to prevent poisoning of the reformer catalyst with sulfur compounds. The natural gas is mixed with superheated steam from the reformer steam circuit in a steam to carbon ratio of around 2.4 to 1 by volume, and the mixture is further superheated to 620C in the reformer recuperator.

The gas mixture is heated in the tubes by gas-fired burners to a temperature of about 830 °C where the reforming reactions take place. The reformed gas passes through a waste heat boiler and through a boiler feed water preheater to recover heat. It is then quenched to remove water remaining in the gas. The product gas contains around 72% H2 and 16% H2. The reactor has a cylindrical upper section with reducing gas inlets and outlets for top gas and cooling gas. The lower part is conical and has inlets for the cooling gas when cold DRI is produced.

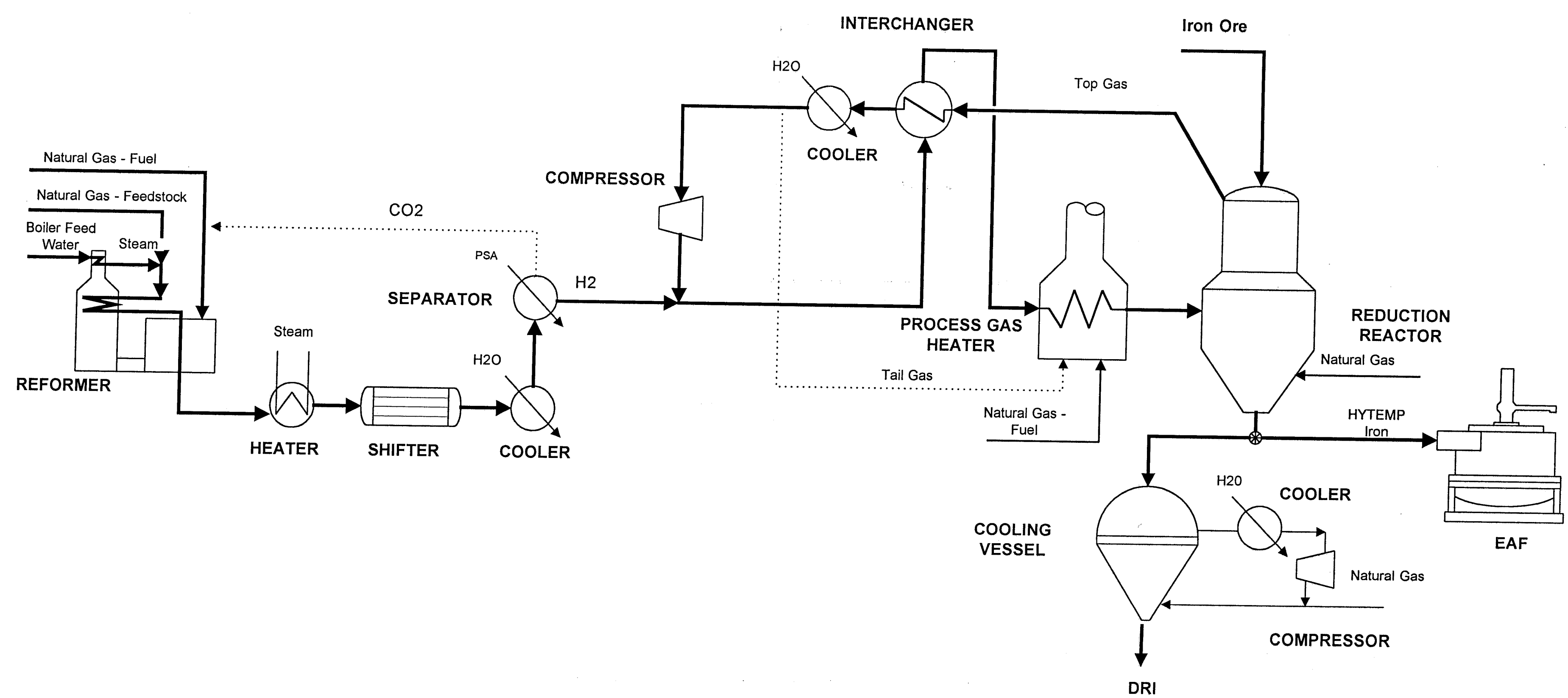
The use of a reformer that does not process gas from the reduction section isolates it from any gas-side changes which might occur in the reactor.

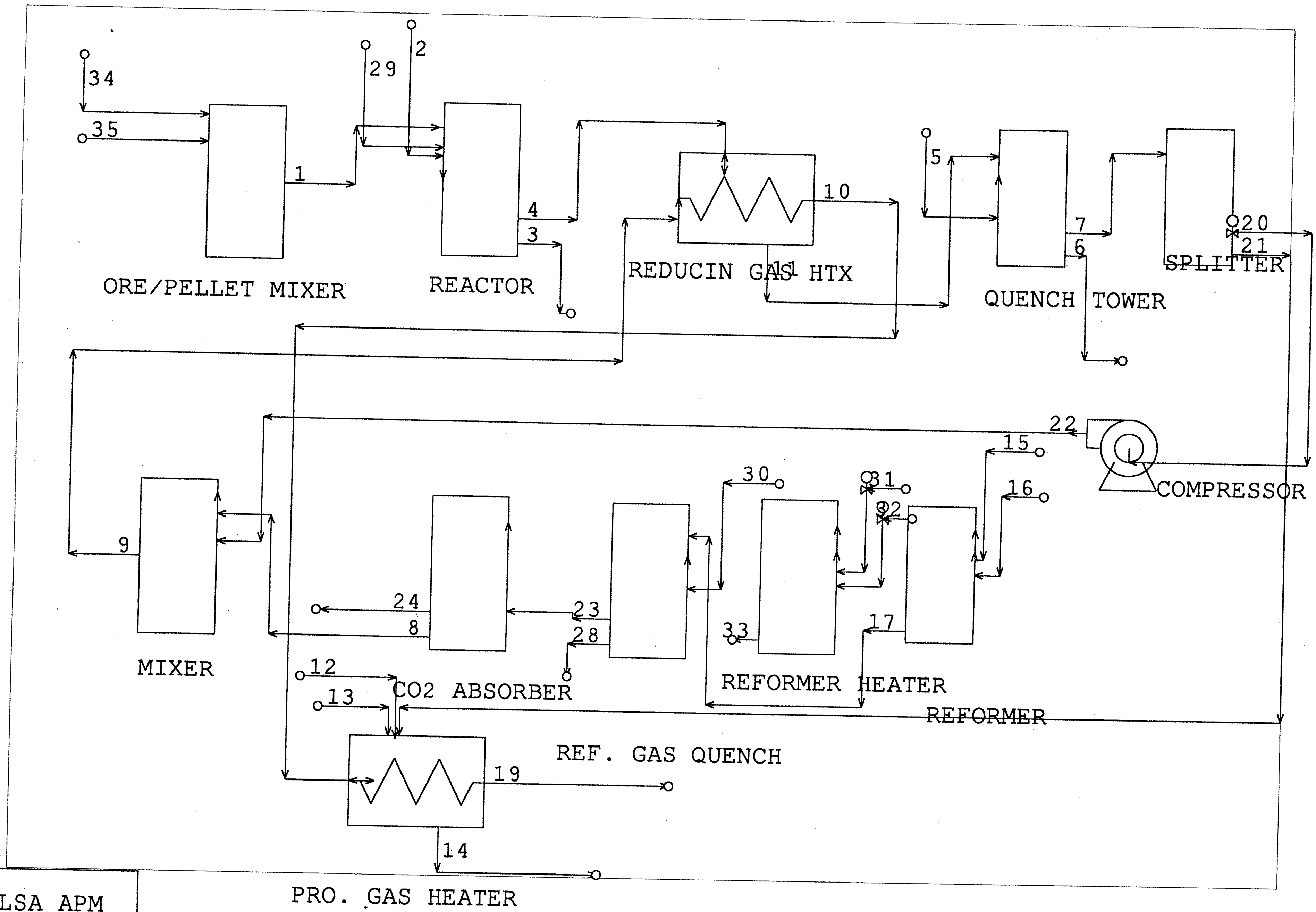
As the solid feed moves down the reactor by gravity flow, it is heated and reduced by reducing gas flowing upwards. The major reductant is H_2 due to its higher concentration in the reducing gas. In the conical lower part of the reactor, the burden is cooled and carburized by a circulating cooling gas that is enriched with natural gas. The product is reduced to a metallization up to 95% and carbon can be controlled in a range of 1.5% to 4.5%. For hot discharge of DRI, Hylsa's HYTEMP™ system is used which links the reactor discharge to the melt shop by way of a pneumatic conveying system.

PROCESS ADVANTAGES

Proven performance
Raw material flexibility (high S ore and natural gas)
Conventional Steam reforming
Selective elimination of H_2O and CO_2 from the reducing gas circuit allows maximum recycle of reducing gases to the reduction reactor.
Higher pressure operation reducing circulating gas volumetric flow at high molar
Flexibility to generate electric power by high pressure steam produced in the reformer.

HYLSA PROCESS FLOWSHEET




34
35
1
29
2
ORE/PELLET MIXER
REACTOR
4
3
REDUCIN GAS HTX
10
11
5
QUENCH TOWER
7
6
SPLITTER
20
21
22
COMPRESSOR
15
16
30
31
32
9
MIXER
24
8
23
28
33
17
12
13
CO2 ABSORBER
REFORMER HEATER
REFORMER
REF. GAS QUENCH
19
14
PRO. GAS HEATER

HYLSA APM

Hylsa Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a basic flowsheet for a Hylsa reactor from HYL, Mexico.

Flowsheet Description

In this case, the ore (Stream 34) is mixed with pellets (Stream 35) to form the iron feed (Stream 1) for the Reduction reactor. The combined stream consists of approx. 96% Fe_2O_3 and rest other oxides. In the Reduction furnace, this feed is heated and reduced by the upcoming reducing gases (Stream 2) into DRI (Stream 3). Stream 4 representing the Top gas is passed through a Reducing gas Heat Exchanger to recover some heat and a Quench Tower to get rid of excess moisture. Then stream 7, the remaining top gas is split into two parts viz, process gas (Stream 20) and tail gas (Stream 21). The process gas is mixed with Reformed gas (Stream 8) to form Stream 9. This stream is preheated with the help of hot Top gases first and then heated further in the Process Gas Heater where heat is provided by burning tail gas and some natural gas (Stream 12).

Hylsa's reforming system is independent of its reduction system. Steam reforming of natural gas (Stream 15) occurs in the Reformer to give Reformed gas (mostly H_2). The Reformer Heater supplies the energy for reforming reactions by burning natural gas (Stream 31) with air (Stream 32). The Reformer and the Reformer Heater are coupled in the model such that heat required by the Reformer is equal to the heat loss of the Reformer Heater. The hot reformed gas is cooled down and its carbon-di-oxide/ carbon-mono oxide/water content reduced so it is almost totally H_2 (Stream 8). This is then mixed with the process gas to generate the Reducing gas.

Model Assumptions:

Reduction Reactor: The temperature of hot reducing gases is 930C. The top gas comes out at 730C. Complete reduction of iron ore takes place along with some reaction between metallic Fe and natural gas to give Fe_3C. No carry-over of solid particles in the Top gas is assumed.

Reducing Gas Heat Exchanger: The hot top gases are used to preheat cold incoming reducing gases. 100% efficiency is assumed.

Quench Tower: Thermal equilibrium is assumed.

Stream Splitter: CO_2 content of the Reducing gas is controlled by adjusting the amount of tail gas.

Compressor: No increase in temperature on compression.

Reformer: The reactions reach equilibrium.

Reformer Heater: The heat required by the Reformer is equal to the heat lost by the Reformer Heater.

Reformed Gas Quench: All water is condensed and removed.

CO2 Absorber: CO, CO2, etc. are absorbed so that remaining gas contains only hydrogen.

Process Gas Heater: The exhaust stream is at 138C. Stream 19 is equivalent to stream 2 (the reducing gases entering the Reduction Reactor).

Results

It was decided to achieve same operating conditions as were outlined in the APM proposal by HYL. In the absence of information on gas compositions and amounts for certain feed streams, a few assumptions were made. These led to some differences between the MetSim Model results and the data by HYL.

It was observed that although complete metallization took place in the furnace, the amount of natural gas required, the amount of gases flowing in and around the reduction reactor were higher than those outlined in the proposal by HYL. This is partly due to the unknowns about the various gas composition.

HYLSA PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8	9	10	11
Stream Names	SIZED ORE/	REDUCING	DRI PRODU	REACTOR E	QUENCH W	WARM WAT	COOLED RE	FRESH REF	COMB. RED	PREHEATE	RECYCLE R
KG/HR SOLIDS	1368.3	0	1002	0	0	0	0	0	0	0	0
KG/HR AQUEOUS	0	0	0	0	4500	4919.3	0	0	0	0	0
KG/HR GASEOUS	0	614.81	0	1004.3	0	0	584.97	49.616	614	614	1004.3
KG/HR TOTAL	1368.3	614.81	1002	1004.3	4500	4919.3	584.97	49.616	614	614	1004.3
Percent Solids	100	0	100	0	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	5.0995	0	3.4767	0	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0.99985	0.97008	0	0	0	0	0
Sp.Gr.GASEOUS	0	0.00032676	0	0.00089157	0	0	0.0011091	0.0000423	0.0001999	0.00015083	0.0010108
Sp.Gr.TOTAL	5.0995	0.00032676	3.4767	0.00089157	0.99985	0.97008	0.0011091	0.0000423	0.0001999	0.00015083	0.0010108
Temperature C	30	930	730	397.26	1	82.447	82.447	307.64	142.69	277.97	277.97
Pressure kPa	101.33	470.78	101.33	450.63	101.33	101.33	380	101.33	101.33	101.33	420
Gas nm3/hr	0	1984.7	0	2041.2	0	0	1519.4	551.65	2017.6	2017.6	2041.2
Sol/Liq m3/hr	0.26831	0	0.2882	0	4.5007	5.0711	0	0	0	0	0
Sol/Liq gpm	1.1813	0	1.2689	0	19.816	22.327	0	0	0	0	0
Component Mass Flow Rates											
1 Fe2O3 KG/HR	1314.1	0	0	0	0	0	0	0	0	0	0
2 Fe1O1 KG/HR	5.2566	0	83.612	0	0	0	0	0	0	0	0
3 Fe1 KG/HR	0	0	701.78	0	0	0	0	0	0	0	0
4 Ca1O1 KG/HR	6.6803	0	6.6803	0	0	0	0	0	0	0	0
5 Mg1O1 KG/HR	0.50587	0	0.50587	0	0	0	0	0	0	0	0
6 Al2O3 KG/HR	10.225	0	10.225	0	0	0	0	0	0	0	0
7 Si1O2 KG/HR	29.633	0	29.633	0	0	0	0	0	0	0	0
8 Mn1O1 KG/HR	0.7463	0	0.7463	0	0	0	0	0	0	0	0
10 Ti1O2 KG/HR	0.16576	0	0.16576	0	0	0	0	0	0	0	0
11 S1 KG/HR	0.056374	0	0.056374	0	0	0	0	0	0	0	0
12 P1 KG/HR	0.71065	0	0.71065	0	0	0	0	0	0	0	0
13 Na2O1 KG/HR	0.11611	0	0.11611	0	0	0	0	0	0	0	0
14 K2O1 KG/HR	0.11611	0	0.11611	0	0	0	0	0	0	0	0
16 H2O KG/HR	0	0	0	0	4500	4919.3	0	0	0	0	0
17 C1H4 KG/HR	0	54.693	0	55.685	0	0	55.685	0	53.726	53.726	55.685
18 N2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
19 O2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
20 C1O1 KG/HR	0	186.32	0	188.91	0	0	188.91	0	182.26	182.26	188.91
21 C1O2 KG/HR	0	208.37	0	217.96	0	0	217.96	0	210.29	210.29	217.96
22 H2O KG/HR	0	18.856	0	437.73	0	0	18.385	0	17.738	17.738	437.73
23 H2 KG/HR	0	146.57	0	104.03	0	0	104.03	49.616	149.98	149.98	104.03
24 C2H6 KG/HR	0	0	0	0	0	0	0	0	0	0	0
25 C3H8 KG/HR	0	0	0	0	0	0	0	0	0	0	0
26 C4H10 KG/HR	0	0	0	0	0	0	0	0	0	0	0
27 C5H12 KG/HR	0	0	0	0	0	0	0	0	0	0	0
28 Fe3C1 KG/HR	0	0	167.63	0	0	0	0	0	0	0	0
Element Mass Flow Rates											
1 H 1	0	162.43	0	167	503.56	550.48	120.08	49.616	165.47	165.47	167
2 C 6	0	177.71	11.213	182.18	0	0	182.18	0	175.77	175.77	182.18
3 N 7	0	0	0	0	0	0	0	0	0	0	0
4 O 8	419.12	274.67	41.605	655.13	3996.4	4368.9	282.71	0	272.76	272.76	655.13
5 Na 11	0.086136	0	0.086136	0	0	0	0	0	0	0	0
6 Mg 12	0.30509	0	0.30509	0	0	0	0	0	0	0	0
7 Al 13	5.4114	0	5.4114	0	0	0	0	0	0	0	0
8 Si 14	13.852	0	13.852	0	0	0	0	0	0	0	0
9 P 15	0.71065	0	0.71065	0	0	0	0	0	0	0	0
10 S 16	0.056374	0	0.056374	0	0	0	0	0	0	0	0
11 K 19	0.096387	0	0.096387	0	0	0	0	0	0	0	0
12 Ca 20	4.7744	0	4.7744	0	0	0	0	0	0	0	0
13 Ti 22	0.099375	0	0.099375	0	0	0	0	0	0	0	0
15 Mn 25	0.57798	0	0.57798	0	0	0	0	0	0	0	0
16 Fe 26	923.19	0	923.19	0	0	0	0	0	0	0	0

HYLSA PROCESS --- STREAM SUMMARY

Stream Number	13	14	15	16	17	19	20	21	22	23	24
Stream Names	AIR	EXHAUST	DESULFURI	WATER	REFORMED	REDUCING	GAS TO CO	TAIL GAS	COMPRESS	QUENCHED	CO2
KG/HR SOLIDS	0	0	0	0	0	0	0	0	0	0	0
KG/HR AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
KG/HR GASEOUS	683.09	738.92	162.15	345.29	507.44	614	564.38	20.584	564.38	378.31	328.69
KG/HR TOTAL	683.09	738.92	162.15	345.29	507.44	614	564.38	20.584	564.38	378.31	328.69
Percent Solids	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.0011598	0.00081419	0.00081212	0.00055843	0.00012886	6.8532E-05	0.00029573	0.00029573	0.001374	0.00023528	0.00075575
Sp.Gr.TOTAL	0.0011598	0.00081419	0.00081212	0.00055843	0.00012886	6.8532E-05	0.00029573	0.00029573	0.001374	0.00023528	0.00075575
Temperature C	30	138	30	120	900	939.77	82.447	82.447	82.447	307.64	307.64
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	470.78	101.33	101.33
Gas nm3/hr	530.7	602.94	179.9	429.6	916.86	2017.6	1466	53.467	1466	756.2	204.55
Sol/Liq m3/hr	0	0	0	0	0	0	0	0	0	0	0
Sol/Liq gpm	0	0	0	0	0	0	0	0	0	0	0
Component Mass Flow Rates											
1 Fe2O3 KG/HR	0	0	0	0	0	0	0	0	0	0	0
2 Fe1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
3 Fe1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
4 Ca1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
5 Mg1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
6 Al2O3 KG/HR	0	0	0	0	0	0	0	0	0	0	0
7 Si1O2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
8 Mn1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
10 Ti1O2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
11 S1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
12 P1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
13 Na2O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
14 K2O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
16 H2O KG/HR	0	0	0	0	0	0	0	0	0	0	0
17 C1H4 KG/HR	0	0	104.43	0	26.107	53.726	53.726	1.9595	53.726	26.107	26.107
18 N2 KG/HR	523.99	523.99	0	0	0	0	0	0	0	0	0
19 O2 KG/HR	159.1	4.2597	0	0	0	0	0	0	0	0	0
20 C1O1 KG/HR	0	0	0	0	48.013	182.26	182.26	6.6473	182.26	48.013	48.013
21 C1O2 KG/HR	0	110.78	28.259	0	254.57	210.29	210.29	7.6698	210.29	254.57	254.57
22 H2O KG/HR	0	99.89	0	345.29	129.13	17.738	17.738	0.64693	17.738	0	0
23 H2 KG/HR	0	0	0	0	49.616	149.98	100.37	3.6605	100.37	49.616	0
24 C2H6 KG/HR	0	0	21.721	0	0	0	0	0	0	0	0
25 C3H8 KG/HR	0	0	3.5393	0	0	0	0	0	0	0	0
26 C4H10 KG/HR	0	0	4.1987	0	0	0	0	0	0	0	0
27 C5H12 KG/HR	0	0	0	0	0	0	0	0	0	0	0
28 Fe3C1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
Element Mass Flow Rates											
1 H 1	0	11.178	31.989	38.639	70.627	165.47	115.85	4.2253	115.85	56.177	6.5612
2 C 6	0	30.234	109.61	0	109.61	175.77	175.77	6.4107	175.77	109.61	109.61
3 N 7	523.99	523.99	0	0	0	0	0	0	0	0	0
4 O 8	159.1	173.52	20.546	306.65	327.2	272.76	272.76	9.948	272.76	212.52	212.52
5 Na 11	0	0	0	0	0	0	0	0	0	0	0
6 Mg 12	0	0	0	0	0	0	0	0	0	0	0
7 Al 13	0	0	0	0	0	0	0	0	0	0	0
8 Si 14	0	0	0	0	0	0	0	0	0	0	0
9 P 15	0	0	0	0	0	0	0	0	0	0	0
10 S 16	0	0	0	0	0	0	0	0	0	0	0
11 K 19	0	0	0	0	0	0	0	0	0	0	0
12 Ca 20	0	0	0	0	0	0	0	0	0	0	0
13 Ti 22	0	0	0	0	0	0	0	0	0	0	0
15 Mn 25	0	0	0	0	0	0	0	0	0	0	0
16 Fe 26	0	0	0	0	0	0	0	0	0	0	0

HYLSA PROCESS — STREAM SUMMARY

Stream Number	29	30	31	32	33	34	35
Stream Names	NATURAL G	QUENCH W	NATURAL G	COMBUSTI	EXHAUST	ORE	PELLET
KG/HR SOLIDS	0	0	0	0	0	207.2	1161.1
KG/HR AQUEOUS	0	800	0	0	0	0	0
KG/HR GASEOUS	23.2	0	47.913	804.31	852.22	0	0
KG/HR TOTAL	23.2	800	47.913	804.31	852.22	207.2	1161.1
Percent Solids	0	0	0	0	0	100	100
Sp.Gr.SOLIDS	0	0	0	0	0	4.9507	5.127
Sp.Gr.AQUEOUS	0	0.99985	0	0	0	0	0
Sp.Gr.GASEOUS	0.00081212	0	0.00091251	0.0011598	0.00084924	0	0
Sp.Gr.TOTAL	0.00081212	0.99985	0.00091251	0.0011598	0.00084924	4.9507	5.127
Temperature C	30	1	30	30	130	30	30
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	25.74	0	47.311	624.87	679.92	0	0
Sol/Liq m3/hr	0	0.80012	0	0	0	0.041853	0.22646
Sol/Liq gpm	0	3.5228	0	0	0	0.18427	0.99708
Component Mass Flow Rates							
1 Fe2O3 KG/HR	0	0	0	0	0	190.96	1123.1
2 Fe1O1 KG/HR	0	0	0	0	0	2.2378	3.0188
3 Fe1 KG/HR	0	0	0	0	0	0	0
4 Ca1O1 KG/HR	0	0	0	0	0	0.06216	6.6182
5 Mg1O1 KG/HR	0	0	0	0	0	0.04144	0.46443
6 Al2O3 KG/HR	0	0	0	0	0	1.8648	8.3598
7 Si1O2 KG/HR	0	0	0	0	0	11.52	18.113
8 Mn1O1 KG/HR	0	0	0	0	0	0.16576	0.58054
10 Ti1O2 KG/HR	0	0	0	0	0	0.16576	0
11 S1 KG/HR	0	0	0	0	0	0.033152	0.023222
12 P1 KG/HR	0	0	0	0	0	0.15333	0.55732
13 Na2O1 KG/HR	0	0	0	0	0	0	0.11611
14 K2O1 KG/HR	0	0	0	0	0	0	0.11611
16 H2O KG/HR	0	800	0	0	0	0	0
17 C1H4 KG/HR	14.942	0	25.736	0	0	0	0
18 N2 KG/HR	0	0	0	616.97	616.97	0	0
19 O2 KG/HR	0	0	0	187.34	29.12	0	0
20 C1O1 KG/HR	0	0	0	0	0	0	0
21 C1O2 KG/HR	4.0432	0	6.8742	0	123.27	0	0
22 H2O KG/HR	0	0	0	0	82.859	0	0
23 H2 KG/HR	0	0	0	0	0	0	0
24 C2H6 KG/HR	3.1079	0	6.0932	0	0	0	0
25 C3H8 KG/HR	0.50641	0	1.7685	0	0	0	0
26 C4H10 KG/HR	0.60074	0	1.3496	0	0	0	0
27 C5H12 KG/HR	0	0	6.0918	0	0	0	0
28 Fe3C1 KG/HR	0	0	0	0	0	0	0
Element Mass Flow Rates							
1 H 1	4.5769	89.521	9.272	0	9.272	0	0
2 C 6	15.683	0	33.643	0	33.643	0	0
3 N 7	0	0	0	616.97	616.97	0	0
4 O 8	2.9398	710.48	4.9981	187.34	192.34	65.044	354.08
5 Na 11	0	0	0	0	0	0	0.086136
6 Mg 12	0	0	0	0	0	0.024993	0.2801
7 Al 13	0	0	0	0	0	0.98695	4.4244
8 Si 14	0	0	0	0	0	5.3851	8.4667
9 P 15	0	0	0	0	0	0.15333	0.55732
10 S 16	0	0	0	0	0	0.033152	0.023222
11 K 19	0	0	0	0	0	0	0.096387
12 Ca 20	0	0	0	0	0	0.044426	4.73
13 Ti 22	0	0	0	0	0	0.099375	0
15 Mn 25	0	0	0	0	0	0.12837	0.4496
16 Fe 26	0	0	0	0	0	135.3	787.89

HYLSA PROJECT

INPUT DATA

TITLE : HYLSA PROJECT
CASE :
DATA STORAGE FILE NAME : hylsapm8V.sfw
HEAT BALANCE OPTION : ON
UNITS OF MASS/TIME : KG/HR

ROW	CNM	CHF		PHC	CMW	SGF
1	Fe2O3Fe2O3SI1		159.6922	5.2400	0.0000	0.0000
2	Fe1O1Fe1O1SI1		71.8464	5.7000	0.0000	0.0000
3	Fe1 Fe1 SI1		55.8470	7.8600	0.0000	0.0000
4	Ca1O1Ca1O1SI1		56.0794	3.3100	0.0000	0.0000
5	Mg1O1Mg1O1SI1		40.3114	3.5800	0.0000	0.0000
6	Al2O3Al2O3SI1		101.9612	3.9650	0.0000	0.0000
7	Si1O2Si1O2SI1		60.0848	2.6500	0.0000	0.0000
8	Mn1O1Mn1O1SI1		70.9374	5.4500	0.0000	0.0000
9	V2O5 V2O5 SI1		181.8810	3.3570	0.0000	0.0000
10	Ti1O2Ti1O2SI1		79.8988	4.2600	0.0000	0.0000
11	S1 S1 SI1		32.0640	2.0000	0.0000	0.0000
12	P1 P1 SI1		30.9738	1.8200	0.0000	0.0000
13	Na2O1Na2O1SI1		61.9790	2.2700	0.0000	0.0000
14	K2O1 K2O1 SI1		94.1954	2.3200	0.0000	0.0000
15	C1 C1 SI1		12.0112	2.2500	0.0000	0.0000
16	H2O H2O LI3		18.0153	1.0000	0.0000	0.0000
17	C1H4 C1H4 GC8		16.0430	0.0007	0.0000	0.0000
18	N2 N2 GC8		28.0134	0.0012	0.0000	0.0000
19	O2 O2 GC8		31.9988	0.0014	0.0000	0.0000
20	C1O1 C1O1 GC8		28.0106	0.0012	0.0000	0.0000
21	C1O2 C1O2 GC8		44.0100	0.0020	0.0000	0.0000
22	H2O H2O GC8		18.0153	0.0008	0.0000	0.0000
23	H2 H2 GC8		2.0159	0.0001	0.0000	0.0000
24	C2H6 C2H6 GC8		30.0701	0.0013	0.0000	0.0000
25	C3H8 C3H8 GC8		44.0972	0.0020	0.0000	0.0000
26	C4H10C4H10GC8		58.1243	0.0026	0.0000	0.0000
27	C5H12C5H12GC8		72.1514	0.0032	0.0000	0.0000
28	Fe3C1Fe3C1SI1		179.5521	1.0000	0.0000	0.0000

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
2	Fe1O1	BAK2248	-62382	8754	-8.5950	9.1416	-21.4692
3	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
4	Ca1O1	B672098	-151790	-4315	12.0730	0.4606	2.0088
5	Mg1O1	B672227	-143760	-4612	11.8081	0.3610	3.1765
6	Al2O3	B672042	-400500	-12425	28.9653	1.0071	11.1085
7	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
8	Mn1O1	B672232	-92070	-3551	10.8451	1.0861	0.6565
9	V2O5	B672460	-370600	-11011	31.3186	6.3456	3.2973
10	Ti1O2	B672431	-225670	-6260	16.8540	0.6334	3.4762
11	S1	B672335	0	13015	-44.4133	56.5440	-14.3084
12	P1	B672282	0	-2816	12.9239	-11.6659	0.0000
13	Na2O1	B672257	-99700	1345	3.7517	9.6170	-10.1495
14	K2O1	B672209	-81260	-6064	18.1536	2.0456	1.3980
15	C1	B672086	0	-2999	5.1802	0.2246	4.3597
16	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
17	C1H4	B6772217	-17880	-6424	11.8424	2.9907	8.0422
18	N2	B672244	0	-2846	7.5728	0.2525	1.7794
19	O2	B672277	0	-2979	7.9696	0.2720	1.7697
20	C1O1	B672093	-26417	-2962	7.7460	0.2285	1.9749
21	C1O2	B672094	-94051	-5911	12.9357	0.3891	6.1869
22	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
23	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
24	C2H6	B6772223	-20240	-5819	11.3274	9.4527	4.7951
25	C3H8	BAK1139A	12720	3185	-13.5908	43.9657	-9.0826
26	C4H10	BAK1126	-29800	-17099	32.8367	11.3643	18.9320
27	C5H12	BAK1132B	-34800	-17182	34.9823	9.5671	17.7272
28	Fe3C1	B6771332	5985	-5013	21.1456	4.1225	-5.0322

HYLSA PROJECT

INPUT DATA

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
2	Fe1O1	298.2	1650.0	-58450	-19.5576	-4.9564	-7.3814
3	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
4	Ca1O1	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
5	Mg1O1	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
6	Al2O3	298.2	2327.0	-386441	-25.8901	-10.0349	-27.6544
7	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
8	Mn1O1	298.2	1500.0	-88030	-17.6692	-5.7458	-7.5421
9	V2O5	298.2	950.0	-364423	-29.8510	-24.3174	-13.1309
10	Ti1O2	298.2	2000.0	-217923	-19.7530	-6.5095	-14.7172
11	S1	298.2	388.4	-5700	12.4302	-23.6630	5.4073
12	P1	298.2	317.3	-2534	6.8556	-27.4268	0.0000
13	Na2O1	298.2	1300.0	-95586	-19.3198	-11.2023	-8.1549
14	K2O1	298.2	1100.0	-76733	-26.1416	-11.7119	-8.8698
15	C1	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
16	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
17	C1H4	298.2	2000.0	-14673	-45.4106	-7.1789	-6.9854
18	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
19	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
20	C1O1	298.2	3000.0	-21272	-52.8075	-2.2569	-10.0674
21	C1O2	298.2	3000.0	-86430	-58.7976	-3.7771	-15.3476
22	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
23	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
24	C2H6	298.2	1000.0	-19821	-48.2326	-15.8609	-2.9266
25	C3H8	298.2	1000.0	8420	-33.7154	-36.2585	1.8620
26	C4H10	298.2	1500.0	-24334	-69.8380	-25.6515	-13.3922
27	C5H12	298.2	1500.0	-27854	-78.1190	-24.7443	-15.6889
28	Fe3C1	298.2	1400.0	15085	-32.7885	-13.6625	-16.6593

	FLOL	FLO												
	TYP LABEL	1	2	3	4	5	6	7	8	9	10	11	12	13
NO	OPR UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC HYLSA APM	0	0	0	0	0	0	0	0	0	0	0	0	0
2	MIX ORE/PELLET MIXER	34	35	0	0	0	0	0	1	0	0	0	0	0
3	SPP REACTOR	1	2	29	0	0	0	0	3	4	0	0	0	0
4	HTX REDUCIN GAS HTX	9	0	0	4	0	0	0	10	11	0	0	0	0
5	SPP QUENCH TOWER	11	5	0	0	0	0	0	6	7	0	0	0	0
6	SUB SPLITTER	7	0	0	0	0	0	0	21	20	0	0	0	0
7	PMC COMPRESSOR	20	0	0	0	0	0	0	22	0	0	0	0	0
8	SPP REFORMER	15	16	0	0	0	0	0	17	0	0	0	0	0
9	SPP REFORMER HEATER	31	32	0	0	0	0	0	33	0	0	0	0	0
10	SPP REF. GAS QUENCH	17	30	0	0	0	0	0	28	23	0	0	0	0
11	SPC CO2 ABSORBER	23	0	0	0	0	0	0	8	24	0	0	0	0
12	MIX MIXER	22	8	0	0	0	0	0	9	0	0	0	0	0
13	HTX PRO. GAS HEATER	10	0	0	12	13	21	0	19	14	0	0	0	0

HYLSA PROJECT

HEAT BALANCE SUMMARY - 1 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	HYLSA APM	0	0	0	0	0	0	0	0
2	ORE/PELLET MIXER	1064	0	0	0	0	0	-1064	0
3	REACTOR	618103	-218320	0	0	-27985	0	-371798	0
4	REDUCIN GAS HTX	337220	0	0	0	0	0	-337220	0
5	QUENCH TOWER	65263	244878	0	0	0	0	-310140	0
6	SPLITTER	27616	0	0	0	0	0	-27616	0
7	COMPRESSOR	26644	0	0	0	0	0	-26644	0
8	REFORMER	15226	-267587	0	0	0	0	-26644	0
9	REFORMER HEATER	1774	478662	0	0	0	553514	-301153	0
10	REF. GAS QUENCH	281931	75406	0	0	-553514	95278	-22200	0
11	CO2 ABSORBER	72416	0	0	0	0	0	-357337	0
12	MIXER	74890	0	0	0	0	0	-72416	0
13	PRO. GAS HEATER	166307	488436	0	0	0	0	-654743	0

HYLSA PROJECT

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1	SIZED ORE/PELLET	30.000	86.00	1064.00	4221.0	4450.0
2	REDUCING GAS	930.000	1706.00	616934.00	2448194.0	2581254.0
3	DRI PRODUCT	730.000	1346.00	111496.00	442451.0	466498.0
4	REACTOR EXHAUST	397.256	747.06	260302.00	1032963.0	1089105.0
5	QUENCH WATER	1.000	33.80	-108121.00	-429058.0	-452378.0
6	WARM WATER	82.447	180.41	282524.00	1121147.0	1182082.0
7	COOLED REDUCING GAS	82.447	180.41	27616.00	109589.0	115545.0
8	FRESH REFORMED GAS	307.641	585.75	48246.00	191456.0	201861.0
9	COMB. REDUCING GAS	142.685	288.83	74890.00	297188.0	313341.0
10	PREHEATED REDUCING GAS	277.965	532.34	163837.00	650158.0	685494.0
11	RECYCLE REDUCING GAS	277.965	532.34	173383.00	688041.0	725437.0
12	FUEL	30.000	86.00	160.00	634.0	669.0
13	AIR	30.000	86.00	1339.00	5312.0	5601.0
14	EXHAUST	138.000	280.40	21455.00	85140.0	89768.0
15	DESULFURIZED NATURAL GAS	30.000	86.00	735.00	2918.0	3076.0
16	WATER	120.000	248.00	14491.00	57503.0	60629.0
17	REFORMED GAS	900.000	1652.00	301153.00	1195070.0	1260022.0
18		0.000	32.00	27783.00	110251.0	116243.0
19	REDUCING GAS EQ 2	939.771	1723.59	633288.00	2513088.0	2649675.0
20	GAS TO COMPRESSOR	82.447	180.41	26644.00	105733.0	111479.0
21	TAIL GAS	82.447	180.41	972.00	3856.0	4066.0
22	COMPRESSED GAS	82.447	180.41	26644.00	105733.0	111479.0
23	QUENCHED REFORMED GAS	307.641	585.75	72416.00	287371.0	302990.0
24	CO2	307.641	585.75	24170.00	95916.0	101129.0
26		78.882	173.99	21253.00	84337.0	88921.0
27		78.882	173.99	0.00	0.0	0.0
28	WARM WATER	307.641	585.75	284921.00	1130657.0	1192108.0
29	NATURAL GAS	30.000	86.00	105.00	417.0	440.0
30	QUENCH WATER	1.000	33.80	-19221.00	-76277.0	-80423.0
31	NATURAL GAS	30.000	86.00	198.00	787.0	829.0
32	COMBUSTION AIR PREHEAT	30.000	86.00	1576.00	6255.0	6595.0
33	EXHAUST	130.000	266.00	22200.00	88097.0	92885.0
34	ORE	30.000	86.00	157.00	624.0	658.0
35	PELLET	30.000	86.00	906.00	3596.0	3792.0

HYLSA PROJECT

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
2	REDUCING GAS	100.0000	1107.441	1168.168	1881.554	1984.730
4	REACTOR EXHAUST	100.0000	663.011	1201.397	1126.462	2041.186
7	COOLED REDUCING GAS	100.0000	310.442	894.313	527.444	1519.448
8	FRESH REFORMED GAS	100.0000	690.379	324.690	1172.962	551.652
9	COMB. REDUCING GAS	100.0000	1807.866	1187.534	3071.584	2017.633
10	PREHEATED REDUCING GAS	100.0000	2396.002	1187.534	4070.833	2017.633
11	RECYCLE REDUCING GAS	100.0000	584.783	1201.397	993.553	2041.186
12	FUEL	100.0000	25.541	23.013	43.394	39.100
13	AIR	100.0000	346.664	312.358	588.987	530.700
14	EXHAUST	100.0000	534.163	354.875	907.549	602.936
15	DESULFURIZED NATURAL GAS	100.0000	117.514	105.885	199.658	179.900
16	WATER	100.0000	363.936	252.853	618.331	429.600
17	REFORMED GAS	100.0000	2317.709	539.643	3937.812	916.859
18		100.0000	894.313	894.313	1519.448	1519.448
19	REDUCING GAS EQ 2	100.0000	5273.236	1187.534	8959.286	2017.633
20	GAS TO COMPRESSOR	100.0000	1123.284	862.844	1908.472	1465.981
21	TAIL GAS	100.0000	40.968	31.469	69.605	53.467
22	COMPRESSED GAS	100.0000	241.761	862.844	410.755	1465.981
23	QUENCHED REFORMED GAS	100.0000	946.364	445.082	1607.883	756.198
24	CO2	100.0000	255.985	120.391	434.921	204.546
26		100.0000	958.117	743.427	1627.851	1263.090
29	NATURAL GAS	100.0000	16.814	15.150	28.567	25.740
31	NATURAL GAS	100.0000	30.904	27.846	52.507	47.311
32	COMBUSTION AIR PREHEAT	100.0000	408.179	367.785	693.501	624.872
33	EXHAUST	100.0000	590.644	400.184	1003.510	679.918

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	SIZED ORE/PELLET	100.0000	1.18135	0.074532	0.268315	6.4396
3	DRI PRODUCT	100.0000	1.26888	0.080054	0.288196	6.9167
5	QUENCH WATER	100.0000	19.81568	1.250183	4.500658	108.0158
6	WARM WATER	100.0000	22.32712	1.408631	5.071071	121.7057
28	WARM WATER	100.0000	5.88098	0.371034	1.335724	32.0574
30	QUENCH WATER	100.0000	3.52279	0.222255	0.800117	19.2028
34	ORE	100.0000	0.18427	0.011626	0.041853	1.0045
35	PELLET	100.0000	0.99708	0.062906	0.226462	5.4351

HYLSA PROJECT

MASS FLOW RATES - KG/HR

NO.	STREAM	KG/HR-SI	KG/HR-LI	KG/HR-GC	KG/HR-TC
1	SIZED ORE/PELLET	1368.280	0.000	0.000	1368.280
2	REDUCING GAS	0.000	0.000	614.814	614.814
3	DRI PRODUCT	1001.977	0.000	0.000	1001.977
4	REACTOR EXHAUST	0.000	0.000	1004.317	1004.317
5	QUENCH WATER	0.000	4500.000	0.000	4500.000
6	WARM WATER	0.000	4919.349	0.000	4919.349
7	COOLED REDUCING GAS	0.000	0.000	584.968	584.968
8	FRESH REFORMED GAS	0.000	0.000	49.616	49.616
9	COMB. REDUCING GAS	0.000	0.000	614.000	614.000
10	PREHEATED REDUCING GAS	0.000	0.000	614.000	614.000
11	RECYCLE REDUCING GAS	0.000	0.000	1004.317	1004.317
12	FUEL	0.000	0.000	35.241	35.241
13	AIR	0.000	0.000	683.094	683.094
14	EXHAUST	0.000	0.000	738.920	738.920
15	DESULFURIZED NATURAL GAS	0.000	0.000	162.147	162.147
16	WATER	0.000	0.000	345.293	345.293
17	REFORMED GAS	0.000	0.000	507.439	507.439
18		0.000	0.000	584.968	584.968
19	REDUCING GAS EQ 2	0.000	0.000	614.000	614.000
20	GAS TO COMPRESSOR	0.000	0.000	564.384	564.384
21	TAIL GAS	0.000	0.000	20.584	20.584
22	COMPRESSED GAS	0.000	0.000	564.384	564.384
23	QUENCHED REFORMED GAS	0.000	0.000	378.308	378.308
24	CO2	0.000	0.000	328.692	328.692
26		0.000	0.000	327.736	327.736
28	WARM WATER	0.000	929.132	0.000	929.132
29	NATURAL GAS	0.000	0.000	23.200	23.200
30	QUENCH WATER	0.000	800.000	0.000	800.000
31	NATURAL GAS	0.000	0.000	47.913	47.913
32	COMBUSTION AIR PREHEAT	0.000	0.000	804.308	804.308
33	EXHAUST	0.000	0.000	852.221	852.221
34	ORE	207.200	0.000	0.000	207.200
35	PELLET	1161.080	0.000	0.000	1161.080

HYLSA PROJECT

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-GC	SG-TC
1	SIZED ORE/PELLET	100.0000	5.0995	0.0000	0.0000	5.0995
2	REDUCING GAS	0.0000	0.0000	0.0000	0.0003	0.0003
3	DRI PRODUCT	100.0000	3.4767	0.0000	0.0000	3.4767
4	REACTOR EXHAUST	0.0000	0.0000	0.0000	0.0009	0.0009
5	QUENCH WATER	0.0000	0.0000	0.9999	0.0000	0.9999
6	WARM WATER	0.0000	0.0000	0.9701	0.0000	0.9701
7	COOLED REDUCING GAS	0.0000	0.0000	0.0000	0.0011	0.0011
8	FRESH REFORMED GAS	0.0000	0.0000	0.0000	0.0000	0.0000
9	COMB. REDUCING GAS	0.0000	0.0000	0.0000	0.0002	0.0002
10	PREHEATED REDUCING GAS	0.0000	0.0000	0.0000	0.0002	0.0002
11	RECYCLE REDUCING GAS	0.0000	0.0000	0.0000	0.0010	0.0010
12	FUEL	0.0000	0.0000	0.0000	0.0008	0.0008
13	AIR	0.0000	0.0000	0.0000	0.0012	0.0012
14	EXHAUST	0.0000	0.0000	0.0000	0.0008	0.0008
15	DESULFURIZED NATURAL GAS	0.0000	0.0000	0.0000	0.0008	0.0008
16	WATER	0.0000	0.0000	0.0000	0.0006	0.0006
17	REFORMED GAS	0.0000	0.0000	0.0000	0.0001	0.0001
18		0.0000	0.0000	0.0000	0.0004	0.0004
19	REDUCING GAS EQ 2	0.0000	0.0000	0.0000	0.0001	0.0001
20	GAS TO COMPRESSOR	0.0000	0.0000	0.0000	0.0003	0.0003
21	TAIL GAS	0.0000	0.0000	0.0000	0.0003	0.0003
22	COMPRESSED GAS	0.0000	0.0000	0.0000	0.0014	0.0014
23	QUENCHED REFORMED GAS	0.0000	0.0000	0.0000	0.0002	0.0002
24	CO2	0.0000	0.0000	0.0000	0.0008	0.0008
26		0.0000	0.0000	0.0000	0.0002	0.0002
28	WARM WATER	0.0000	0.0000	0.6956	0.0000	0.6956
29	NATURAL GAS	0.0000	0.0000	0.0000	0.0008	0.0008
30	QUENCH WATER	0.0000	0.0000	0.9999	0.0000	0.9999
31	NATURAL GAS	0.0000	0.0000	0.0000	0.0009	0.0009
32	COMBUSTION AIR PREHEAT	0.0000	0.0000	0.0000	0.0012	0.0012
33	EXHAUST	0.0000	0.0000	0.0000	0.0008	0.0008
34	ORE	100.0000	4.9507	0.0000	0.0000	4.9507
35	PELLET	100.0000	5.1270	0.0000	0.0000	5.1270

HYLSA PROJECT

STREAM DATA

SOLIDS - KG/HR

NO.	STREAM	Fe2O3	Fe1O1	Fe1	Ca1O1	Mg1O1	Al2O3	Si1O2
1	SIZED ORE/PELLET	1314.07	5.2566	0.000	6.68032	0.50587	10.2246	29.6332
3	DRI PRODUCT	0.00	83.6119	701.784	6.68032	0.50587	10.2246	29.6332
34	ORE	190.96	2.2378	0.000	0.06216	0.04144	1.8648	11.5203
35	PELLET	1123.11	3.0188	0.000	6.61816	0.46443	8.3598	18.1128

SOLIDS - KG/HR

NO.	STREAM	Mn1O1	V2O5	Ti1O2	S1	P1	Na2O1	K2O1
1	SIZED ORE/PELLET	0.74630	0.00000	0.16576	0.05637	0.71065	0.11611	0.11611
3	DRI PRODUCT	0.74630	0.00000	0.16576	0.05637	0.71065	0.11611	0.11611
34	ORE	0.16576	0.00000	0.16576	0.03315	0.15333	0.00000	0.00000
35	PELLET	0.58054	0.00000	0.00000	0.02322	0.55732	0.11611	0.11611

SOLIDS - KG/HR

NO.	STREAM	C1	Fe3C1
3	DRI PRODUCT	0.00000	167.625

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Fe2O3	Fe1O1	Fe1	Ca1O1	Mg1O1	Al2O3	Si1O2
1	SIZED ORE/PELLET	96.0380	0.38417	0.0000	0.48823	0.03697	0.74726	2.16572
3	DRI PRODUCT	0.0000	8.34470	70.0400	0.66671	0.05049	1.02044	2.95747
34	ORE	92.1600	1.08000	0.0000	0.03000	0.02000	0.90000	5.56000
35	PELLET	96.7300	0.26000	0.0000	0.57000	0.04000	0.72000	1.56000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Mn1O1	V2O5	Ti1O2	S1	P1	Na2O1	K2O1
1	SIZED ORE/PELLET	0.05454	0.00000	0.01211	0.00412	0.05194	0.00849	0.00849
3	DRI PRODUCT	0.07448	0.00000	0.01654	0.00563	0.07092	0.01159	0.01159
34	ORE	0.08000	0.00000	0.08000	0.01600	0.07400	0.00000	0.00000
35	PELLET	0.05000	0.00000	0.00000	0.00200	0.04800	0.01000	0.01000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	C1	Fe3C1
3	DRI PRODUCT	0.00000	16.7295

AQUEOUS - KG/HR

NO.	STREAM	H2O
5	QUENCH WATER	4500.00
6	WARM WATER	4919.35
28	WARM WATER	929.13
30	QUENCH WATER	800.00

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
5	QUENCH WATER	100.000
6	WARM WATER	100.000
28	WARM WATER	100.000
30	QUENCH WATER	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
5	QUENCH WATER	999.85
6	WARM WATER	970.08
28	WARM WATER	695.60
30	QUENCH WATER	999.85

HYLSA PROJECT

STREAM DATA

GASEOUS - KG/HR

NO.	STREAM	C1H4	N2	O2	C1O1	C1O2	H2O	H2
2	REDUCING GAS	54.693	0.000	0.000	186.320	208.374	18.856	146.572
4	REACTOR EXHAUST	55.685	0.000	0.000	188.907	217.965	437.734	104.026
7	COOLED REDUCING GAS	55.685	0.000	0.000	188.907	217.965	18.385	104.026
8	FRESH REFORMED GAS	0.000	0.000	0.000	0.000	0.000	0.000	49.616
9	COMB. REDUCING GAS	53.726	0.000	0.000	182.260	210.295	17.738	149.982
10	PREHEATED REDUCING GAS	53.726	0.000	0.000	182.260	210.295	17.738	149.982
11	RECYCLE REDUCING GAS	55.685	0.000	0.000	188.907	217.965	437.734	104.026
12	FUEL	22.697	0.000	0.000	0.000	6.142	0.000	0.000
13	AIR	0.000	523.990	159.105	0.000	0.000	0.000	0.000
14	EXHAUST	0.000	523.990	4.260	0.000	110.780	99.890	0.000
15	DESULFURIZED NATURAL GAS	104.429	0.000	0.000	0.000	28.259	0.000	0.000
16	WATER	0.000	0.000	0.000	0.000	0.000	345.293	0.000
17	REFORMED GAS	26.107	0.000	0.000	48.013	254.571	129.132	49.616
18		55.685	0.000	0.000	188.907	217.965	18.385	104.026
19	REDUCING GAS EQ 2	53.726	0.000	0.000	182.260	210.295	17.738	149.982
20	GAS TO COMPRESSOR	53.726	0.000	0.000	182.260	210.295	17.738	100.366
21	TAIL GAS	1.959	0.000	0.000	6.647	7.670	0.647	3.660
22	COMPRESSED GAS	53.726	0.000	0.000	182.260	210.295	17.738	100.366
23	QUENCHED REFORMED GAS	26.107	0.000	0.000	48.013	254.571	0.000	49.616
24	CO2	26.107	0.000	0.000	48.013	254.571	0.000	0.000
26		36.895	25.356	0.000	145.169	11.510	14.230	94.575
29	NATURAL GAS	14.942	0.000	0.000	0.000	4.043	0.000	0.000
31	NATURAL GAS	25.736	0.000	0.000	0.000	6.874	0.000	0.000
32	COMBUSTION AIR PREHEAT	0.000	616.970	187.337	0.000	0.000	0.000	0.000
33	EXHAUST	0.000	616.970	29.120	0.000	123.271	82.859	0.000

GASEOUS - KG/HR

NO.	STREAM	C2H6	C3H8	C4H10	C5H12
12	FUEL	4.7210	0.76925	0.91255	0.00000
15	DESULFURIZED NATURAL GAS	21.7215	3.53935	4.19867	0.00000
29	NATURAL GAS	3.1079	0.50641	0.60074	0.00000
31	NATURAL GAS	6.0932	1.76850	1.34956	6.09180

GASEOUS - WEIGHT PERCENT

NO.	STREAM	C1H4	N2	O2	C1O1	C1O2	H2O	H2
2	REDUCING GAS	8.8958	0.0000	0.0000	30.3051	33.8922	3.067	23.840
4	REACTOR EXHAUST	5.5446	0.0000	0.0000	18.8095	21.7028	43.585	10.358
7	COOLED REDUCING GAS	9.5193	0.0000	0.0000	32.2936	37.2609	3.143	17.783
8	FRESH REFORMED GAS	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	100.000
9	COMB. REDUCING GAS	8.7501	0.0000	0.0000	29.6840	34.2500	2.889	24.427
10	PREHEATED REDUCING GAS	8.7501	0.0000	0.0000	29.6840	34.2500	2.889	24.427
11	RECYCLE REDUCING GAS	5.5446	0.0000	0.0000	18.8095	21.7028	43.585	10.358
12	FUEL	64.4037	0.0000	0.0000	0.0000	17.4279	0.000	0.000
13	AIR	0.0000	76.7082	23.2918	0.0000	0.0000	0.000	0.000
14	EXHAUST	0.0000	70.9129	0.5765	0.0000	14.9922	13.518	0.000
15	DESULFURIZED NATURAL GAS	64.4037	0.0000	0.0000	0.0000	17.4279	0.000	0.000
16	WATER	0.0000	0.0000	0.0000	0.0000	0.0000	100.000	0.000
17	REFORMED GAS	5.1449	0.0000	0.0000	9.4618	50.1678	25.448	9.778
18		9.5193	0.0000	0.0000	32.2936	37.2609	3.143	17.783
19	REDUCING GAS EQ 2	8.7501	0.0000	0.0000	29.6840	34.2500	2.889	24.427
20	GAS TO COMPRESSOR	9.5193	0.0000	0.0000	32.2936	37.2609	3.143	17.783
21	TAIL GAS	9.5193	0.0000	0.0000	32.2936	37.2609	3.143	17.783
22	COMPRESSED GAS	9.5193	0.0000	0.0000	32.2936	37.2609	3.143	17.783
23	QUENCHED REFORMED GAS	6.9010	0.0000	0.0000	12.6915	67.2922	0.000	13.115
24	CO2	7.9427	0.0000	0.0000	14.6073	77.4500	0.000	0.000
26		11.2575	7.7368	0.0000	44.2944	3.5121	4.342	28.857
29	NATURAL GAS	64.4037	0.0000	0.0000	0.0000	17.4279	0.000	0.000
31	NATURAL GAS	53.7137	0.0000	0.0000	0.0000	14.3472	0.000	0.000
32	COMBUSTION AIR PREHEAT	0.0000	76.7082	23.2918	0.0000	0.0000	0.000	0.000
33	EXHAUST	0.0000	72.3956	3.4170	0.0000	14.4647	9.723	0.000

HYLSA PROJECT

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	C2H6	C3H8	C4H10	C5H12
12	FUEL	13.3962	2.18280	2.58943	0.0000
15	DESULFURIZED NATURAL GAS	13.3962	2.18280	2.58943	0.0000
29	NATURAL GAS	13.3962	2.18280	2.58943	0.0000
31	NATURAL GAS	12.7172	3.69105	2.81667	12.7142

GASEOUS - VOLUME PERCENT

NO.	STREAM	C1H4	N2	O2	C1O1	C1O2	H2O	H2
2	REDUCING GAS	3.8500	0.0000	0.0000	7.5120	5.3470	1.182	82.109
4	REACTOR EXHAUST	3.8114	0.0000	0.0000	7.4057	5.4384	26.681	56.663
7	COOLED REDUCING GAS	5.1202	0.0000	0.0000	9.9486	7.3058	1.505	76.120
8	FRESH REFORMED GAS	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	100.000
9	COMB. REDUCING GAS	3.7203	0.0000	0.0000	7.2285	5.3083	1.094	82.649
10	PREHEATED REDUCING GAS	3.7203	0.0000	0.0000	7.2285	5.3083	1.094	82.649
11	RECYCLE REDUCING GAS	3.8114	0.0000	0.0000	7.4057	5.4384	26.681	56.663
12	FUEL	81.1000	0.0000	0.0000	0.0000	8.0000	0.000	0.000
13	AIR	0.0000	79.0000	21.0000	0.0000	0.0000	0.000	0.000
14	EXHAUST	0.0000	69.5352	0.4949	0.0000	9.3575	20.612	0.000
15	DESULFURIZED NATURAL GAS	81.1000	0.0000	0.0000	0.0000	8.0000	0.000	0.000
16	WATER	0.0000	0.0000	0.0000	0.0000	0.0000	100.000	0.000
17	REFORMED GAS	3.9782	0.0000	0.0000	4.1904	14.1409	17.523	60.168
18		5.1202	0.0000	0.0000	9.9486	7.3058	1.505	76.120
19	REDUCING GAS EQ 2	3.7203	0.0000	0.0000	7.2285	5.3083	1.094	82.649
20	GAS TO COMPRESSOR	5.1202	0.0000	0.0000	9.9486	7.3058	1.505	76.120
21	TAIL GAS	5.1202	0.0000	0.0000	9.9486	7.3058	1.505	76.120
22	COMPRESSED GAS	5.1202	0.0000	0.0000	9.9486	7.3058	1.505	76.120
23	QUENCHED REFORMED GAS	4.8234	0.0000	0.0000	5.0807	17.1452	0.000	72.951
24	CO2	17.8320	0.0000	0.0000	18.7830	63.3850	0.000	0.000
26		4.0810	1.6062	0.0000	9.1968	0.4641	1.402	83.250
29	NATURAL GAS	81.1000	0.0000	0.0000	0.0000	8.0000	0.000	0.000
31	NATURAL GAS	76.0000	0.0000	0.0000	0.0000	7.4000	0.000	0.000
32	COMBUSTION AIR PREHEAT	0.0000	79.0000	21.0000	0.0000	0.0000	0.000	0.000
33	EXHAUST	0.0000	72.6042	3.0000	0.0000	9.2337	15.162	0.000

GASEOUS - VOLUME PERCENT

NO.	STREAM	C2H6	C3H8	C4H10	C5H12
12	FUEL	9.00000	1.00000	0.90000	0.00000
15	DESULFURIZED NATURAL GAS	9.00000	1.00000	0.90000	0.00000
29	NATURAL GAS	9.00000	1.00000	0.90000	0.00000
31	NATURAL GAS	9.60000	1.90000	1.10000	4.00000

APPENDIX E-3

TECNORED SHAFT MELTER

TECNORED PROCESS

PROCESS BACKGROUND:
The Tecnored process is based upon a low pressure moving bed reduction furnace which reduces pellets made out of iron ore fines with cement and coke fines. Reduction is carried out at typical reduction temperatures. The process produces liquid pig iron.

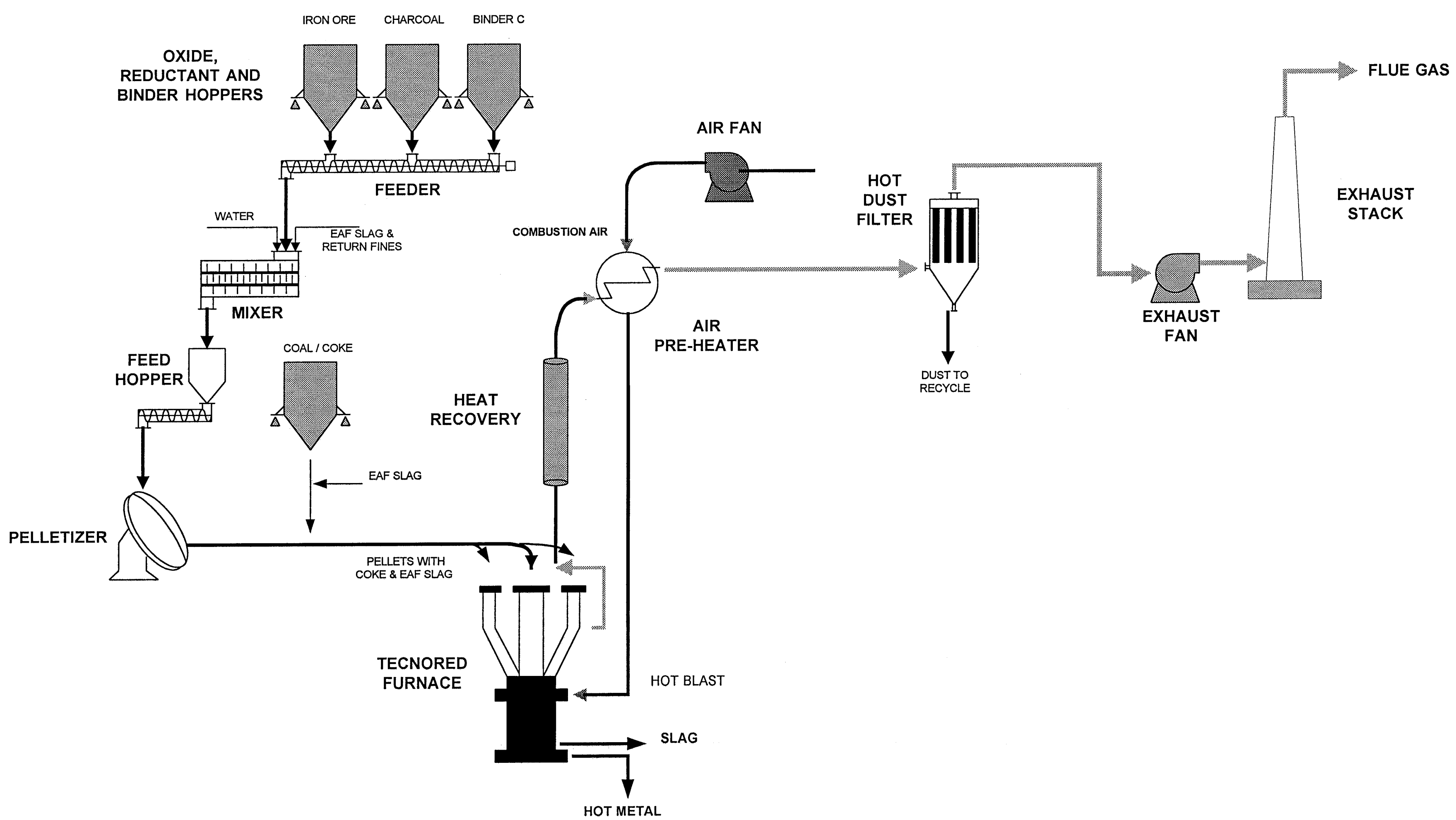
PROCESS DESCRIPTION:
The Tecnored process consists of pelletizing of the iron ore fines with cement and coke fines. The pellet size is controlled for the optimum reaction in the reduction furnace. The pellets are cured and dried at 200C and fed to the top of the furnace. The furnace internal pressure is about 3.5 to 5.2 psig. The total furnace residence time is 30 to 40 minutes against 6 to 8 hours in blast furnace.

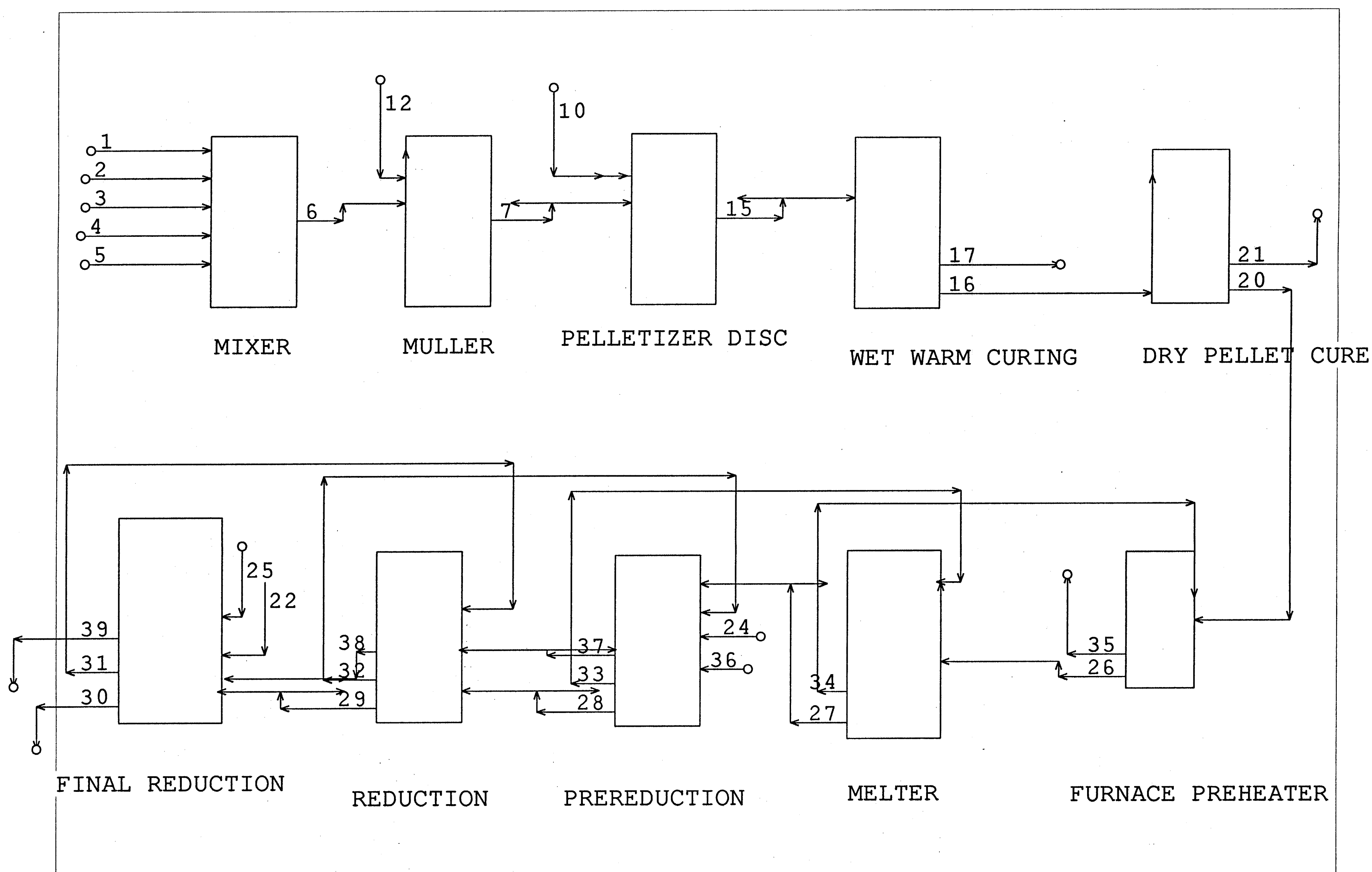
Lump coke is fed into side feeders in the furnace below the hot pellet area. Hot blast air at about 1550C is blown in through tuyeres located in the side of the furnace to provide combustion air for the coke. A small amount of furnace gas is allowed to flow through the side feeders to use for pet coke drying and preheating. Cold blast air is blown in at a higher point to promote post combustion of CO in the upper shaft. The use of coke with sulfur (pet coke) necessitates an elaborate furnace clean-up system in order to meet environmental regulations.

The pig iron produced is tapped into a ladle on a ladle car, which can tilt the ladle for deslagging. The liquid iron is desulfurized in the ladle, and slag raked into a slag pot.

PROCESS ADVANTAGES
Low cost raw materials
Low metling costs using low cost fuels to reduce electric power and electrode cost.
High productivity and energy efficiency in the furnace
Full metallization (upto 99%)

TECNORED PROCESS FLOWSHEET





TECNORED PROCESS

Tecnored Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a production flowsheet for North Star BHP by Tecnored – Tecnologia de Auto-Reducao Ltd., Brazil.

Flowsheet Description

In this case, the Iron Ore Fines (Stream 1) is first mixed with Pet-Coke (Stream 2), Sand (Stream 3), Cement (Stream 4) and water (Stream 5) to form disc feed (Stream 6). This feed passes through a Muller where Return Fines (Stream Stream 12) are added and then through Pelletizing discs to form Green Pellets (Stream 15). These pellets then undergo two curing operations: Wet warm Curing and Dry Pellet Curing. These operations make the pellets (Stream 20) ready to be charged in the Furnace.

For this model, the Tecnored furnace has been divided into five unit operation steps: Preheater, Melter, Prereduction, Reduction and Final Reduction. The Furnace preheater represents the topmost part of the Tecnored furnace where the pellets are preheated and Top gases leave the Furnace at almost equilibrium conditions. In the Melter, the preheated pellets undergo further heating. The reducing gases (Stream 33) carry the thermal energy needed for this step. In the prereductor, Fe_2O_3 converts to Fe_3O_4 with the help of upcoming reducing gases (Stream 32). Also, Petroleum Coke (Stream 36) is added along with Cold Blast of Air (Stream 24) to help in reduction. The Coke reacts with Air to form CO and H_2, main reductants. Next, in the Reductor, the pellets undergo further reduction from Fe_3O_4 to FeO with the help of upcoming reducing gases (Stream 31). The Pet-Coke moving downwards reacts with CO_2 and H_2O from reducing gases to form CO and H_2. In the Final Reductor, the metallization takes place and FeO is converted into metallic Fe. The metallic iron and Slag (Stream 30) are withdrawn from the Furnace. Stream 39, the solid organic part, when combined with Stream 21, Fume losses is quantitatively similar to the Return Fines (Stream 12).

Model Assumptions:

Wet Warm Curing: 6616 kg/h of water comes out as Stream 17 as per NorthStar BHP flowsheet.

Dry Pellet Cure: 710 kg/h of solids loss is assumed.

Furnace Preheater: No carry-over of solid particles in the Top gas is assumed.

Prereduction: Complete reduction of Fe_2O_3 to Fe_3O_4 takes place in this unit operation.

Reduction: Again complete reduction of Fe_3O_4 to FeO takes place here.

Final Reduction: About 99.9% reduction of FeO to Fe takes place. 4 - 4.5% C shows up in the pig iron. Pig iron and Slag together form Stream 30. Stream 39 represents extra organic solids. This along with fume losses account for the Return Fines.

Results

It was decided to achieve same operating conditions as were outlined in the North Star BHP proposal by Tecnored. In the absence of information on coal/coke accurate compositions, a few assumptions were made. The model results are very close to the numbers provided by Tecnored.

TECNORED PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	10	12	15	16
Stream Names	Iron Ore Fine	Pet Coke Fin	Sand	Cement	Water	Disc Feed	Muller Disch	Water to Pell	Return Fines	Pelletizer Dis	Wet Cured P
KG/HR SOLIDS	51273	575	1747.5	3930.2	0	57526	58957	0	1431.7	58957	58957
KG/HR SLD-ORG	0	8925	0	0	0	8925	10242	0	1317	10242	10242
KG/HR AQUEOUS	0	0	0	982.5	6102.8	7085.3	7085.3	1556.8	0	8642.1	2025.6
KG/HR MOLTEN1	0	0	0	0	0	0	0	0	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	0	0	0	0
KG/HR GASEOUS	0	0	0	0	0	0	0	0	0	0	0
KG/HR TOTAL	51273	9500	1747.5	4912.7	6102.8	73536	76285	1556.8	2748.7	77841	71225
Percent Solids	100	100	100	80.001	0	90.365	90.712	0	100	88.898	97.156
Sp.Gr.SOLIDS	5.1929	2.1267	2.6622	3.2642	0	4.792	4.7176	0	2.9057	4.7176	4.7176
Sp.Gr.SLD-ORG	0	2.25	0	0	0	2.25	2.25	0	2.25	2.25	2.25
Sp.Gr.AQUEOUS	0	0	0	0.99826	0.99826	0.99826	0.99801	0.99826	0	0.99803	0.97766
Sp.Gr.MOLTEN1	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.TOTAL	5.1929	2.2421	2.6622	2.2451	0.99826	3.1877	3.159	0.99826	2.5497	3.0279	3.7249
Temperature C	20	20	20	20	20	20	21.233	20	80	21.115	70
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	0	0	0	0	0	0	0	0	0	0
Sol/Liq m3/hr	9.8737	4.237	0.65641	2.1882	6.1134	23.069	24.149	1.5595	1.0781	25.708	19.121
Sol/Liq gpm	43.472	18.655	2.8901	9.6344	26.917	101.57	106.32	6.8663	4.7465	113.19	84.187
Component Mass Flow Rates											
1 Fe2O3 KG/HR	50365	0	0	0	0	50365	50938	0	572.82	50938	50938
2 Fe3O4 KG/HR	0	0	0	0	0	0	0	0	0	0	0
4 Si1O2 KG/HR	427.89	0	1712.6	652.41	0	2792.9	2835.8	0	42.951	2835.8	2835.8
5 Al2O3 KG/HR	182.64	6.0375	0	193.37	0	382.04	389.63	0	7.588	389.63	389.63
6 Ca1O1 KG/HR	0	0	17.475	2582.1	0	2599.6	2699.8	0	100.22	2699.8	2699.8
7 Mg1O1 KG/HR	0	0	17.475	393.02	0	410.5	410.5	0	0	410.5	410.5
9 Fe1O1 KG/HR	0	0	0	109.26	0	109.26	109.26	0	0	109.26	109.26
10 Mn1O1 KG/HR	297.44	0	0	0	0	297.44	297.44	0	0	297.44	297.44
13 S1 KG/HR	0	28.75	0	0	0	28.75	65.258	0	36.508	65.258	65.258
14 C1 KG/HR	0	540.21	0	0	0	540.21	1211.8	0	671.61	1211.8	1211.8
15 C1 KG/HR	0	8925	0	0	0	8925	10242	0	1317	10242	10242
16 H2O KG/HR	0	0	0	982.5	6102.8	7085.3	7085.3	1556.8	0	8642.1	2025.6
17 Fe1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
19 C1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
22 C6H14 KG/HR	0	0	0	0	0	0	0	0	0	0	0
23 C7H16 KG/HR	0	0	0	0	0	0	0	0	0	0	0
24 Ca1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
26 Si1O2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
28 Al2O3 KG/HR	0	0	0	0	0	0	0	0	0	0	0
30 Mn1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
31 Fe1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
32 Mg1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	0
33 N2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
34 O2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
35 H2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
36 CO KG/HR	0	0	0	0	0	0	0	0	0	0	0
37 CO2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
Element Mass Flow Rates											
1 H 1	0	0	0	109.94	682.91	792.85	792.85	174.21	0	967.06	226.67
2 C 6	0	9465.2	0	0	0	9465.2	11454	0	1988.6	11454	11454
3 N 7	0	0	0	0	0	0	0	0	0	0	0
4 O 8	15519	2.8422	923.96	2228	5419.9	24094	24321	1382.6	227.21	25704	19827
6 Mg 12	0	0	10.539	237.03	0	247.57	247.57	0	0	247.57	247.57
7 Al 13	96.661	3.1953	0	102.34	0	202.2	206.21	0	4.016	206.21	206.21
8 Si 14	200.01	0	800.51	304.96	0	1305.5	1325.6	0	20.077	1325.6	1325.6
9 S 16	0	28.75	0	0	0	28.75	65.258	0	36.508	65.258	65.258
10 Ca 20	0	0	12.489	1845.5	0	1857.9	1929.6	0	71.627	1929.6	1929.6
11 Mn 25	230.35	0	0	0	0	230.35	230.35	0	0	230.35	230.35
12 Fe 26	35227	0	0	84.929	0	35312	35712	0	400.65	35712	35712

TECNORED PROCESS --- STREAM SUMMARY

Stream Number	17	20	21	22	24	25	26	27	28	29	30
Stream Names	Water Vapor	Dry Cured P	Fume Losse	Oxygen	Cold Blast	Hot Blast	Preheat prod	Post combus	Prereduced	Reduced ore	Metal & Slag
KG/HR SOLIDS	0	58247	710	0	0	0	57050	57050	55532	6887.8	161.73
KG/HR SLD-ORG	0	10242	0	0	0	0	11439	10089	0	0	0
KG/HR AQUEOUS	6616.5	2025.6	0	0	0	0	2025.6	0	0	0	0
KG/HR MOLTEN1	0	0	0	0	0	0	0	0	0	0	36857
KG/HR MOLTEN3	0	0	0	0	0	0	0	0	0	45282	6663.6
KG/HR GASEOUS	0	0	0	526.79	20184	72025	0	0	0	0	0
KG/HR TOTAL	6616.5	70515	710	526.79	20184	72025	70515	67139	55532	52170	43683
Percent Solids	0	97.127	100	0	0	0	97.127	100	100	13.203	0.37024
Sp.Gr.SOLIDS	0	4.7176	4.7176	0	0	0	4.8288	4.8288	4.7369	2.953	1
Sp.Gr.SLD-ORG	0	2.25	0	0	0	0	2.25	2.25	0	0	0
Sp.Gr.AQUEOUS	0.97766	0.9726	0	0	0	0	0.57358	0	0	0	0
Sp.Gr.MOLTEN1	0	0	0	0	0	0	0	0	0	0	7.0879
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0	0	1	3.0327
Sp.Gr.GASEOUS	0	0	0	0.0013302	0.0011992	0.000313	0	0	0	0	0
Sp.Gr.TOTAL	0.97766	3.7149	4.7176	0.0013302	0.0011992	0.000313	3.4515	4.1193	4.7369	1.0957	5.7789
Temperature C	70	78.44	70	20	20	850	350	530.78	728.62	1012.1	1447.1
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	108.2
Gas nm3/hr	0	0	0	369	15683	55963	0	0	0	0	0
Sol/Liq m3/hr	6.7677	18.981	0.1505	0	0	0	20.43	16.299	11.723	47.615	50.393
Sol/Liq gpm	29.797	83.572	0.66263	0	0	0	89.951	71.76	51.615	209.64	221.87
Component Mass Flow Rates											
1 Fe2O3 KG/HR	0	50324	613.42	0	0	0	50324	50324	0	0	0
2 Fe3O4 KG/HR	0	0	0	0	0	0	0	0	48644	0	0
4 Si1O2 KG/HR	0	2801.7	34.151	0	0	0	2801.7	2801.7	2866.5	2866.5	0
5 Al2O3 KG/HR	0	384.94	4.6921	0	0	0	384.94	384.94	384.94	384.94	0
6 Ca1O1 KG/HR	0	2667.3	32.513	0	0	0	2667.3	2667.3	2667.3	2667.3	0
7 Mg1O1 KG/HR	0	405.55	4.9434	0	0	0	405.55	405.55	405.55	405.55	0
9 Fe1O1 KG/HR	0	107.94	1.3158	0	0	0	107.94	107.94	107.94	107.94	0
10 Mn1O1 KG/HR	0	293.86	3.5819	0	0	0	293.86	293.86	293.86	293.86	0
13 S1 KG/HR	0	64.472	0.78588	0	0	0	64.472	64.472	161.73	161.73	161.73
14 C1 KG/HR	0	1197.2	14.594	0	0	0	0	0	0	0	0
15 C1 KG/HR	0	10242	0	0	0	0	11439	10089	0	0	0
16 H2O KG/HR	6616.5	2025.6	0	0	0	0	2025.6	0	0	0	0
17 Fe1 KG/HR	0	0	0	0	0	0	0	0	0	0	35247
19 C1 KG/HR	0	0	0	0	0	0	0	0	0	0	1610.3
22 C6H14 KG/HR	0	0	0	0	0	0	0	0	0	0	0
23 C7H16 KG/HR	0	0	0	0	0	0	0	0	0	0	0
24 Ca1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	2667.3
26 Si1O2 KG/HR	0	0	0	0	0	0	0	0	0	0	2866.5
28 Al2O3 KG/HR	0	0	0	0	0	0	0	0	0	0	384.94
30 Mn1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	293.86
31 Fe1O1 KG/HR	0	0	0	0	0	0	0	0	0	45282	45.39
32 Mg1O1 KG/HR	0	0	0	0	0	0	0	0	0	0	405.55
33 N2 KG/HR	0	0	0	0	15501	55315	0	0	0	0	0
34 O2 KG/HR	0	0	0	526.79	4682.7	16710	0	0	0	0	0
35 H2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
36 CO KG/HR	0	0	0	0	0	0	0	0	0	0	0
37 CO2 KG/HR	0	0	0	0	0	0	0	0	0	0	0
Element Mass Flow Rates											
1 H 1	740.39	226.67	0	0	0	0	226.67	0	0	0	0
2 C 6	0	11439	14.594	0	0	0	11439	10089	0	0	1610.3
3 N 7	0	0	0	0	15501	55315	0	0	0	0	0
4 O 8	5876.1	19610	217.11	526.79	4682.7	16710	19610	17811	16165	12804	2706.1
6 Mg 12	0	244.59	2.9814	0	0	0	244.59	244.59	244.59	244.59	244.59
7 Al 13	0	203.73	2.4833	0	0	0	203.73	203.73	203.73	203.73	203.73
8 Si 14	0	1309.6	15.963	0	0	0	1309.6	1309.6	1339.9	1339.9	1339.9
9 S 16	0	64.472	0.78588	0	0	0	64.472	64.472	161.73	161.73	161.73
10 Ca 20	0	1906.3	23.237	0	0	0	1906.3	1906.3	1906.3	1906.3	1906.3
11 Mn 25	0	227.58	2.7741	0	0	0	227.58	227.58	227.58	227.58	227.58
12 Fe 26	0	35282	430.07	0	0	0	35282	35282	35282	35282	35282

TECNORED PROCESS --- STREAM SUMMARY

Stream Number	31	32	33	34	35	36	37	38	39
Stream Names	Gas off Final	Gas off Redu	Gas off Prere	Gas off Postc	Furnace gas	Solid fuel Car			Eq to Return Fines
KG/HR SOLIDS	0	0	0	0	0	162.1	0	0	0
KG/HR SLD-ORG	0	0	0	0	0	15242	20254	12780	1073.5
KG/HR AQUEOUS	0	0	0	0	0	810	0	0	0
KG/HR MOLTEN1	0	0	0	0	0	0	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	0	0
KG/HR GASEOUS	92746	1.04E+05	1.31E+05	1.35E+05	1.35E+05	0	0	0	0
KG/HR TOTAL	92746	1.04E+05	1.31E+05	1.35E+05	1.35E+05	16214	20254	12780	1073.5
Percent Solids	0	0	0	0	0	95.004	100	100	100
Sp.Gr.SOLIDS	0	0	0	0	0	1.3317	0	0	0
Sp.Gr.SLD-ORG	0	0	0	0	0	1.8	2.25	2.25	2.25
Sp.Gr.AQUEOUS	0	0	0	0	0	0.99507	0	0	0
Sp.Gr.MOLTEN1	0	0	0	0	0	0	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.00023532	0.0002857	0.00034263	0.00041778	0.00058604	0	0	0	0
Sp.Gr.TOTAL	0.00023532	0.0002857	0.00034263	0.00041778	0.00058604	1.7243	2.25	2.25	2.25
Temperature C	1447.1	1012.1	728.62	530.78	300	32	728.62	1012.1	1447.1
Pressure kPa	108.2	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	78618	77046	1.05E+05	1.10E+05	1.10E+05	0	0	0	0
Sol/Liq m3/hr	0	0	0	0	0	9.4032	9.0019	5.68	0.47712
Sol/Liq gpm	0	0	0	0	0	41.401	39.634	25.008	2.1007
Component Mass Flow Rates									
1 Fe2O3 KG/HR	0	0	0	0	0	0	0	0	0
2 Fe3O4 KG/HR	0	0	0	0	0	0	0	0	0
4 Si1O2 KG/HR	0	0	0	0	0	64.84	0	0	0
5 Al2O3 KG/HR	0	0	0	0	0	0	0	0	0
6 Ca1O1 KG/HR	0	0	0	0	0	0	0	0	0
7 Mg1O1 KG/HR	0	0	0	0	0	0	0	0	0
9 Fe1O1 KG/HR	0	0	0	0	0	0	0	0	0
10 Mn1O1 KG/HR	0	0	0	0	0	0	0	0	0
13 S1 KG/HR	0	0	0	0	0	97.26	0	0	0
14 C1 KG/HR	0	0	0	0	0	0	0	0	0
15 C1 KG/HR	0	0	0	0	0	12193	20254	12780	1073.5
16 H2O KG/HR	0	0	0	0	0	810	0	0	0
17 Fe1 KG/HR	0	0	0	0	0	0	0	0	0
19 C1 KG/HR	0	0	0	0	0	0	0	0	0
22 C6H14 KG/HR	0	0	0	0	0	1524.2	0	0	0
23 C7H16 KG/HR	0	0	0	0	0	1524.2	0	0	0
24 Ca1O1 KG/HR	0	0	0	0	0	0	0	0	0
26 Si1O2 KG/HR	0	0	0	0	0	0	0	0	0
28 Al2O3 KG/HR	0	0	0	0	0	0	0	0	0
30 Mn1O1 KG/HR	0	0	0	0	0	0	0	0	0
31 Fe1O1 KG/HR	0	0	0	0	0	0	0	0	0
32 Mg1O1 KG/HR	0	0	0	0	0	0	0	0	0
33 N2 KG/HR	55315	55315	70816	70816	70816	0	0	0	0
34 O2 KG/HR	5320	0	0	0	0	0	0	0	0
35 H2 KG/HR	0	0	585.52	812.19	812.19	0	0	0	0
36 CO KG/HR	8548.8	28210	37177	40327	40327	0	0	0	0
37 CO2 KG/HR	23562	20056	22753	22753	22753	0	0	0	0
Element Mass Flow Rates									
1 H 1	0	0	585.52	812.19	812.19	585.52	0	0	0
2 C 6	10096	17570	22152	23502	23502	14747	20254	12780	1073.5
3 N 7	55315	55315	70816	70816	70816	0	0	0	0
4 O 8	27334	30696	37778	39577	39577	753.89	0	0	0
6 Mg 12	0	0	0	0	0	0	0	0	0
7 Al 13	0	0	0	0	0	0	0	0	0
8 Si 14	0	0	0	0	0	30.309	0	0	0
9 S 16	0	0	0	0	0	97.26	0	0	0
10 Ca 20	0	0	0	0	0	0	0	0	0
11 Mn 25	0	0	0	0	0	0	0	0	0
12 Fe 26	0	0	0	0	0	0	0	0	0

Tecnored Pig Iron Process
Mass and Energy Balance

INPUT DATA

TITLE : Tecnored Pig Iron Process
CASE : Mass and Energy Balance
DATA STORAGE FILE NAME : tecnored3.sfw
HEAT BALANCE OPTION : ON
UNITS OF MASS/TIME : KG/HR

ROW	CNM	CHF			PHC	CMW	SGF
1	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
2	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
3	Fe1	Fe1	SI1	55.8470	7.8600	0.0000	0.0000
4	Si1O2	Si1O2	SI1	60.0848	2.6500	0.0000	0.0000
5	Al2O3	Al2O3	SI1	101.9612	3.9650	0.0000	0.0000
6	Ca1O1	Ca1O1	SI1	56.0794	3.3100	0.0000	0.0000
7	Mg1O1	Mg1O1	SI1	40.3114	3.5800	0.0000	0.0000
8	Si1	Si1	SI1	28.0860	2.3300	0.0000	0.0000
9	Fe1O1	Fe1O1	SI1	71.8464	5.7000	0.0000	0.0000
10	Mn1O1	Mn1O1	SI1	70.9374	5.4500	0.0000	0.0000
11	Mn1	Mn1	SI1	54.9380	7.2000	0.0000	0.0000
12	Ca1	Ca1	SI1	40.0800	1.5400	0.0000	0.0000
13	S1	S1	SI1	32.0640	1.0000	0.0000	0.0000
14	C1	C1	SI1	12.0112	2.2500	0.0000	0.0000
15	C1	C1	SO2	12.0112	2.2500	0.0000	0.0000
16	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
17	Fe1	Fe1	M15	55.8470	7.8600	0.0000	0.0000
18	Mn1	Mn1	M15	54.9380	7.2000	0.0000	0.0000
19	C1	C1	M15	12.0112	2.2500	0.0000	0.0000
20	Si1	Si1	M15	28.0860	1.0000	0.0000	0.0000
21	S1	S1	M15	32.0640	2.0000	0.0000	0.0000
22	C6H14	C6H14	SO2	86.1785	1.0000	0.0000	0.0000
23	C7H16	C7H16	SO2	100.2056	1.0000	0.0000	0.0000
24	Ca1O1	Ca1O1	M37	56.0794	3.3100	0.0000	0.0000
25	Ca1F2	Ca1F2	M37	78.0768	1.0000	0.0000	0.0000
26	Si1O2	Si1O2	M37	60.0848	2.6500	0.0000	0.0000
27	S1	S1	M37	32.0640	1.0000	0.0000	0.0000
28	Al2O3	Al2O3	M37	101.9612	3.9650	0.0000	0.0000
29	Ca1S1	Ca1S1	M37	72.1440	2.5000	0.0000	0.0000
30	Mn1O1	Mn1O1	M37	70.9374	5.4500	0.0000	0.0000
31	Fe1O1	Fe1O1	M37	71.8464	1.0000	0.0000	0.0000
32	Mg1O1	Mg1O1	M37	40.3114	3.5800	0.0000	0.0000
33	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
34	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
35	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
36	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000
37	CO2	CO2	GC8	44.0100	0.0020	0.0000	0.0000
38	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
39	COS	COS	GC8	60.0746	0.0027	0.0000	0.0000
40	H2S1	H2S1	GC8	34.0799	0.0015	0.0000	0.0000
41	CH4	CH4	GC8	16.0430	0.0007	0.0000	0.0000
42	C2H6	C2H6	GC8	30.0701	0.0013	0.0000	0.0000
43	S1O2	S1O2	GC8	64.0628	0.0029	0.0000	0.0000
44	F1	F1	GC8	18.9984	0.0008	0.0000	0.0000
45	S1	S1	GC8	32.0640	0.0014	0.0000	0.0000

Tecnored Pig Iron Process
Mass and Energy Balance

INPUT DATA

ROW	CNM	SOL	A	B	C	pH	Wi	COV	A B C
1	Fe2O3	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	Fe3O4	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	Fe1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	Si1O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	Al2O3	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	Ca1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	Mg1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8	Si1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	Fe1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
10	Mn1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	Mn1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
12	Ca1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13	S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14	C1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	C1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
16	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
17	Fe1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	Mn1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
19	C1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
20	Si1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
22	C6H14	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
23	C7H16	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	Ca1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
25	Ca1F2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
26	Si1O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
27	S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
28	Al2O3	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
29	Ca1S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
30	Mn1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
31	Fe1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
32	Mg1O1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
33	N2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
34	O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
35	H2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
36	CO	23.77	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
37	CO2	1950.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
38	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
39	COS	1150.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
40	H2S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
41	CH4	24.40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
42	C2H6	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
43	S1O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
44	F1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
45	S1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Tecnored Pig Iron Process
Mass and Energy Balance

INPUT DATA

ROW	CNM	CRIT T	CRIT P	CRIT V	ANTOINE VAPOR PRES A	B	C	HENRY
1	Fe2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
2	Fe3O4	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
3	Fe1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
4	Si1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
5	Al2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
6	Ca1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
7	Mg1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
8	Si1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
9	Fe1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
10	Mn1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
11	Mn1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
12	Ca1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
13	S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
14	C1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
15	C1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
16	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
17	Fe1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
18	Mn1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
19	C1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
20	Si1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
21	S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
22	C6H14	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
23	C7H16	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
24	Ca1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
25	Ca1F2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
26	Si1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
27	S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
28	Al2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
29	Ca1S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
30	Mn1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
31	Fe1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
32	Mg1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
33	N2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
34	O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
35	H2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
36	CO	133.400	35.4638	93.100	6.24020	230.27	260.010	63426.0
37	CO2	304.200	74.8792	94.800	9.81060	1347.79	273.000	1215.7
38	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
39	COS	378.000	62.6189	141.700	6.90723	804.48	250.000	2812.5
40	H2S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
41	CH4	190.700	46.9135	98.900	6.69561	405.42	267.777	35389.5
42	C2H6	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
43	S1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
44	F1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
45	S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0

Tecnored Pig Iron Process
Mass and Energy Balance

INPUT DATA

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe2O3	1452165	-197094	-19152	43.5138	-2.6706	19.1514
2	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
3	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
4	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
5	Al2O3	B672042	-400500	-12425	28.9653	1.0071	11.1085
6	Ca1O1	B672098	-151790	-4315	12.0730	0.4606	2.0088
7	Mg1O1	B672227	-143760	-4612	11.8081	0.3610	3.1765
8	Si1	B672382	0	-2201	5.8656	0.2868	1.2792
9	Fe1O1	B672157	-65000	-3998	12.1207	1.0479	0.8685
10	Mn1O1	B672232	-92070	-3551	10.8451	1.0861	0.6565
11	Mn1	B672229	0	-578	2.8728	3.5454	-1.8081
12	Ca1	B672095	0	-1526	4.1007	2.8398	0.1633
13	S1	B672335	0	-9791	24.2677	-10.4646	11.4735
14	C1	B672086	0	-2999	5.1802	0.2246	4.3597
15	C1	B672086	0	-2999	5.1802	0.2246	4.3597
16	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
17	Fe1	B672151	0	-2609	11.0000	0.0000	0.0000
18	Mn1	B672229	0	-1889	11.0000	0.0000	-0.0001
19	C1	B672086	0	-2999	5.1802	0.2246	4.3597
20	Si1	B672382	0	9241	6.7069	-0.1082	7.0337
21	S1	B672335	0	13015	-44.4133	56.5440	-14.3084
22	C6H14	BAK1127	-47510	-14269	49.2252	-4.5786	0.0000
23	C7H16	BAK1128	-53630	-15340	49.4035	6.8713	0.0000
24	Ca1O1	B672098	-151790	-4315	12.0730	0.4606	2.0088
25	Ca1F2	B674125	-293800	-10219	29.2494	-1.0693	55.2944
26	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
27	S1	B672335	0	-9791	24.2677	-10.4646	11.4735
28	Al2O3	B672042	-400500	-19492	46.0000	0.0000	0.0000
29	Ca1S1	B689066	-113100	-4092	12.2005	0.4197	1.2535
30	Mn1O1	1452186	-92070	-4090	11.6219	0.7611	1.6782
31	Fe1O1	BAK2248	-62382	-3623	16.3000	0.0000	0.0000
32	Mg1O1	B672227	-143760	-4612	11.8081	0.3610	3.1765
33	N2	B672244	0	-2846	7.5728	0.2525	1.7794
34	O2	B672277	0	-2979	7.9696	0.2720	1.7697
35	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
36	CO	YAWS	-26420	-1787	6.0661	0.9368	-0.3112
37	CO2	YAWS	-94050	-3105	8.4720	2.5871	1.0415
38	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
39	COS	YAWS	-33080	-3637	10.1215	2.0671	1.2989
40	H2S1	B689140	-4930	-3383	8.6760	1.2152	2.1081
41	CH4	YAWS	-17890	-1649	3.8363	7.1302	-0.3830
42	C2H6	B6772223	-20240	-5819	11.3274	9.4527	4.7951
43	S1O2	B672348	-70940	-5603	13.1364	0.2172	5.0762
44	F1	B672147	18860	-1326	5.0561	-0.0161	-0.5489
45	S1	B672336	66200	-1100	4.9085	0.0430	-1.1282

Tecnored Pig Iron Process
Mass and Energy Balance

INPUT DATA

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	Fe2O3	298.2	1800.0	-182416	-34.5250	-13.8053	-28.6100
2	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
3	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
4	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
5	Al2O3	298.2	2327.0	-386441	-25.8901	-10.0349	-27.6544
6	Ca1O1	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
7	Mg1O1	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
8	Si1	298.2	1687.0	2177	-6.4390	-2.6130	-4.1096
9	Fe1O1	298.2	1600.0	-60048	-19.0598	-5.9536	-9.2221
10	Mn1O1	298.2	1500.0	-88030	-17.6692	-5.7458	-7.5421
11	Mn1	298.2	1517.0	1277	-7.4008	-4.8754	-2.7466
12	Ca1	298.2	1112.0	950	-9.1634	-4.9597	-2.2181
13	S1	388.4	717.8	3293	-10.8450	-4.2603	-5.7915
14	C1	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
15	C1	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
16	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
17	Fe1	1811.0	3000.0	23276	-21.2611	-1.5440	-100.5828
18	Mn1	1517.0	2000.0	3724	-12.2196	-3.5366	24.2905
19	C1	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
20	Si1	1687.0	2000.0	14952	-16.3206	-1.5743	12.0020
21	S1	298.2	388.4	-5700	12.4302	-23.6630	5.4073
22	C6H14	298.2	342.0	-53950	-27.4686	-72.7203	0.0000
23	C7H16	298.2	371.0	-60793	-30.1668	-81.1627	0.0000
24	Ca1O1	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
25	Ca1F2	1690.0	1800.0	-281936	-29.9150	-7.6022	49.9481
26	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
27	S1	388.4	717.8	3293	-10.8450	-4.2603	-5.7915
28	Al2O3	2327.0	2500.0	-364648	-36.7635	-9.5560	0.0000
29	Ca1S1	298.2	2000.0	-107098	-19.8175	-4.7200	-11.1981
30	Mn1O1	298.2	1800.0	-87077	-19.0502	-5.1431	-9.4245
31	Fe1O1	1700.0	3000.0	-28942	-36.8962	-2.3586	-138.6148
32	Mg1O1	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
33	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
34	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
35	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
36	CO	298.0	700.0	-25393	-46.6664	-5.1645	-2.2650
37	CO2	298.0	700.0	-93224	-48.5944	-8.4916	-2.4252
38	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
39	COS	298.0	700.0	-32021	-52.9787	-9.1212	-2.8701
40	H2S1	298.2	2000.0	-1229	-52.4032	-4.2869	-7.0969
41	CH4	298.0	700.0	-17759	-40.3353	-9.8039	-1.5255
42	C2H6	298.2	1000.0	-19821	-48.2326	-15.8609	-2.9266
43	S1O2	298.2	3000.0	-62759	-67.8617	-3.6510	-16.3249
44	F1	298.2	3000.0	22872	-42.6161	-1.3003	-7.6415
45	S1	298.2	3000.0	70298	-44.9239	-1.3180	-7.7688

	FLOL	FLO												
	TYP LABEL	1	2	3	4	5	6	7	8	9	10	11	12	13
NO	OPR UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC TECNORED PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	MIX MIXER	1	2	3	4	5	0	0	6	0	0	0	0	0
3	MIX MULLER	6	12	0	0	0	0	0	7	0	0	0	0	0
4	MIX PELLETIZER DISC	7	10	0	0	0	0	0	15	0	0	0	0	0
5	SPP WET WARM CURING	15	0	0	0	0	0	0	16	17	0	0	0	0
6	SPP DRY PELLET CURE	16	0	0	0	0	0	0	20	21	0	0	0	0
7	SPP FURNACE PREHEATER	0	34	20	0	0	0	0	26	35	0	0	0	0
8	SPP MELTER	26	33	0	0	0	0	0	27	34	0	0	0	0
9	SPP PREREDUCTION	27	32	24	36	0	0	0	28	33	37	0	0	0
10	SPP REDUCTION	28	31	37	0	0	0	0	29	32	38	0	0	0
11	SPP FINAL REDUCTION	29	0	25	22	38	0	0	30	31	39	0	0	0

Tecnored Pig Iron Process
Mass and Energy Balance

HEAT BALANCE SUMMARY - 1000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	TECNORED PROCESS	0	0	0	0	0	0	0	0
2	MIXER	-49	0	0	0	0	0	49	0
3	MULLER	-27	0	0	0	0	0	27	0
4	PELLETIZER DISC	-34	0	0	0	0	0	34	0
5	WET WARM CURING	-34	0	0	0	0	884	-850	0
6	DRY PELLET CURE	552	0	0	110	0	0	-663	0
7	FURNACE PREHEATE	19356	0	0	0	0	-4227	-15130	0
8	MELTER	30942	-4711	0	0	0	0	-26231	0
9	PREREDUCTION	35391	3539	0	0	0	0	-38930	0
10	REDUCTION	50809	-5787	0	0	0	0	-45022	0
11	FINAL REDUCTION	32707	19040	0	0	0	0	-51747	0

Tecnored Pig Iron Process
Mass and Energy Balance

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1	Iron Ore Fines	20.00	68.00	-29710.00	-117900.0	-124308.0
2	Pet Coke Fines	20.00	68.00	20811.00	82583.0	87072.0
3	Sand	20.00	68.00	-1387.00	-5506.0	-5805.0
4	Cement	20.00	68.00	-8304.00	-32953.0	-34744.0
5	Water	20.00	68.00	-30469.00	-120910.0	-127482.0
6	Disc Feed	20.00	68.00	-49060.00	-194685.0	-205266.0
7	Muller Discharge	21.23	70.22	-26666.00	-105819.0	-111571.0
10	Water to Pelletizer	20.00	68.00	-7772.00	-30844.0	-32520.0
12	Return Fines	80.00	176.00	22394.00	88866.0	93696.0
15	Pelletizer Discharge	21.12	70.01	-34439.00	-136663.0	-144091.0
16	Wet Cured Pellets	70.00	158.00	552393.00	2192074.0	2311213.0
17	Water Vapor	70.00	158.00	297405.00	1180200.0	1244344.0
18	not used	70.00	158.00	17671.00	70126.0	73937.0
19	not used	70.00	158.00	100135.00	397369.0	418966.0
20	Dry Cured Pellets	78.44	173.19	658091.00	2611517.0	2753454.0
21	*Fume Losses	70.00	158.00	4781.00	18971.0	20002.0
22	Oxygen	20.00	68.00	-255.00	-1011.0	-1066.0
23	not used	20.00	68.00	21143.00	83901.0	88462.0
24	Cold Blast	20.00	68.00	-1078.00	-4279.0	-4512.0
25	Hot Blast	850.00	1562.00	15495890.00	61492662.0	64834804.0
26	Preheat product	350.00	662.00	5355193.00	21251122.0	22406127.0
27	Post combust product	530.78	987.40	7531664.00	29888057.0	31512481.0
28	Prereduced ore	728.62	1343.52	8534090.00	33866006.0	35706632.0
29	Reduced ore	1012.07	1853.73	12562707.00	49852850.0	52562366.0
30	Metal & Slag	1447.11	2636.80	13667709.00	54237851.0	57185693.0
31	Gas off Final Reductor	1447.11	2636.80	37468541.00	148687188.0	156768377.0
32	Gas off Reductor	1012.07	1853.73	27811237.00	110363908.0	116362217.0
33	Gas off Prereductor	728.62	1343.52	25588620.00	101543851.0	107062787.0
34	Gas off Postcombustor	530.78	987.40	18699551.00	74205816.0	78238922.0
35	Furnace gas	300.00	572.00	9774409.00	38787988.0	40896126.0
36	Solid fuel Carbon	32.00	89.60	50183.00	199143.0	209966.0
37		728.62	1343.52	4807373.00	19077197.0	20114048.0
38		1012.07	1853.73	4648464.00	18446595.0	19449172.0
39	Eq to Return Fines	1447.11	2636.80	610464.00	2422519.0	2554183.0

Tecnored Pig Iron Process
Mass and Energy Balance

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
18	not used	15.0000	5685.5	4833.37	9659.7	8211.9
19	not used	85.0000	5685.3	4833.20	9659.4	8211.7
22	Oxygen	100.0000	233.1	217.19	396.0	369.0
24	Cold Blast	100.0000	9906.5	9230.67	16831.3	15683.0
25	Hot Blast	100.0000	135438.3	32938.58	230111.1	55963.0
31	Gas off Final Reductor	85.0000	272915.4	46272.97	463686.2	78618.3
32	Gas off Reductor	100.0000	213386.6	45347.86	362546.2	77046.5
33	Gas off Prereductor	100.0000	225607.1	61511.30	383308.8	104508.4
34	Gas off Postcombustor	100.0000	189779.9	64477.94	322438.0	109548.7
35	Furnace gas	100.0000	135290.6	64477.94	229860.2	109548.7

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore Fines	100.0000	43.4725	2.74270	9.87374	236.970
2	Pet Coke Fines	100.0000	18.6550	1.17695	4.23703	101.689
3	Sand	100.0000	2.8901	0.18234	0.65641	15.754
4	Cement	100.0000	9.6344	0.60784	2.18823	52.517
5	Water	100.0000	26.9165	1.69818	6.11344	146.723
6	Disc Feed	100.0000	101.5685	6.40801	23.06885	553.652
7	Muller Discharge	100.0000	106.3228	6.70797	24.14869	579.568
10	Water to Pelletizer	100.0000	6.8663	0.43320	1.55951	37.428
12	Return Fines	100.0000	4.7465	0.29946	1.07805	25.873
15	Pelletizer Discharge	100.0000	113.1899	7.14121	25.70837	617.001
16	Wet Cured Pellets	100.0000	84.1873	5.31143	19.12114	458.907
17	Water Vapor	100.0000	29.7972	1.87992	6.76772	162.425
20	Dry Cured Pellets	100.0000	83.5722	5.27262	18.98141	455.554
21	*Fume Losses	100.0000	0.6626	0.04181	0.15050	3.612
26	Preheat product	100.0000	89.9513	5.67508	20.43027	490.327
27	Post combust product	100.0000	71.7598	4.52737	16.29852	391.164
28	Prereduced ore	100.0000	51.6152	3.25643	11.72316	281.356
29	Reduced ore	100.0000	209.6408	13.22635	47.61488	1142.757
30	Metal & Slag	15.0000	221.8737	13.99814	50.39329	1209.439
36	Solid fuel Carbon	100.0000	41.4010	2.61201	9.40324	225.678
37		100.0000	39.6338	2.50052	9.00186	216.045
38		100.0000	25.0083	1.57779	5.68004	136.321
39	Eq to Return Fines	100.0000	2.1007	0.13253	0.47712	11.451

Tecnored Pig Iron Process
Mass and Energy Balance

MASS FLOW RATES - KG/HR

NO.	STREAM	KG/HR-SI	KG/HR-SO	KG/HR-LI	KG/HR-M1	KG/HR-M3	KG/HR-GC	KG/HR-TC
1	Iron Ore Fines	51272.90	0.00	0.000	0.0	0.00	0.0	51272.9
2	Pet Coke Fines	575.00	8925.00	0.000	0.0	0.00	0.0	9500.0
3	Sand	1747.50	0.00	0.000	0.0	0.00	0.0	1747.5
4	Cement	3930.20	0.00	982.500	0.0	0.00	0.0	4912.7
5	Water	0.00	0.00	6102.800	0.0	0.00	0.0	6102.8
6	Disc Feed	57525.60	8925.00	7085.300	0.0	0.00	0.0	73535.9
7	Muller Discharge	58957.30	10242.00	7085.300	0.0	0.00	0.0	76284.6
10	Water to Pelletizer	0.00	0.00	1556.800	0.0	0.00	0.0	1556.8
12	Return Fines	1431.70	1317.00	0.000	0.0	0.00	0.0	2748.7
15	Pelletizer Discharge	58957.30	10242.00	8642.100	0.0	0.00	0.0	77841.4
16	Wet Cured Pellets	58957.30	10242.00	2025.600	0.0	0.00	0.0	71224.9
17	Water Vapor	0.00	0.00	6616.500	0.0	0.00	0.0	6616.5
18	not used	0.00	0.00	39.722	0.0	0.00	3298.3	3338.0
19	not used	0.00	0.00	39.728	0.0	0.00	3298.7	3338.5
20	Dry Cured Pellets	58247.30	10242.00	2025.600	0.0	0.00	0.0	70514.9
21	*Fume Losses	710.00	0.00	0.000	0.0	0.00	0.0	710.0
22	Oxygen	0.00	0.00	0.000	0.0	0.00	526.8	526.8
24	Cold Blast	0.00	0.00	0.000	0.0	0.00	20184.1	20184.1
25	Hot Blast	0.00	0.00	0.000	0.0	0.00	72024.7	72024.7
26	Preheat product	57050.07	11439.23	2025.600	0.0	0.00	0.0	70514.9
27	Post combust product	57050.07	10088.73	0.000	0.0	0.00	0.0	67138.8
28	Prereduced ore	55531.52	0.00	0.000	0.0	0.00	0.0	55531.5
29	Reduced ore	6887.84	0.00	0.000	0.0	45282.39	0.0	52170.2
30	Metal & Slag	1078.22	0.00	0.000	245716.1	44423.69	0.0	291218.0
31	Gas off Final Reductor	0.00	0.00	0.000	0.0	0.00	109112.4	109112.4
32	Gas off Reductor	0.00	0.00	0.000	0.0	0.00	103581.0	103581.0
33	Gas off Prereductor	0.00	0.00	0.000	0.0	0.00	131331.7	131331.7
34	Gas off Postcombustor	0.00	0.00	0.000	0.0	0.00	134707.9	134707.9
35	Furnace gas	0.00	0.00	0.000	0.0	0.00	134707.9	134707.9
36	Solid fuel Carbon	162.10	15241.50	810.000	0.0	0.00	0.0	16213.6
37		0.00	20254.19	0.000	0.0	0.00	0.0	20254.2
38		0.00	12780.10	0.000	0.0	0.00	0.0	12780.1
39	Eq to Return Fines	0.00	1073.53	0.000	0.0	0.00	0.0	1073.5

Tecnored Pig Iron Process
Mass and Energy Balance

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-SO	SG-LI	SG-M1	SG-M3	SG-GC	SG-TC
1	Iron Ore Fines	100.0000	5.1929	0.0000	0.0000	0.0000	0.0000	0.0000	5.1929
2	Pet Coke Fines	100.0000	2.1267	2.2500	0.0000	0.0000	0.0000	0.0000	2.2421
3	Sand	100.0000	2.6622	0.0000	0.0000	0.0000	0.0000	0.0000	2.6622
4	Cement	80.0008	3.2642	0.0000	0.9983	0.0000	0.0000	0.0000	2.2451
5	Water	0.0000	0.0000	0.0000	0.9983	0.0000	0.0000	0.0000	0.9983
6	Disc Feed	90.3648	4.7920	2.2500	0.9983	0.0000	0.0000	0.0000	3.1877
7	Muller Discharge	90.7120	4.7176	2.2500	0.9980	0.0000	0.0000	0.0000	3.1590
10	Water to Pelletizer	0.0000	0.0000	0.0000	0.9983	0.0000	0.0000	0.0000	0.9983
12	Return Fines	100.0000	2.9057	2.2500	0.0000	0.0000	0.0000	0.0000	2.5497
15	Pelletizer Discharge	88.8978	4.7176	2.2500	0.9980	0.0000	0.0000	0.0000	3.0279
16	Wet Cured Pellets	97.1561	4.7176	2.2500	0.9777	0.0000	0.0000	0.0000	3.7249
17	Water Vapor	0.0000	0.0000	0.0000	0.9777	0.0000	0.0000	0.0000	0.9777
18	not used	0.0000	0.0000	0.0000	0.9777	0.0000	0.0000	0.0003	0.0003
19	not used	0.0000	0.0000	0.0000	0.9777	0.0000	0.0000	0.0003	0.0003
20	Dry Cured Pellets	97.1274	4.7176	2.2500	0.9726	0.0000	0.0000	0.0000	3.7149
21	*Fume Losses	100.0000	4.7176	0.0000	0.0000	0.0000	0.0000	0.0000	4.7176
22	Oxygen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0013
24	Cold Blast	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
25	Hot Blast	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003
26	Preheat product	97.1274	4.8288	2.2500	0.5736	0.0000	0.0000	0.0000	3.4515
27	Post combust product	100.0000	4.8288	2.2500	0.0000	0.0000	0.0000	0.0000	4.1193
28	Prereduced ore	100.0000	4.7369	0.0000	0.0000	0.0000	0.0000	0.0000	4.7369
29	Reduced ore	13.2026	2.9530	0.0000	0.0000	0.0000	1.0000	0.0000	1.0957
30	Metal & Slag	0.3702	1.0000	0.0000	0.0000	7.0879	3.0327	0.0000	5.7789
31	Gas off Final Reductor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
32	Gas off Reductor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003
33	Gas off Prereductor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003
34	Gas off Postcombustor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004
35	Furnace gas	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
36	Solid fuel Carbon	95.0042	1.3317	1.8000	0.9951	0.0000	0.0000	0.0000	1.7243
37		100.0000	0.0000	2.2500	0.0000	0.0000	0.0000	0.0000	2.2500
38		100.0000	0.0000	2.2500	0.0000	0.0000	0.0000	0.0000	2.2500
39	Eq to Return Fines	100.0000	0.0000	2.2500	0.0000	0.0000	0.0000	0.0000	2.2500

Tecnored Pig Iron Process
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STREAM DATA

SOLIDS - KG/HR

NO.	STREAM	Fe2O3	Fe3O4	Fe1	Si1O2	Al2O3	Ca1O1	Mg1O1
1	Iron Ore Fines	50364.9	0.0	0.00000	427.89	182.637	0.00	0.000
2	Pet Coke Fines	0.0	0.0	0.00000	0.00	6.038	0.00	0.000
3	Sand	0.0	0.0	0.00000	1712.55	0.000	17.48	17.475
4	Cement	0.0	0.0	0.00000	652.41	193.366	2582.14	393.020
6	Disc Feed	50364.9	0.0	0.00000	2792.86	382.041	2599.62	410.495
7	Muller Discharge	50937.8	0.0	0.00000	2835.81	389.629	2699.84	410.495
12	Return Fines	572.8	0.0	0.00000	42.95	7.588	100.22	0.000
15	Pelletizer Discharge	50937.8	0.0	0.00000	2835.81	389.629	2699.84	410.495
16	Wet Cured Pellets	50937.8	0.0	0.00000	2835.81	389.629	2699.84	410.495
20	Dry Cured Pellets	50324.3	0.0	0.00000	2801.66	384.937	2667.32	405.552
21	*Fume Losses	613.4	0.0	0.00000	34.15	4.692	32.51	4.943
23	not used	0.0	0.0	0.00000	769.46	0.000	204.54	0.000
26	Preheat product	50324.3	0.0	0.00000	2801.66	384.937	2667.32	405.552
27	Post combust product	50324.3	0.0	0.00000	2801.66	384.937	2667.32	405.552
28	Prereduced ore	0.0	48643.7	0.00000	2866.50	384.937	2667.32	405.552
29	Reduced ore	0.0	0.0	0.00000	2866.50	384.937	2667.32	405.552
36	Solid fuel Carbon	0.0	0.0	0.00000	64.84	0.000	0.00	0.000

SOLIDS - KG/HR

NO.	STREAM	Si1	Fe1O1	Mn1O1	Mn1	Ca1	S1	C1
1	Iron Ore Fines	0.00000	0.000	297.438	0.00000	0.00000	0.000	0.00
2	Pet Coke Fines	0.00000	0.000	0.000	0.00000	0.00000	28.750	540.21
4	Cement	0.00000	109.260	0.000	0.00000	0.00000	0.000	0.00
6	Disc Feed	0.00000	109.260	297.438	0.00000	0.00000	28.750	540.21
7	Muller Discharge	0.00000	109.260	297.438	0.00000	0.00000	65.258	1211.82
12	Return Fines	0.00000	0.000	0.000	0.00000	0.00000	36.508	671.61
15	Pelletizer Discharge	0.00000	109.260	297.438	0.00000	0.00000	65.258	1211.82
16	Wet Cured Pellets	0.00000	109.260	297.438	0.00000	0.00000	65.258	1211.82
20	Dry Cured Pellets	0.00000	107.944	293.856	0.00000	0.00000	64.472	1197.23
21	*Fume Losses	0.00000	1.316	3.582	0.00000	0.00000	0.786	14.59
26	Preheat product	0.00000	107.944	293.856	0.00000	0.00000	64.472	0.00
27	Post combust product	0.00000	107.944	293.856	0.00000	0.00000	64.472	0.00
28	Prereduced ore	0.00000	107.944	293.856	0.00000	0.00000	161.732	0.00
29	Reduced ore	0.00000	107.944	293.856	0.00000	0.00000	161.732	0.00
30	Metal & Slag	0.00000	0.000	0.000	0.00000	0.00000	161.732	0.00
36	Solid fuel Carbon	0.00000	0.000	0.000	0.00000	0.00000	97.260	0.00

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Fe2O3	Fe3O4	Fe1	Si1O2	Al2O3	Ca1O1	Mg1O1
1	Iron Ore Fines	98.2291	0.0000	0.00000	0.8345	0.35621	0.0000	0.0000
2	Pet Coke Fines	0.0000	0.0000	0.00000	0.0000	1.05000	0.0000	0.0000
3	Sand	0.0000	0.0000	0.00000	98.0000	0.00000	1.0000	1.0000
4	Cement	0.0000	0.0000	0.00000	16.6000	4.92000	65.7000	10.0000
6	Disc Feed	87.5522	0.0000	0.00000	4.8550	0.66412	4.5191	0.7136
7	Muller Discharge	86.3977	0.0000	0.00000	4.8099	0.66087	4.5793	0.6963
12	Return Fines	40.0100	0.0000	0.00000	3.0000	0.53000	7.0000	0.0000
15	Pelletizer Discharge	86.3977	0.0000	0.00000	4.8099	0.66087	4.5793	0.6963
16	Wet Cured Pellets	86.3977	0.0000	0.00000	4.8099	0.66087	4.5793	0.6963
20	Dry Cured Pellets	86.3977	0.0000	0.00000	4.8099	0.66087	4.5793	0.6963
21	*Fume Losses	86.3977	0.0000	0.00000	4.8099	0.66087	4.5793	0.6963
23	not used	0.0000	0.0000	0.00000	79.0000	0.00000	21.0000	0.0000
26	Preheat product	88.2108	0.0000	0.00000	4.9109	0.67473	4.6754	0.7109
27	Post combust product	88.2108	0.0000	0.00000	4.9109	0.67473	4.6754	0.7109
28	Prereduced ore	0.0000	87.5965	0.00000	5.1619	0.69319	4.8033	0.7303
29	Reduced ore	0.0000	0.0000	0.00000	41.6168	5.58864	38.7251	5.8879
36	Solid fuel Carbon	0.0000	0.0000	0.00000	40.0000	0.00000	0.0000	0.0000

Tecnored Pig Iron Process
Mass and Energy Balance

STREAM DATA

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Si1	Fe1O1	Mn1O1	Mn1	Ca1	S1	C1
1	Iron Ore Fines	0.00000	0.00000	0.58011	0.00000	0.00000	0.000	0.0000
2	Pet Coke Fines	0.00000	0.00000	0.00000	0.00000	0.00000	5.000	93.9500
4	Cement	0.00000	2.78000	0.00000	0.00000	0.00000	0.000	0.0000
6	Disc Feed	0.00000	0.18993	0.51705	0.00000	0.00000	0.050	0.9391
7	Muller Discharge	0.00000	0.18532	0.50450	0.00000	0.00000	0.111	2.0554
12	Return Fines	0.00000	0.00000	0.00000	0.00000	0.00000	2.550	46.9100
15	Pelletizer Discharge	0.00000	0.18532	0.50450	0.00000	0.00000	0.111	2.0554
16	Wet Cured Pellets	0.00000	0.18532	0.50450	0.00000	0.00000	0.111	2.0554
20	Dry Cured Pellets	0.00000	0.18532	0.50450	0.00000	0.00000	0.111	2.0554
21	*Fume Losses	0.00000	0.18532	0.50450	0.00000	0.00000	0.111	2.0554
26	Preheat product	0.00000	0.18921	0.51508	0.00000	0.00000	0.113	0.0000
27	Post combust product	0.00000	0.18921	0.51508	0.00000	0.00000	0.113	0.0000
28	Prereduced ore	0.00000	0.19438	0.52917	0.00000	0.00000	0.291	0.0000
29	Reduced ore	0.00000	1.56716	4.26630	0.00000	0.00000	2.348	0.0000
30	Metal & Slag	0.00000	0.00000	0.00000	0.00000	0.00000	100.000	0.0000
36	Solid fuel Carbon	0.00000	0.00000	0.00000	0.00000	0.00000	60.000	0.0000

SLD-ORG - KG/HR

NO.	STREAM	C1	C6H14	C7H16
2	Pet Coke Fines	8925.0	0.00	0.00
6	Disc Feed	8925.0	0.00	0.00
7	Muller Discharge	10242.0	0.00	0.00
12	Return Fines	1317.0	0.00	0.00
15	Pelletizer Discharge	10242.0	0.00	0.00
16	Wet Cured Pellets	10242.0	0.00	0.00
20	Dry Cured Pellets	10242.0	0.00	0.00
23	not used	12954.0	1143.00	1143.00
26	Preheat product	11439.2	0.00	0.00
27	Post combust product	10088.7	0.00	0.00
36	Solid fuel Carbon	12193.2	1524.15	1524.15
37		20254.2	0.00	0.00
38		12780.1	0.00	0.00
39	Eq to Return Fines	1073.5	0.00	0.00

SLD-ORG - WEIGHT PERCENT

NO.	STREAM	C1	C6H14	C7H16
2	Pet Coke Fines	100.000	0.0000	0.0000
6	Disc Feed	100.000	0.0000	0.0000
7	Muller Discharge	100.000	0.0000	0.0000
12	Return Fines	100.000	0.0000	0.0000
15	Pelletizer Discharge	100.000	0.0000	0.0000
16	Wet Cured Pellets	100.000	0.0000	0.0000
20	Dry Cured Pellets	100.000	0.0000	0.0000
23	not used	85.000	7.5000	7.5000
26	Preheat product	100.000	0.0000	0.0000
27	Post combust product	100.000	0.0000	0.0000
36	Solid fuel Carbon	80.000	10.0000	10.0000
37		100.000	0.0000	0.0000
38		100.000	0.0000	0.0000
39	Eq to Return Fines	100.000	0.0000	0.0000

Tecnored Pig Iron Process
Mass and Energy Balance

STREAM DATA

AQUEOUS - KG/HR

NO.	STREAM	H2O
4	Cement	982.50
5	Water	6102.80
6	Disc Feed	7085.30
7	Muller Discharge	7085.30
10	Water to Pelletizer	1556.80
15	Pelletizer Discharge	8642.10
16	Wet Cured Pellets	2025.60
17	Water Vapor	6616.50
18	not used	5.96
19	not used	33.77
20	Dry Cured Pellets	2025.60
26	Preheat product	2025.60
36	Solid fuel Carbon	810.00

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
4	Cement	100.000
5	Water	100.000
6	Disc Feed	100.000
7	Muller Discharge	100.000
10	Water to Pelletizer	100.000
15	Pelletizer Discharge	100.000
16	Wet Cured Pellets	100.000
17	Water Vapor	100.000
18	not used	100.000
19	not used	100.000
20	Dry Cured Pellets	100.000
26	Preheat product	100.000
36	Solid fuel Carbon	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
4	Cement	998.259
5	Water	998.259
6	Disc Feed	998.259
7	Muller Discharge	998.008
10	Water to Pelletizer	998.259
15	Pelletizer Discharge	998.034
16	Wet Cured Pellets	977.655
17	Water Vapor	977.655
18	not used	977.655
19	not used	977.655
20	Dry Cured Pellets	972.597
26	Preheat product	573.576
36	Solid fuel Carbon	995.067

MOLTEN1 - KG/HR

NO.	STREAM	Fe1	Mn1	C1	Si1	S1
30	Metal & Slag	35247.1	0.00000	1610.29	0.00000	0.00000

MOLTEN1 - WEIGHT PERCENT

NO.	STREAM	Fe1	Mn1	C1	Si1	S1
30	Metal & Slag	95.6310	0.00000	4.36898	0.00000	0.00000

MOLTEN3 - KG/HR

NO.	STREAM	Ca1O1	Ca1F2	Si1O2	S1	Al2O3	Ca1S1	Mn1O1
30	Metal & Slag	2667.32	0.00000	2866.50	0.00000	384.937	0.00000	293.856

Tecnored Pig Iron Process
Mass and Energy Balance

STREAM DATA

MOLTEN3 - KG/HR

NO.	STREAM	Fe1O1	Mg1O1
29	Reduced ore	45282.4	0.000
30	Metal & Slag	45.4	405.552

MOLTEN3 - WEIGHT PERCENT

NO.	STREAM	Ca1O1	Ca1F2	Si1O2	S1	Al2O3	Ca1S1	Mn1O1
30	Metal & Slag	40.0285	0.00000	43.0175	0.00000	5.77675	0.00000	4.40990

MOLTEN3 - WEIGHT PERCENT

NO.	STREAM	Fe1O1	Mg1O1
29	Reduced ore	100.000	0.00000
30	Metal & Slag	0.681	6.08612

GASEOUS - KG/HR

NO.	STREAM	N2	O2	H2	CO	CO2	H2O	COS
18	not used	240.9	0.0	82.480	100.3	63.4	0.00000	0.15021
19	not used	1365.2	0.0	467.341	568.7	359.3	0.00000	0.96482
22	Oxygen	0.0	526.8	0.000	0.0	0.0	0.00000	0.00000
24	Cold Blast	15501.4	4682.7	0.000	0.0	0.0	0.00000	0.00000
25	Hot Blast	55315.0	16709.7	0.000	0.0	0.0	0.00000	0.00000
31	Gas off Final Reductor	55315.0	5320.0	0.000	8548.8	23561.9	0.00000	0.00000
32	Gas off Reductor	55315.0	0.0	0.000	28210.2	20055.8	0.00000	0.00000
33	Gas off Prereductor	70816.3	0.0	585.520	37177.2	22752.7	0.00000	0.00000
34	Gas off Postcombustor	70816.3	0.0	812.188	40326.7	22752.7	0.00000	0.00000
35	Furnace gas	70816.3	0.0	812.188	40326.7	22752.7	0.00000	0.00000

GASEOUS - KG/HR

NO.	STREAM	H2S1	CH4	C2H6	S1O2	F1	S1
18	not used	0.45063	6.3088	0.00000	0.73603	0.00000	0.00000
19	not used	2.55393	35.7550	0.00000	4.17142	0.00000	0.00000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	N2	O2	H2	CO	CO2	H2O	COS
18	not used	48.6894	0.000	16.6714	20.2813	12.8125	0.00000	0.03036
19	not used	48.6894	0.000	16.6673	20.2813	12.8125	0.00000	0.03441
22	Oxygen	0.0000	100.000	0.0000	0.0000	0.0000	0.00000	0.00000
24	Cold Blast	76.8000	23.200	0.0000	0.0000	0.0000	0.00000	0.00000
25	Hot Blast	76.8000	23.200	0.0000	0.0000	0.0000	0.00000	0.00000
31	Gas off Final Reductor	59.6416	5.736	0.0000	9.2175	25.4048	0.00000	0.00000
32	Gas off Reductor	53.4026	0.000	0.0000	27.2349	19.3624	0.00000	0.00000
33	Gas off Prereductor	53.9217	0.000	0.4458	28.3079	17.3246	0.00000	0.00000
34	Gas off Postcombustor	52.5703	0.000	0.6029	29.9364	16.8904	0.00000	0.00000
35	Furnace gas	52.5703	0.000	0.6029	29.9364	16.8904	0.00000	0.00000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2S1	CH4	C2H6	S1O2	F1	S1
18	not used	0.09108	1.27517	0.00000	0.14877	0.00000	0.00000
19	not used	0.09108	1.27517	0.00000	0.14877	0.00000	0.00000

Tecnored Pig Iron Process
Mass and Energy Balance

STREAM DATA

GASEOUS - VOLUME PERCENT

NO.	STREAM	N2	O2	H2	CO	CO2	H2O	COS
18	not used	15.6470	0.000	74.4487	6.5184	2.6209	0.00000	0.00455
19	not used	15.6497	0.000	74.4436	6.5195	2.6213	0.00000	0.00516
22	Oxygen	0.0000	100.000	0.0000	0.0000	0.0000	0.00000	0.00000
24	Cold Blast	79.0852	20.915	0.0000	0.0000	0.0000	0.00000	0.00000
25	Hot Blast	79.0852	20.915	0.0000	0.0000	0.0000	0.00000	0.00000
31	Gas off Final Reductor	66.2298	5.576	0.0000	10.2367	17.9571	0.00000	0.00000
32	Gas off Reductor	57.4438	0.000	0.0000	29.2989	13.2573	0.00000	0.00000
33	Gas off Prereductor	54.2171	0.000	6.2292	28.4658	11.0879	0.00000	0.00000
34	Gas off Postcombustor	51.7225	0.000	8.2431	29.4566	10.5777	0.00000	0.00000
35	Furnace gas	51.7225	0.000	8.2431	29.4566	10.5777	0.00000	0.00000

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2S1	CH4	C2H6	S1O2	F1	S1
18	not used	0.02406	0.71556	0.00000	0.02091	0.00000	0.00000
19	not used	0.02406	0.71569	0.00000	0.02091	0.00000	0.00000

APPENDIX E-4:

HISMELT OXYGEN REACTOR

HISMELT PROCESS

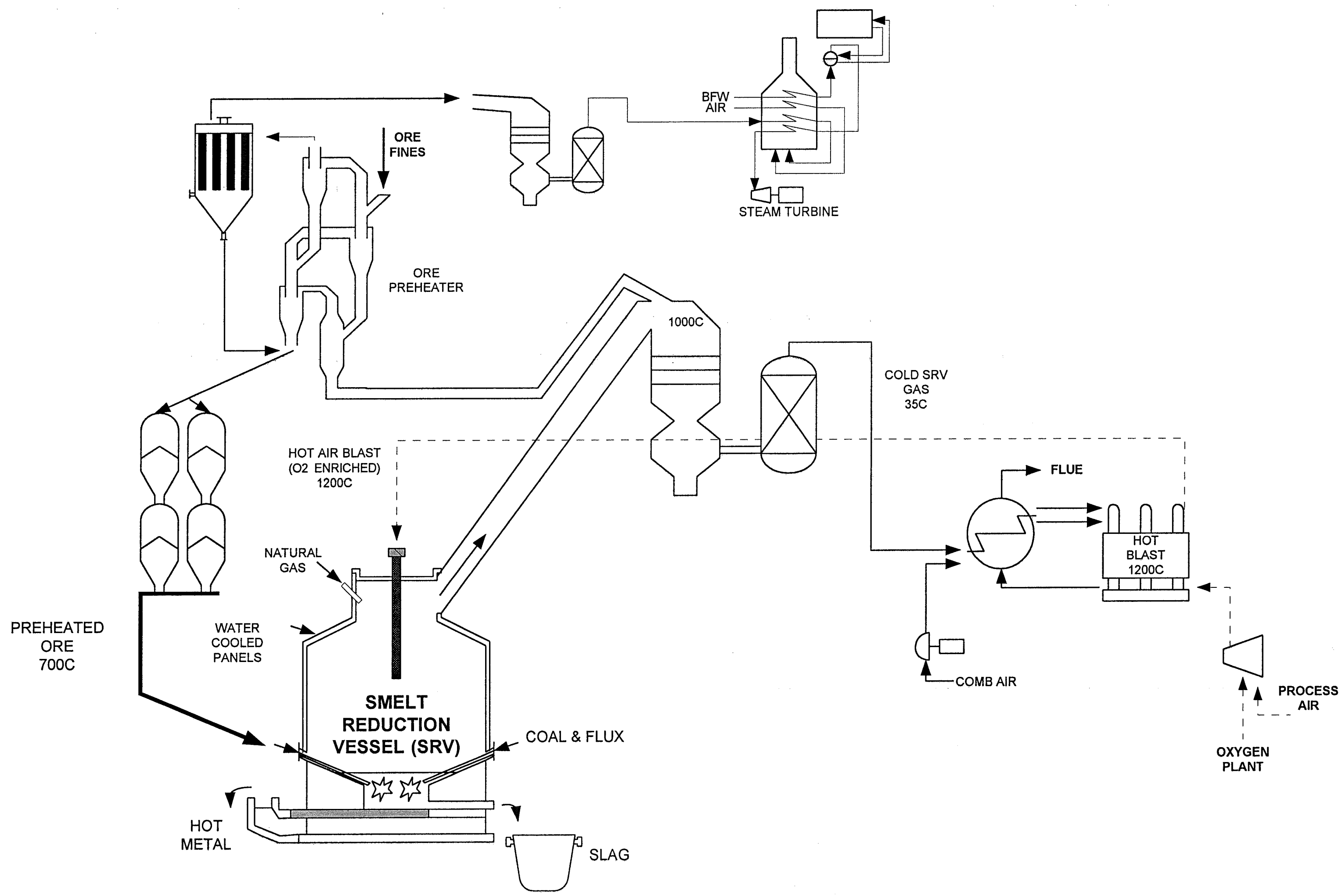
PROCESS BACKGROUND:
The HIsmelt process was initially developed as an air-blown, bottom-injected, refractory-lined process. But due to excessive refractory wear, the initial horizontal design was abandoned and a new Vertical smelt reduction vessel (SRV) was proposed.

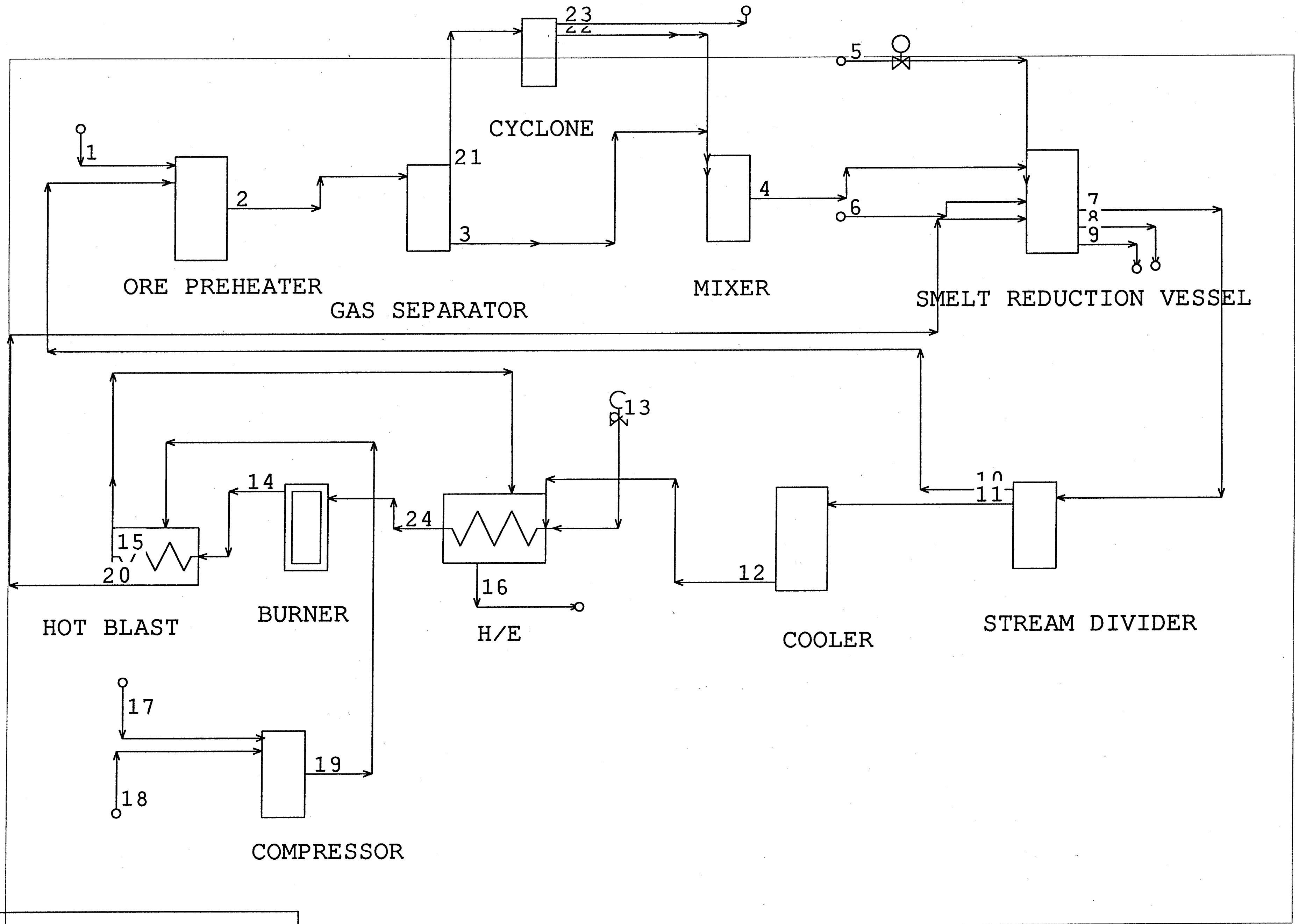
PROCESS DESCRIPTION:
In this process, the iron ore is preheated (and optionally prereduced as far as magnetite) in a lean-phase cyclone preheat system similar to that on many cement kilns. It is then injected into the SRV, along with coal and flux materials through two water-cooled solids injection lances such that the mixture is carried predominantly into the metal phase. Rapid dissolution and smelting occur in the metal and the resulting product gases (mainly hydrogen and carbon monoxide) rise under buoyancy to generate the large liquid fountain, a characterstic of HIsmelt. The result is strong mixing within the metal and slag phases with effective elimination of any significant thermal gradients.

Hot offgas from the SRV is enriched with a small quantity of natural gas, the resulting mixture being roughly equivalent to blast furnace gas. This gas is cooled to around 1000C and split into roughly equal proportions. One portion is used (hot) in the preheater, whilst the other is scrubbed and subsequently burned as fuel in the hot blast stoves.

PROCESS ADVANTAGES
Direct smelting

HISMELT PROCESS FLOWSHEET





HISMELT PROCESS

6/1/00

HIsmelt Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a typical commercial flowsheet published in a technical article, "HIsmelt - The Future in Direct Ironmaking" by HIsmelt Corporation, Kwinana, Australia.

Flowsheet Description

Stream 1 representing the ore fines feed consists of 82% Fe_2O_3, 12% Fe_3O_4 and 6% SiO_2. In the Ore Preheater, this feed is heated upto 700C and also partially prereduced (~11% prereduction) by the stream 10 representing a portion of hot gases generated from the Smelt Reduction Vessel. The preheated ore (Stream 2) is passed through a Gas Separator (MetSim unit op) and a Cyclone to capture lost particles (stream 22) . The combined prereduced ore (stream 4) is introduced in the Smelt Reduction Vessel along with coal and flux (stream 6).

The oxygen enriched air (30% O_2) at 1200C comes into the Reduction vessel as stream 20. Process Air (Stream 17) and Oxygen (Stream 18) are combined and compressed (Stream 19) and then heated to generate stream 20 by using hot gases (stream 14) from the Burner.

Hot gases (Stream 7), Slag (Stream 8) and Hot Metal (Stream 9) are the outgoing streams from the Smelt Reduction Vessel at about 1500C. Hot gases are enriched with Natural Gas (Stream 5) and divided in two parts: one for use in the Ore Preheater, the other for burning as fuel in Burner (hot blast stoves). The latter (stream 11) is first cooled to 35C (stream 12), mixed with combustion air (stream 13) and then preheated by flue gases (Stream 15) before burning. The gases (stream 24) when burned produce sufficient heat to increase the temperature of cold oxygen enriched air (Stream 19) to about 1200C.

Model Assumptions:

Ore Preheater: The temperature of preheated ore fines is 700C. The model requires some external heating.

Gas Separator: 5% solids enter the Cyclone along with hot gases.

Cyclone: 100% efficient, all solid particles are separated from gases and mixed with preheated ore.

Smelt Reduction Vessel: All oxides are grouped together as slag. Hot Metal contains about 5% Carbon. No reaction occurs between Natural gas and hot SRV gases. 10% heat loss.

Stream Divider: 70% of hot SRV gases are burned to heat oxygen enriched air. Rest is used for preheating fine ore.

Cooler: Cold SRV gas temperature is 35C.

H/E: Air is mixed to burn cold SRV gas and preheated by flue gases.

Burner: The reactions reach equilibrium.

Hot Blast: 100% Efficient.

Compressor: No increase in temperature.

Results

It was decided to achieve same operating conditions as were outlined in the article by Hismelt Corporation. In the absence of information on gas compositions and amounts for certain feed streams, a few assumptions were made. These led to some differences between the MetSim Model results and the Commercial flowsheet data by Hismelt Corp. It was observed that Natural gas added to the SRV gas was not sufficient to increase the temperature of oxygen enriched air to 1200C. Hence, instead of 9000Nm3/hr of natural gas, 15000 Nm3/hr of natural gas was needed. Also 70% of the SRV was routed for burners and 30% for preheating instead of equal portions as shown in the Commercial flowsheet. The Ore preheater also required external heating. The natural gas in the SRV gases routed to the Ore Preheater went waste in the absence of any air. More natural gas meant more combustion air to burn than that outlined in the commercial flowsheet.

HISMELT PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8
Stream Names	ORE FINES	HOT ORE FI	PREHEATE	PREHEATE	NATURAL G	COAL FLUX	HOT SRV G	SLAG
KG/HR SOLIDS	2.87E+05	2.78E+05	2.64E+05	2.78E+05	0	1.42E+05	0	0
KG/HR AQUEOUS	0	0	0	0	0	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	67737
KG/HR GASEOUS	0	1.67E+05	0	0	10736	0	5.26E+05	0
KG/HR TOTAL	2.87E+05	4.45E+05	2.64E+05	2.78E+05	10736	1.42E+05	5.26E+05	67737
Percent Solids	100	62.471	100	100	0	100	0	0
Sp.Gr.SOLIDS	4.9432	4.9167	4.9167	4.9167	0	2.4691	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	3.0287
Sp.Gr.GASEOUS	0	0.00038945	0	0	0.00063446	0	0.00021782	0
Sp.Gr.TOTAL	4.9432	0.0010376	4.9167	4.9167	0.00063446	2.4691	0.00021782	3.0287
Temperature C	35	700	700	700	35	35	1504.7	1504.7
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	1.20E+05	0	0	14999	0	3.71E+05	0
Sol/Liq m3/hr	58.059	56.517	53.691	56.517	0	57.51	0	22.365
Sol/Liq gpm	255.62	248.83	236.39	248.83	0	253.21	0	98.471
Component Mass Flow rates								
1 C KG/HR	0	0	0	0	0	95140	0	0
2 CO KG/HR	0	28719	0	0	0	0	74010	0
3 CO2 KG/HR	0	56622	0	0	0	0	1.93E+05	0
4 Fe KG/HR	0	0	0	0	0	0	0	0
5 FeO KG/HR	0	17068	16214	17068	0	0	0	0
6 Fe2O3 KG/HR	2.35E+05	0	0	0	0	0	0	0
7 Fe3O4 KG/HR	34440	2.44E+05	2.31E+05	2.44E+05	0	0	0	0
9 H2O KG/HR	0	0	0	0	0	0	0	0
10 H2O KG/HR	0	7233.5	0	0	0	0	0	0
11 N2 KG/HR	0	74357	0	0	0	0	2.48E+05	0
12 O2 KG/HR	0	0	0	0	0	0	0	0
15 CaO KG/HR	0	0	0	0	0	32660	0	0
17 SiO2 KG/HR	17220	17220	16359	17220	0	14200	0	0
18 CH4 KG/HR	0	0	0	0	10736	0	10736	0
20 CaO KG/HR	0	0	0	0	0	0	0	32660
22 SiO2 KG/HR	0	0	0	0	0	0	0	31420
23 FeO KG/HR	0	0	0	0	0	0	0	3657.3
Element Mass Flow Rates								
1 H 1	0	809.44	0	0	2698.1	0	2698.1	0
2 C 6	0	27768	0	0	8037.9	95140	92560	0
3 N 7	0	74357	0	0	0	0	2.48E+05	0
4 O 8	89425	1.44E+05	76284	80299	0	16880	1.83E+05	26865
7 Si 14	8049.3	8049.3	7646.8	8049.3	0	6637.6	0	14687
8 Ca 20	0	0	0	0	0	23342	0	23342
9 Fe 26	1.90E+05	1.90E+05	1.80E+05	1.90E+05	0	0	0	2842.9

HISMELT PROCESS --- STREAM SUMMARY

Stream Number	9	10	11	12	13	14	15	16
Stream Names	HOT METAL	HOT GASES	HOT GASES	COLD SRV	COMBUSTI		BURNT SRV	FLUE
KG/HR SOLIDS	1.97E+05	0	0	0	0	0	0	0
KG/HR AQUEOUS	0	0	0	0	0	14325	14325	14325
KG/HR MOLTEN3	0	0	0	0	0	0	0	0
KG/HR GASEOUS	0	1.58E+05	3.68E+05	3.68E+05	2.90E+05	6.44E+05	6.44E+05	6.44E+05
KG/HR TOTAL	1.97E+05	1.58E+05	3.68E+05	3.68E+05	2.90E+05	6.58E+05	6.58E+05	6.58E+05
Percent Solids	100	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	6.9301	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0.31545	0.31545	0.31545
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0.00030416	0.00030416	0.0013853	0.0011376	0.00019093	0.00026396	0.00042448
Sp.Gr.TOTAL	6.9301	0.00030416	0.00030416	0.0013853	0.0011376	0.00019518	0.00026983	0.00043391
Temperature C	1504.7	1000	1000	35	35	1786.9	1217	653.48
Pressure kPa	101.33	101.33	101.33	111.69	101.33	101.33	101.33	101.33
Gas nm3/hr	0	1.11E+05	2.60E+05	2.60E+05	2.26E+05	4.47E+05	4.47E+05	4.47E+05
Sol/Liq m3/hr	28.47	0	0	0	0	45.412	45.412	45.412
Sol/Liq gpm	125.35	0	0	0	0	199.94	199.94	199.94
Component Mass Flow rates								
1 C KG/HR	10618	0	0	0	0	0	0	0
2 CO KG/HR	0	22203	51807	51807	0	0	0	0
3 CO2 KG/HR	0	58024	1.35E+05	1.35E+05	0	2.37E+05	2.37E+05	2.37E+05
4 Fe KG/HR	1.87E+05	0	0	0	0	0	0	0
5 FeO KG/HR	0	0	0	0	0	0	0	0
6 Fe2O3 KG/HR	0	0	0	0	0	0	0	0
7 Fe3O4 KG/HR	0	0	0	0	0	0	0	0
9 H2O KG/HR	0	0	0	0	0	14325	14325	14325
10 H2O KG/HR	0	0	0	0	0	2553.2	2553.2	2553.2
11 N2 KG/HR	0	74357	1.74E+05	1.74E+05	2.29E+05	4.03E+05	4.03E+05	4.03E+05
12 O2 KG/HR	0	0	0	0	60900	1329.3	1329.3	1329.3
15 CaO KG/HR	0	0	0	0	0	0	0	0
17 SiO2 KG/HR	0	0	0	0	0	0	0	0
18 CH4 KG/HR	0	3220.8	7515.2	7515.2	0	0	0	0
20 CaO KG/HR	0	0	0	0	0	0	0	0
22 SiO2 KG/HR	0	0	0	0	0	0	0	0
23 FeO KG/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	0	809.44	1888.7	1888.7	0	1888.7	1888.7	1888.7
2 C 6	10618	27768	64792	64792	0	64792	64792	64792
3 N 7	0	74357	1.74E+05	1.74E+05	2.29E+05	4.03E+05	4.03E+05	4.03E+05
4 O 8	0	54870	1.28E+05	1.28E+05	60900	1.89E+05	1.89E+05	1.89E+05
7 Si 14	0	0	0	0	0	0	0	0
8 Ca 20	0	0	0	0	0	0	0	0
9 Fe 26	1.87E+05	0	0	0	0	0	0	0

HISMELT PROCESS --- STREAM SUMMARY

Stream Number	17	18	19	20	21	22	23	24
Stream Names	PROCESS A	OXYGEN	O2 ENRICH	HOT AIR BL	FINES+GAS	PREHEATE	GASES	
KG/HR SOLIDS	0	0	0	0	13894	13894	0	0
KG/HR AQUEOUS	0	0	0	0	0	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	0
KG/HR GASEOUS	3.13E+05	47300	3.60E+05	3.60E+05	1.67E+05	0	1.67E+05	6.58E+05
KG/HR TOTAL	3.13E+05	47300	3.60E+05	3.60E+05	1.81E+05	13894	1.67E+05	6.58E+05
Percent Solids	0	0	0	0	7.6835	100	0	0
Sp.Gr.SOLIDS	0	0	0	0	4.9167	4.9167	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.0011376	0.0012637	0.0011527	0.00023838	0.00038945	0	0.00038945	0.00039948
Sp.Gr.TOTAL	0.0011376	0.0012637	0.0011527	0.00023838	0.00042186	4.9167	0.00038945	0.00039948
Temperature C	35	35	35	1217	700	700	700	653.48
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	2.44E+05	33179	2.77E+05	2.77E+05	1.20E+05	0	1.20E+05	4.86E+05
Sol/Liq m3/hr	0	0	0	0	2.8258	2.8258	0	0
Sol/Liq gpm	0	0	0	0	12.442	12.442	0	0
Component Mass Flow rates								
1 C KG/HR	0	0	0	0	0	0	0	0
2 CO KG/HR	0	0	0	0	28719	0	28719	51807
3 CO2 KG/HR	0	0	0	0	56622	0	56622	1.35E+05
4 Fe KG/HR	0	0	0	0	0	0	0	0
5 FeO KG/HR	0	0	0	0	853.38	853.38	0	0
6 Fe2O3 KG/HR	0	0	0	0	0	0	0	0
7 Fe3O4 KG/HR	0	0	0	0	12179	12179	0	0
9 H2O KG/HR	0	0	0	0	0	0	0	0
10 H2O KG/HR	0	0	0	0	7233.5	0	7233.5	0
11 N2 KG/HR	2.47E+05	473	2.48E+05	2.48E+05	74357	0	74357	4.03E+05
12 O2 KG/HR	65761	46827	1.13E+05	1.13E+05	0	0	0	60900
15 CaO KG/HR	0	0	0	0	0	0	0	0
17 SiO2 KG/HR	0	0	0	0	861	861	0	0
18 CH4 KG/HR	0	0	0	0	0	0	0	7515.2
20 CaO KG/HR	0	0	0	0	0	0	0	0
22 SiO2 KG/HR	0	0	0	0	0	0	0	0
23 FeO KG/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	0	0	0	0	809.44	0	809.44	1888.7
2 C 6	0	0	0	0	27768	0	27768	64792
3 N 7	2.47E+05	473	2.48E+05	2.48E+05	74357	0	74357	4.03E+05
4 O 8	65761	46827	1.13E+05	1.13E+05	68012	4014.9	63997	1.89E+05
7 Si 14	0	0	0	0	402.47	402.47	0	0
8 Ca 20	0	0	0	0	0	0	0	0
9 Fe 26	0	0	0	0	9476.3	9476.3	0	0

HISMELT PROCESS

INPUT DATA

TITLE : HISMELT PROCESS
CASE :
DATA STORAGE FILE NAME : HIsmelt4.sfw
HEAT BALANCE OPTION : ON
UNITS OF MASS/TIME : KG/HR

ROW	CNM	CHF			PHC	CMW	SGF
1	C	C	SI1	12.0112	2.2500	0.0000	0.0000
2	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000
3	CO2	CO2	GC8	44.0100	0.0020	0.0000	0.0000
4	Fe	Fe	SI1	55.8470	7.8600	0.0000	0.0000
5	FeO	FeO	SI1	71.8464	5.7000	0.0000	0.0000
6	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
7	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
8	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
9	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
10	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
11	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
12	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
13	C5H8	C5H8	GC8	68.1195	0.0030	0.0000	0.0000
14	Al2O3	Al2O3	SI1	101.9612	3.9650	0.0000	0.0000
15	CaO	CaO	SI1	56.0794	3.3100	0.0000	0.0000
16	MgO	MgO	SI1	40.3114	3.5800	0.0000	0.0000
17	SiO2	SiO2	SI1	60.0848	2.6500	0.0000	0.0000
18	CH4	CH4	GC8	16.0430	0.0007	0.0000	0.0000
19	Al2O3	Al2O3	M37	101.9612	1.0000	0.0000	0.0000
20	CaO	CaO	M37	56.0794	3.3100	0.0000	0.0000
21	MgO	MgO	M37	40.3114	3.5800	0.0000	0.0000
22	SiO2	SiO2	M37	60.0848	2.6500	0.0000	0.0000
23	FeO	FeO	M37	71.8464	5.7000	0.0000	0.0000

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	C	B672086	0	-2999	5.1802	0.2246	4.3597
2	CO	B672093	-26417	-2962	7.7460	0.2285	1.9749
3	CO2	B672094	-94051	-5911	12.9357	0.3891	6.1869
4	Fe	B672151	0	-7903	14.0914	-1.3293	11.6233
5	FeO	B672157	-65000	-3998	12.1207	1.0479	0.8685
6	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
7	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
8	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
9	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
10	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
11	N2	B672244	0	-2846	7.5728	0.2525	1.7794
12	O2	B672277	0	-2979	7.9696	0.2720	1.7697
13	C5H8	BAK1132B	-34800	-17182	34.9823	9.5671	17.7272
14	Al2O3	B672042	-400500	-12425	28.9653	1.0071	11.1085
15	CaO	B672098	-151790	-4315	12.0730	0.4606	2.0088
16	MgO	B672227	-143760	-4612	11.8081	0.3610	3.1765
17	SiO2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
18	CH4	B6772217	-17880	-6424	11.8424	2.9907	8.0422
19	Al2O3	B672042	-400500	-19492	46.0000	0.0000	0.0000
20	CaO	B672098	-151790	-4315	12.0730	0.4606	2.0088
21	MgO	B672227	-143760	-4612	11.8081	0.3610	3.1765
22	SiO2	BAR1359	-217700	-6112	20.5000	0.0000	0.0000
23	FeO	B672157	-65000	-3998	12.1207	1.0479	0.8685

HISMELT PROCESS

INPUT DATA

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	C	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
2	CO	298.2	3000.0	-21272	-52.8075	-2.2569	-10.0674
3	CO2	298.2	3000.0	-86430	-58.7976	-3.7771	-15.3476
4	Fe	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
5	FeO	298.2	1600.0	-60048	-19.0598	-5.9536	-9.2221
6	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
7	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
8	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
9	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
10	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
11	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
12	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
13	C5H8	298.2	1500.0	-27854	-78.1190	-24.7443	-15.6889
14	Al2O3	298.2	2327.0	-386441	-25.8901	-10.0349	-27.6544
15	CaO	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
16	MgO	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
17	SiO2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
18	CH4	298.2	2000.0	-14673	-45.4106	-7.1789	-6.9854
19	Al2O3	2327.0	2500.0	-364648	-36.7635	-9.5560	0.0000
20	CaO	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
21	MgO	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
22	SiO2	1996.0	3000.0	-177514	-35.2811	-2.7700	-203.7107
23	FeO	298.2	1600.0	-60048	-19.0598	-5.9536	-9.2221

ROW	CNM	PRES RANGE kPa	
1	C	0.0	0.0
2	CO	0.0	0.0
3	CO2	0.0	0.0
4	Fe	0.0	0.0
5	FeO	0.0	0.0
6	Fe2O3	0.0	0.0
7	Fe3O4	0.0	0.0
8	H2	0.0	0.0
9	H2O	0.0	0.0
10	H2O	50.0	120.0
11	N2	0.0	0.0
12	O2	0.0	0.0
13	C5H8	0.0	0.0
14	Al2O3	0.0	0.0
15	CaO	0.0	0.0
16	MgO	0.0	0.0
17	SiO2	0.0	0.0
18	CH4	0.0	0.0
19	Al2O3	0.0	0.0
20	CaO	0.0	0.0
21	MgO	0.0	0.0
22	SiO2	0.0	0.0
23	FeO	0.0	0.0

	FLOL		FLO												
	TYP	LABEL	1	2	3	4	5	6	7	8	9	10	11	12	13
NO	OPR	UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC	HISMELT PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	MIX	ORE PREHEATER	1	10	0	0	0	0	0	2	0	0	0	0	0
3	SPP	GAS SEPARATOR	2	0	0	0	0	0	0	3	21	0	0	0	0
4	SPP	CYCLONE	21	0	0	0	0	0	0	22	23	0	0	0	0
5	MIX	MIXER	3	22	0	0	0	0	0	4	0	0	0	0	0
6	SPP	SMELT REDUCTION VESSEL	4	5	6	20	0	0	0	9	8	7	0	0	0
7	SPS	STREAM DIVIDER	7	0	0	0	0	0	0	10	11	0	0	0	0
8	SPS	COOLER	11	0	0	0	0	0	0	12	0	0	0	0	0
9	HTX	H/E	12	13	0	15	0	0	0	24	16	0	0	0	0
10	FEM	BURNER	24	0	0	0	0	0	0	14	0	0	0	0	0
11	HTX	HOT BLAST	19	0	0	14	0	0	0	20	15	0	0	0	0
12	MIX	COMPRESSOR	17	18	0	0	0	0	0	19	0	0	0	0	0

HISMELT PROCESS

HEAT BALANCE SUMMARY - 1000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	HISMELT PROCESS	0	0	0	0	0	0	0	0
2	ORE PREHEATER	44004	-10666	0	0	0	37698	-71036	0
3	GAS SEPARATOR	71036	0	0	0	0	0	-71036	0
4	CYCLONE	32549	0	0	0	0	0	-32549	0
5	MIXER	40512	0	0	0	0	0	-40512	0
6	SMELT REDUCTION	155456	189782	0	0	-34524	0	-310714	0
7	STREAM DIVIDER	231087	0	0	0	0	-85725	-145362	0
8	COOLER	101753	0	0	0	0	-100619	-1134	0
9	H/E	220900	0	0	0	0	0	-220900	0
10	BURNER	109076	223286	0	0	0	0	-332362	0
11	HOT BLAST	333416	0	0	0	0	0	-333416	0
12	COMPRESSOR	1054	0	0	0	0	0	-1054	0

HISMELT PROCESS

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1	ORE FINES	35.00	95.00	395334.00	1568813.0	1654079.0
2	HOT ORE FINES+GASES	700.00	1292.00	71035713.00	281892490.0	297213423.0
3	PREHEATED COARSE ORE	700.00	1292.00	38486540.00	152726934.0	161027684.0
4	PREHEATED ORE	700.00	1292.00	40512147.00	160765193.0	169502825.0
5	NATURAL GAS	35.00	95.00	79954.00	317282.0	334526.0
6	COAL FLUX	35.00	95.00	343801.00	1364311.0	1438461.0
7	HOT SRV GAS	1504.68	2740.42	231087283.00	917028450.0	966869193.0
8	SLAG	1504.68	2740.42	27827718.00	110429308.0	116431171.0
9	HOT METAL	1504.68	2740.42	51798975.00	205554945.0	216726912.0
10	HOT GASES FOR PREHEATER	1000.00	1832.00	43608595.00	173052891.0	182458362.0
11	HOT GASES TO COOLER	1000.00	1832.00	101753389.00	403790078.0	425736178.0
12	COLD SRV GAS	35.00	95.00	1134438.00	4501815.0	4746489.0
13	COMBUSTION AIR	35.00	95.00	870306.00	3453654.0	3641361.0
14		1786.91	3248.44	332361759.00	1318918047.0	1390601598.0
15	BURNT SRV GAS	1216.97	2222.54	218895751.00	868648541.0	915859824.0
16	FLUE	653.48	1208.26	111824590.00	443755837.0	467874086.0
17	PROCESS AIR	35.00	95.00	939768.00	3729300.0	3931989.0
18	OXYGEN	35.00	95.00	114372.00	453864.0	478531.0
19	O2 ENRICHED PROCESS AIR	35.00	95.00	1054140.00	4183164.0	4410520.0
20	HOT AIR BLAST	1216.97	2222.54	114520147.00	454452670.0	479152295.0
21	FINES+GAS	700.00	1292.00	32549173.00	129165557.0	136185739.0
22	PREHEATED FINES	700.00	1292.00	2025607.00	8038260.0	8475141.0
23	GASES	700.00	1292.00	30523566.00	121127297.0	127710598.0
24		653.48	1208.26	109075905.00	432848171.0	456373586.0

HISMELT PROCESS

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
2	HOT ORE FINES+GASES	100.0000	252319	70846.4	428692	120368.8
5	NATURAL GAS	100.0000	9960	8828.3	16921	14999.5
7	HOT SRV GAS	100.0000	1421399	218387.1	2414973	371042.1
10	HOT GASES FOR PREHEATER	100.0000	305370	65516.1	518827	111312.6
11	HOT GASES TO COOLER	100.0000	712530	152871.0	1210597	259729.4
12	COLD SRV GAS	100.0000	156448	152871.0	265806	259729.4
13	COMBUSTION AIR	100.0000	150040	132998.0	254919	225965.1
14		100.0000	1984885	263187.4	3372342	447158.3
15	BURNT SRV GAS	100.0000	1435747	263187.4	2439350	447158.3
16	FLUE	100.0000	892829	263187.4	1516926	447158.3
17	PROCESS AIR	100.0000	162015	143613.0	275265	244000.0
18	OXYGEN	100.0000	22031	19528.5	37430	33179.1
19	O2 ENRICHED PROCESS AIR	100.0000	184046	163141.4	312695	277179.1
20	HOT AIR BLAST	100.0000	889985	163141.4	1512095	277179.1
21	FINES+GAS	100.0000	252287	70814.8	428639	120315.1
23	GASES	100.0000	252286	70813.1	428636	120312.3
24		100.0000	969775	285869.0	1647658	485694.5

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	ORE FINES	100.0000	255.6245	16.12749	58.05898	1393.415
3	PREHEATED COARSE ORE	100.0000	236.3926	14.91414	53.69092	1288.582
4	PREHEATED ORE	100.0000	248.8343	15.69910	56.51675	1356.402
6	COAL FLUX	100.0000	253.2074	15.97500	57.51000	1380.240
8	SLAG	100.0000	98.4709	6.21259	22.36531	536.767
9	HOT METAL	100.0000	125.3485	7.90831	28.46991	683.278
22	PREHEATED FINES	100.0000	12.4417	0.78495	2.82584	67.820

MASS FLOW RATES - KG/HR

NO.	STREAM	KG/HR-SI	KG/HR-LI	KG/HR-M3	KG/HR-GC	KG/HR-TC
1	ORE FINES	287000.0	0.00	0.00	0.0	287000.0
2	HOT ORE FINES+GASES	277873.6	0.00	0.00	166931.8	444805.4
3	PREHEATED COARSE ORE	263979.9	0.00	0.00	0.0	263979.9
4	PREHEATED ORE	277873.6	0.00	0.00	0.0	277873.6
5	NATURAL GAS	0.0	0.00	0.00	10736.0	10736.0
6	COAL FLUX	142000.0	0.00	0.00	0.0	142000.0
7	HOT SRV GAS	0.0	0.00	0.00	526017.9	526017.9
8	SLAG	0.0	0.00	67737.33	0.0	67737.3
9	HOT METAL	197300.1	0.00	0.00	0.0	197300.1
10	HOT GASES FOR PREHEATER	0.0	0.00	0.00	157805.4	157805.4
11	HOT GASES TO COOLER	0.0	0.00	0.00	368212.5	368212.5
12	COLD SRV GAS	0.0	0.00	0.00	368212.5	368212.5
13	COMBUSTION AIR	0.0	0.00	0.00	290000.0	290000.0
14		0.0	14325.03	0.00	643887.5	658212.5
15	BURNT SRV GAS	0.0	14325.03	0.00	643887.5	658212.5
16	FLUE	0.0	14325.03	0.00	643887.5	658212.5
17	PROCESS AIR	0.0	0.00	0.00	313145.7	313145.7
18	OXYGEN	0.0	0.00	0.00	47300.0	47300.0
19	O2 ENRICHED PROCESS AIR	0.0	0.00	0.00	360445.7	360445.7
20	HOT AIR BLAST	0.0	0.00	0.00	360445.7	360445.7
21	FINES+GAS	13893.7	0.00	0.00	166931.8	180825.5
22	PREHEATED FINES	13893.7	0.00	0.00	0.0	13893.7
23	GASES	0.0	0.00	0.00	166931.8	166931.8
24		0.0	0.00	0.00	658212.5	658212.5

HISMELT PROCESS

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-M3	SG-GC	SG-TC
1	ORE FINES	100.0000	4.9432	0.0000	0.0000	0.0000	4.9432
2	HOT ORE FINES+GASES	62.4708	4.9167	0.0000	0.0000	0.0004	0.0010
3	PREHEATED COARSE ORE	100.0000	4.9167	0.0000	0.0000	0.0000	4.9167
4	PREHEATED ORE	100.0000	4.9167	0.0000	0.0000	0.0000	4.9167
5	NATURAL GAS	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
6	COAL FLUX	100.0000	2.4691	0.0000	0.0000	0.0000	2.4691
7	HOT SRV GAS	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
8	SLAG	0.0000	0.0000	0.0000	3.0287	0.0000	3.0287
9	HOT METAL	100.0000	6.9301	0.0000	0.0000	0.0000	6.9301
10	HOT GASES FOR PREHEATER	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003
11	HOT GASES TO COOLER	0.0000	0.0000	0.0000	0.0000	0.0003	0.0003
12	COLD SRV GAS	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014
13	COMBUSTION AIR	0.0000	0.0000	0.0000	0.0000	0.0011	0.0011
14		0.0000	0.0000	0.3154	0.0000	0.0002	0.0002
15	BURNT SRV GAS	0.0000	0.0000	0.3154	0.0000	0.0003	0.0003
16	FLUE	0.0000	0.0000	0.3154	0.0000	0.0004	0.0004
17	PROCESS AIR	0.0000	0.0000	0.0000	0.0000	0.0011	0.0011
18	OXYGEN	0.0000	0.0000	0.0000	0.0000	0.0013	0.0013
19	O2 ENRICHED PROCESS AIR	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
20	HOT AIR BLAST	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
21	FINES+GAS	7.6835	4.9167	0.0000	0.0000	0.0004	0.0004
22	PREHEATED FINES	100.0000	4.9167	0.0000	0.0000	0.0000	4.9167
23	GASES	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004
24		0.0000	0.0000	0.0000	0.0000	0.0004	0.0004

HISMELT PROCESS

STREAM DATA

SOLIDS - KG/HR

NO.	STREAM	C	Fe	FeO	Fe2O3	Fe3O4	Al2O3	CaO
1	ORE FINES	0.0	0	0.0	235340	34440	0.00000	0.0
2	HOT ORE FINES+GASES	0.0	0	17067.5	0	243586	0.00000	0.0
3	PREHEATED COARSE ORE	0.0	0	16214.1	0	231407	0.00000	0.0
4	PREHEATED ORE	0.0	0	17067.5	0	243586	0.00000	0.0
6	COAL FLUX	95140.0	0	0.0	0	0	0.00000	32660.0
9	HOT METAL	10617.7	186682	0.0	0	0	0.00000	0.0
21	FINES+GAS	0.0	0	853.4	0	12179	0.00000	0.0
22	PREHEATED FINES	0.0	0	853.4	0	12179	0.00000	0.0

SOLIDS - KG/HR

NO.	STREAM	MgO	SiO2
1	ORE FINES	0.00000	17220.0
2	HOT ORE FINES+GASES	0.00000	17220.0
3	PREHEATED COARSE ORE	0.00000	16359.0
4	PREHEATED ORE	0.00000	17220.0
6	COAL FLUX	0.00000	14200.0
21	FINES+GAS	0.00000	861.0
22	PREHEATED FINES	0.00000	861.0

SOLIDS - WEIGHT PERCENT

NO.	STREAM	C	Fe	FeO	Fe2O3	Fe3O4	Al2O3	CaO
1	ORE FINES	0.0000	0.0000	0.00000	82.0000	12.0000	0.00000	0.0000
2	HOT ORE FINES+GASES	0.0000	0.0000	6.14219	0.0000	87.6607	0.00000	0.0000
3	PREHEATED COARSE ORE	0.0000	0.0000	6.14219	0.0000	87.6607	0.00000	0.0000
4	PREHEATED ORE	0.0000	0.0000	6.14219	0.0000	87.6607	0.00000	0.0000
6	COAL FLUX	67.0000	0.0000	0.00000	0.0000	0.0000	0.00000	23.0000
9	HOT METAL	5.3815	94.6185	0.00000	0.0000	0.0000	0.00000	0.0000
21	FINES+GAS	0.0000	0.0000	6.14219	0.0000	87.6607	0.00000	0.0000
22	PREHEATED FINES	0.0000	0.0000	6.14219	0.0000	87.6607	0.00000	0.0000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	MgO	SiO2
1	ORE FINES	0.00000	6.0000
2	HOT ORE FINES+GASES	0.00000	6.1971
3	PREHEATED COARSE ORE	0.00000	6.1971
4	PREHEATED ORE	0.00000	6.1971
6	COAL FLUX	0.00000	10.0000
21	FINES+GAS	0.00000	6.1971
22	PREHEATED FINES	0.00000	6.1971

AQUEOUS - KG/HR

NO.	STREAM	H2O
14		14325.0
15	BURNT SRV GAS	14325.0
16	FLUE	14325.0

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
14		100.000
15	BURNT SRV GAS	100.000
16	FLUE	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
14		315.448
15	BURNT SRV GAS	315.448
16	FLUE	315.448

HISMELT PROCESS

STREAM DATA

MOLTEN3 - KG/HR

NO.	STREAM	Al2O3	CaO	MgO	SiO2	FeO
8	SLAG	0.00000	32660.0	0.00000	31420.0	3657.33

MOLTEN3 - WEIGHT PERCENT

NO.	STREAM	Al2O3	CaO	MgO	SiO2	FeO
8	SLAG	0.00000	48.2157	0.00000	46.3851	5.39928

GASEOUS - KG/HR

NO.	STREAM	CO	CO2	H2	H2O	N2	O2	C5H8
2	HOT ORE FINES+GASES	28718.7	56622	0.00000	7233.52	74357	0	0.00000
7	HOT SRV GAS	74009.7	193414	0.00000	0.00	247858	0	0.00000
10	HOT GASES FOR PREHEATER	22202.9	58024	0.00000	0.00	74357	0	0.00000
11	HOT GASES TO COOLER	51806.8	135390	0.00000	0.00	173501	0	0.00000
12	COLD SRV GAS	51806.8	135390	0.00000	0.00	173501	0	0.00000
13	COMBUSTION AIR	0.0	0	0.00000	0.00	229100	60900	0.00000
14		0.0	237404	0.00000	2553.18	402601	1329	0.00000
15	BURNT SRV GAS	0.0	237404	0.00000	2553.18	402601	1329	0.00000
16	FLUE	0.0	237404	0.00000	2553.18	402601	1329	0.00000
17	PROCESS AIR	0.0	0	0.00000	0.00	247385	65761	0.00000
18	OXYGEN	0.0	0	0.00000	0.00	473	46827	0.00000
19	O2 ENRICHED PROCESS AIR	0.0	0	0.00000	0.00	247858	112588	0.00000
20	HOT AIR BLAST	0.0	0	0.00000	0.00	247858	112588	0.00000
21	FINES+GAS	28718.7	56622	0.00000	7233.52	74357	0	0.00000
23	GASES	28718.7	56622	0.00000	7233.52	74357	0	0.00000
24		51806.8	135390	0.00000	0.00	402601	60900	0.00000

GASEOUS - KG/HR

NO.	STREAM	CH4
5	NATURAL GAS	10736.0
7	HOT SRV GAS	10736.0
10	HOT GASES FOR PREHEATER	3220.8
11	HOT GASES TO COOLER	7515.2
12	COLD SRV GAS	7515.2
24		7515.2

GASEOUS - WEIGHT PERCENT

NO.	STREAM	CO	CO2	H2	H2O	N2	O2	C5H8
2	HOT ORE FINES+GASES	17.2038	33.9193	0.00000	4.33322	44.5436	0.0000	0.00000
7	HOT SRV GAS	14.0698	36.7695	0.00000	0.00000	47.1197	0.0000	0.00000
10	HOT GASES FOR PREHEATER	14.0698	36.7695	0.00000	0.00000	47.1197	0.0000	0.00000
11	HOT GASES TO COOLER	14.0698	36.7695	0.00000	0.00000	47.1197	0.0000	0.00000
12	COLD SRV GAS	14.0698	36.7695	0.00000	0.00000	47.1197	0.0000	0.00000
13	COMBUSTION AIR	0.0000	0.0000	0.00000	0.00000	79.0000	21.0000	0.00000
14		0.0000	36.8705	0.00000	0.39653	62.5266	0.2065	0.00000
15	BURNT SRV GAS	0.0000	36.8705	0.00000	0.39653	62.5266	0.2065	0.00000
16	FLUE	0.0000	36.8705	0.00000	0.39653	62.5266	0.2065	0.00000
17	PROCESS AIR	0.0000	0.0000	0.00000	0.00000	79.0000	21.0000	0.00000
18	OXYGEN	0.0000	0.0000	0.00000	0.00000	1.0000	99.0000	0.00000
19	O2 ENRICHED PROCESS AIR	0.0000	0.0000	0.00000	0.00000	68.7643	31.2357	0.00000
20	HOT AIR BLAST	0.0000	0.0000	0.00000	0.00000	68.7643	31.2357	0.00000
21	FINES+GAS	17.2038	33.9193	0.00000	4.33322	44.5436	0.0000	0.00000
23	GASES	17.2038	33.9193	0.00000	4.33322	44.5436	0.0000	0.00000
24		7.8708	20.5693	0.00000	0.00000	61.1658	9.2523	0.00000

HISMELT PROCESS

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	CH4
5	NATURAL GAS	100.000
7	HOT SRV GAS	2.041
10	HOT GASES FOR PREHEATER	2.041
11	HOT GASES TO COOLER	2.041
12	COLD SRV GAS	2.041
24		1.142

GASEOUS - VOLUME PERCENT

NO.	STREAM	CO	CO2	H2	H2O	N2	O2	C5H8
2	HOT ORE FINES+GASES	19.1008	23.9687	0.00000	7.48026	49.4502	0.0000	0.00000
7	HOT SRV GAS	15.9611	26.5481	0.00000	0.00000	53.4483	0.0000	0.00000
10	HOT GASES FOR PREHEATER	15.9611	26.5481	0.00000	0.00000	53.4483	0.0000	0.00000
11	HOT GASES TO COOLER	15.9611	26.5481	0.00000	0.00000	53.4483	0.0000	0.00000
12	COLD SRV GAS	15.9611	26.5481	0.00000	0.00000	53.4483	0.0000	0.00000
13	COMBUSTION AIR	0.0000	0.0000	0.00000	0.00000	81.1218	18.8782	0.00000
14		0.0000	27.0402	0.00000	0.71041	72.0412	0.2082	0.00000
15	BURNT SRV GAS	0.0000	27.0402	0.00000	0.71041	72.0412	0.2082	0.00000
16	FLUE	0.0000	27.0402	0.00000	0.71041	72.0412	0.2082	0.00000
17	PROCESS AIR	0.0000	0.0000	0.00000	0.00000	81.1218	18.8782	0.00000
18	OXYGEN	0.0000	0.0000	0.00000	0.00000	1.1406	98.8594	0.00000
19	O2 ENRICHED PROCESS AIR	0.0000	0.0000	0.00000	0.00000	71.5478	28.4522	0.00000
20	HOT AIR BLAST	0.0000	0.0000	0.00000	0.00000	71.5478	28.4522	0.00000
21	FINES+GAS	19.1008	23.9687	0.00000	7.48026	49.4502	0.0000	0.00000
23	GASES	19.1008	23.9687	0.00000	7.48026	49.4502	0.0000	0.00000
24		8.5354	14.1968	0.00000	0.00000	66.3231	8.7829	0.00000

GASEOUS - VOLUME PERCENT

NO.	STREAM	CH4
5	NATURAL GAS	100.000
7	HOT SRV GAS	4.043
10	HOT GASES FOR PREHEATER	4.043
11	HOT GASES TO COOLER	4.043
12	COLD SRV GAS	4.043
24		2.162

APPENDIX E-5:

REDSMELT ROTARY HEARTH FURNACE

REDSMELT PROCESS

PROCESS BACKGROUND:

The Redsmelt process is based upon a rotary hearth furnace which reduces green pellets made out of iron ore, reductant fines and binders to produce hot, metallized DRI that is charged to a Submerged Arc Furnace. The process operates at high temperature and atmospheric pressure.

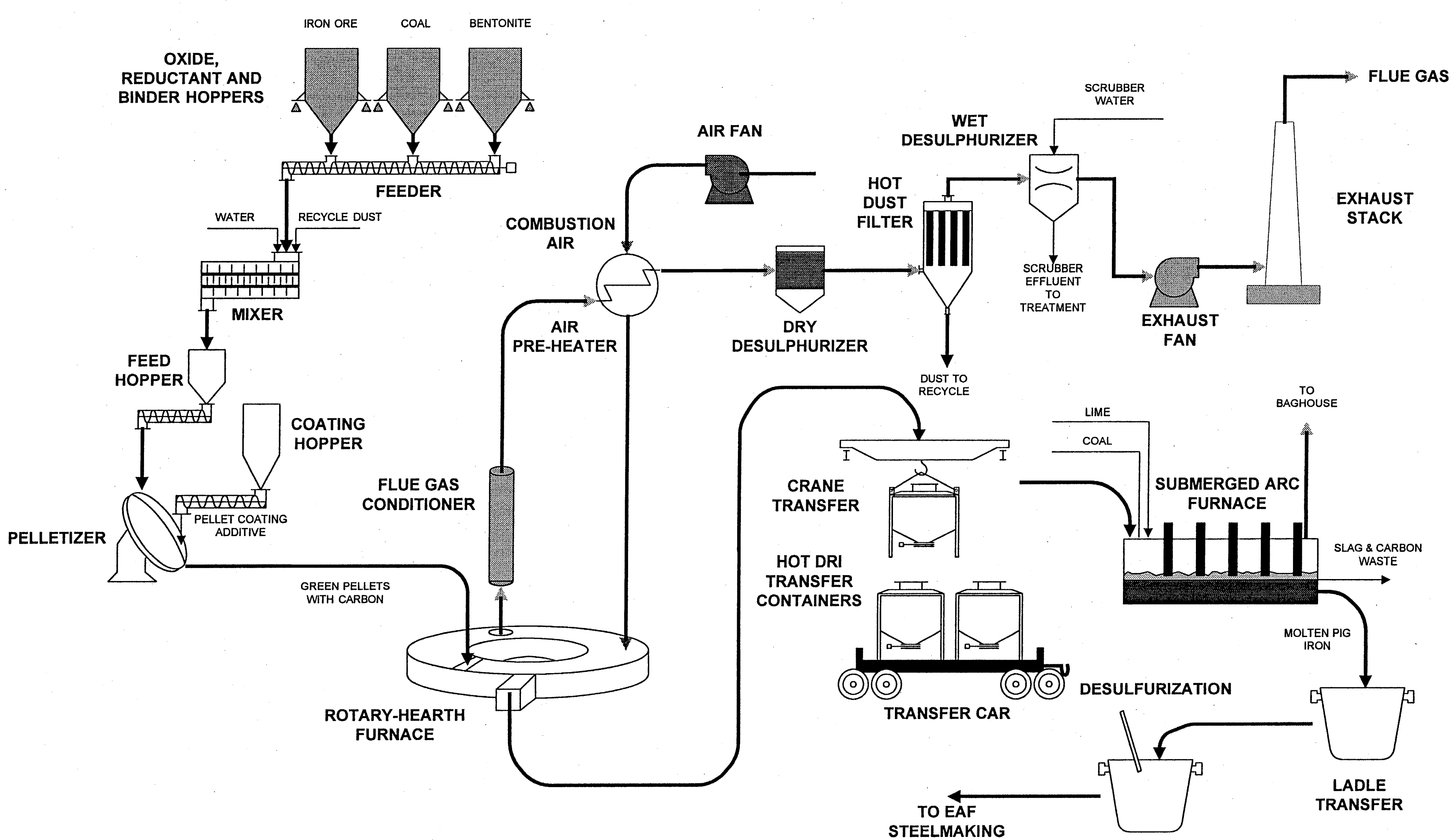
PROCESS DESCRIPTION:

The iron oxide feed to a Redsmelt furnace is in the form of green pellets made of fine iron ore, reductant and binders. Binders are to give to the green pellets sufficient mechanical strength to support the handling shocks downstream. Pellets are screened on a roller-type screen to a size between 8 to 16 mm. Under and oversize materials are recirculated to feed the pelletizing disks. Pellets are then distributed onto the RHF in a layer up to 30 kg/m2. While travelling throughout the furnace in 12 to 18 minutes, pellets are heated up to 1370C. Drying of the pellets, coal devotalitization and iron oxide reduction takes place during the heating process. The intimate contact between iron oxide and carbon at a very high temperature results in a very fast reaction rate. To prevent reoxidation of metallized iron the final zones of the furnace are operated in sub-stoichiometric atmosphere. The hot DRI product is then fed to the submerged arc furnace (SAF) for smelting into Hot metal and slag.

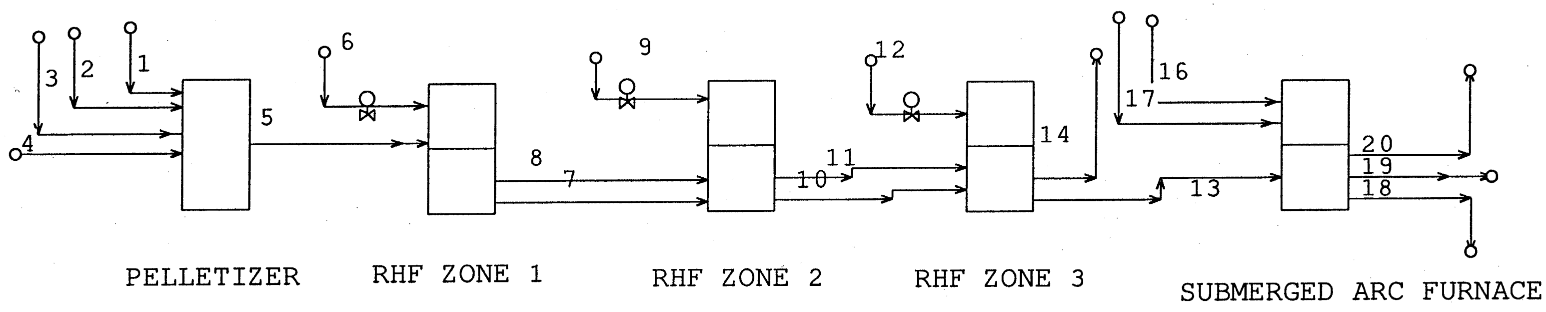
PROCESS ADVANTAGES

Iron ore fines as raw material
Wide variety of solid reductants
Less reduction time (12 to 18 minutes)
Proven equipment usage

MANNESMANN DEMAG REDSMELT PROCESS FLOWSHEET



REDSMELT PROCESS –



REDSMELT PROCESS

Redsmelt Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a basic flowsheet developed by Mannesmann Demag.

Flowsheet Description

Iron ore fines (Stream 1), coal (Stream 2) and an organic or inorganic binder (Stream 3) are mixed with water and pelletized on a disc to green pellets. Then the pellets pass through three furnace zones: Heating (RHF Zone 1), Main Reduction (RHF Zone 2) and Final Reduction (RHF Zone 3). The temperature in the three zones is adjusted with the burners and the air to match the process requirement. In Zone 1, the pellets are heated so that all moisture is released, the coal is volatilized and some reduction takes place. This generates streams 7 (solids) and 8 (gases). In Zone 2, main reduction takes place. Then the solids (stream 10) and gases (Stream 11) enter in third zone where final reduction takes place. This leads to the formation of DRI (Stream 13) and the gases (Stream 14) go to the exhaust after some treatment to control hazardous emissions. DRI is then conveyed to a Submerged Arc Furnace where some coal(Stream 16) and lime (stream 17) are added. This leads to separation of slag (Stream 19) from hot metal (Stream 18). Gases from the SAF (Stream 20) have lots of calorific value and can be used elsewhere.

Model Assumptions:

RHF Zone 1: Partial reduction of iron ore to Fe_3O_4 takes place in this zone.

RHF Zone 2: Reduction of Fe_3O_4 to FeO takes place in this zone.

RHF Zone 3: Reduction of FeO to Fe takes place in this zone.

Submerged Arc Furnace: Separation of Slag from Hot metal occurs here.

Results

With the information available about the rotary hearth furnace, several estimates have been made in the model. A more complete analysis can be carried out on receiving more information about the process flows and conditions.

REDSMELT PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8
Description	Iron Ore	Coal	Binder	Water	Green Pellet	Combustion	Pellets from	Gases from Z
KG/HR SOLIDS	1446	490.2	16	0	1952.2	0	1739.3	0
KG/HR AQUEOUS	0	25.8	0	100	125.8	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	0
KG/HR GASEOUS	0	0	0	0	0	1261.5	0	1600.1
KG/HR TOTAL	1446	516	16	100	2078	1261.5	1739.3	1600.1
Percent Solids	100	95	100	0	93.946	0	100	0
Sp.Gr.SOLIDS	5.1103	1.6075	3.31	0	3.2935	0	4.1027	0
Sp.Gr.AQUEOUS	0	0.99712	0	0.99712	0.99712	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0	0	0	0	0.0006132	0	0.00019492
Sp.Gr.TOTAL	5.1103	1.5598	3.31	0.99712	2.8905	0.0006132	4.1027	0.00019492
Temperature C	25	25	25	25	25	300	1400	1400
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	0	0	0	0	980.41	0	1340.2
Sol/Liq m3/hr	0.28296	0.33082	0.0048338	0.10029	0.7189	0	0.42395	0
Component Mass Flow Rates								
1 CaO KG/HR	14.46	0	16	0	30.46	0	30.46	0
2 CaO KG/HR	0	0	0	0	0	0	0	0
3 CO KG/HR	0	0	0	0	0	0	0	280.82
4 CO2 KG/HR	0	0	0	0	0	0	0	128.85
5 C KG/HR	0	372.55	0	0	372.55	0	294.76	0
6 Fe KG/HR	0	0	0	0	0	0	0	0
7 FeO KG/HR	0	0	0	0	0	0	0	0
8 Fe2O3 KG/HR	1402.6	0	0	0	1402.6	0	0	0
9 Fe3O4 KG/HR	0	0	0	0	0	0	1355.8	0
10 H2O KG/HR	0	25.8	0	100	125.8	0	0	0
11 H2O KG/HR	0	0	0	0	0	0	0	219.14
12 N2 KG/HR	0	0	0	0	0	971.33	0	971.33
13 O2 KG/HR	0	0	0	0	0	290.14	0	0
14 SiO2 KG/HR	28.92	29.412	0	0	58.332	0	58.332	0
15 SiO2 KG/HR	0	0	0	0	0	0	0	0
16 C5H8 KG/HR	0	88.236	0	0	88.236	0	0	0
17 C5H8 KG/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	0	13.332	0	11.19	24.522	0	0	24.522
2 C 6	0	450.34	0	0	450.34	0	294.76	155.58
3 N 7	0	0	0	0	0	971.33	0	971.33
4 O 8	441.11	38.577	4.5648	88.81	573.06	290.14	414.49	448.7
5 Si 14	13.518	13.748	0	0	27.267	0	27.267	0
6 Ca 20	10.335	0	11.435	0	21.77	0	21.77	0
7 Fe 26	981.04	0	0	0	981.04	0	981.04	0

REDSMELT PROCESS --- STREAM SUMMARY

Stream Number	9	10	11	12	13	14	16	17
Description	Combustion	Pellets from	Gases from	Combustion	DRI	Gases from	Coal	Lime
KG/HR SOLIDS	0	1610.5	0	0	1153.6	0	40	60
KG/HR AQUEOUS	0	0	0	0	0	0	0	0
KG/HR MOLTEN3	0	0	0	0	0	0	0	0
KG/HR GASEOUS	0.001	0	1729	0.86988	0	2186.7	0	0
KG/HR TOTAL	0.001	1610.5	1729	0.86988	1153.6	2186.7	40	60
Percent Solids	0	100	0	0	100	0	100	100
Sp.Gr.SOLIDS	0	4.3762	0	0	6.103	0	1.6075	3.31
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0
Sp.Gr.MOLTEN3	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.0006132	0	0.00020078	0.0006132	0	0.00019687	0	0
Sp.Gr.TOTAL	0.0006132	4.3762	0.00020078	0.0006132	6.103	0.00019687	1.6075	3.31
Temperature C	300	1400	1400	300	1100	1400	25	25
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0.0007772	0	1405.8	0.67607	0	1813.2	0	0
Sol/Liq m3/hr	0	0.36801	0	0	0.18903	0	0.024883	0.018127
Component Mass Flow Rates								
1 CaO KG/HR	0	30.46	0	0	30.46	0	0	60
2 CaO KG/HR	0	0	0	0	0	0	0	0
3 CO KG/HR	0	0	280.82	0	0	879.15	0	0
4 CO2 KG/HR	0	0	257.7	0	0	116.22	0	0
5 C KG/HR	0	259.6	0	0	41.638	0	30.4	0
6 Fe KG/HR	0	0	0	0	833.88	0	0	0
7 FeO KG/HR	0	1262.1	0	0	189.31	0	0	0
8 Fe2O3 KG/HR	0	0	0	0	0	0	0	0
9 Fe3O4 KG/HR	0	0	0	0	0	0	0	0
10 H2O KG/HR	0	0	0	0	0	0	0	0
11 H2O KG/HR	0	0	219.14	0	0	219.14	0	0
12 N2 KG/HR	0.00077	0	971.34	0.66981	0	972.01	0	0
13 O2 KG/HR	0.00023	0	0.00023	0.20007	0	0.2003	0	0
14 SiO2 KG/HR	0	58.332	0	0	58.332	0	2.4	0
15 SiO2 KG/HR	0	0	0	0	0	0	0	0
16 C5H8 KG/HR	0	0	0	0	0	0	7.2	0
17 C5H8 KG/HR	0	0	0	0	0	0	0	0
Element Mass Flow Rates								
1 H 1	0	0	24.522	0	0	24.522	0.85231	0
2 C 6	0	259.6	190.75	0	41.638	408.7	36.748	0
3 N 7	0.00077	0	971.34	0.66981	0	972.01	0	0
4 O 8	0.00023	320.81	542.39	0.20007	81.914	781.49	1.2781	17.118
5 Si 14	0	27.267	0	0	27.267	0	1.1219	0
6 Ca 20	0	21.77	0	0	21.77	0	0	42.882
7 Fe 26	0	981.04	0	0	981.04	0	0	0

REDSMELT PROCESS --- STREAM SUMMARY

Stream Number	18	19	20
Description	Hot Metal	Slag	Gases from SAF
KG/HR SOLIDS	1021.8	0	0
KG/HR AQUEOUS	0	0	0
KG/HR MOLTEN3	0	151.19	0
KG/HR GASEOUS	0	0	80.638
KG/HR TOTAL	1021.8	151.19	80.638
Percent Solids	100	0	0
Sp.Gr.SOLIDS	7.1501	0	0
Sp.Gr.AQUEOUS	0	0	0
Sp.Gr.MOLTEN3	0	3.009	0
Sp.Gr.GASEOUS	0	0	0.00042395
Sp.Gr.TOTAL	7.1501	3.009	0.00042395
Temperature C	576.54	576.54	576.54
Pressure kPa	101.33	101.33	101.33
Gas nm3/hr	0	0	61.134
Sol/Liq m3/hr	0.14291	0.050247	0
Component Mass Flow Rates			
1 CaO KG/HR	0	0	0
2 CaO KG/HR	0	90.46	0
3 CO KG/HR	0	0	73.438
4 CO2 KG/HR	0	0	0
5 C KG/HR	40.547	0	0
6 Fe KG/HR	980.3	0	0
7 FeO KG/HR	0.94657	0	0
8 Fe2O3 KG/HR	0	0	0
9 Fe3O4 KG/HR	0	0	0
10 H2O KG/HR	0	0	0
11 H2O KG/HR	0	0	0
12 N2 KG/HR	0	0	0
13 O2 KG/HR	0	0	0
14 SiO2 KG/HR	0	0	0
15 SiO2 KG/HR	0	60.732	0
16 C5H8 KG/HR	0	0	0
17 C5H8 KG/HR	0	0	7.2
Element Mass Flow Rates			
1 H 1	0	0	0.85231
2 C 6	40.547	0	37.839
3 N 7	0	0	0
4 O 8	0.21079	58.152	41.947
5 Si 14	0	28.389	0
6 Ca 20	0	64.652	0
7 Fe 26	981.04	0	0

REDSMELT PROCESS

CASE DEFINITION

Title : REDSMELT PROCESS
Case :

Data Storage File Name	:	Redsmelt2.sfw
Mass Balance Option	:	ON
Heat Balance Option	:	ON
Units of Mass	:	kilogram
Units of Time	:	hour
Ambient Air Pressure	:	101.325 kPa
Standard Pressure	:	101.325 kPa
Ambient Air Temperature	:	20.00 C
Standard Temperature	:	0.00 C
Plant Site Latitude	:	0.00 Degrees
Plant Site Elevation	:	0.00 Meters

REDSMELT PROCESS

COMPONENT DATA

ROW	CNM	CHF			PHC	CMW	SGF
1	CaO	CaO	SI1	56.0794	3.3100	0.0000	0.0000
2	CaO	CaO	M37	56.0794	3.3100	0.0000	0.0000
3	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000
4	CO2	CO2	GC8	44.0100	0.0020	0.0000	0.0000
5	C	C	SI1	12.0112	2.2500	0.0000	0.0000
6	Fe	Fe	SI1	55.8470	7.8600	0.0000	0.0000
7	FeO	FeO	SI1	71.8464	5.7000	0.0000	0.0000
8	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
9	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
10	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
11	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
12	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
13	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
14	SiO2	SiO2	SI1	60.0848	2.6500	0.0000	0.0000
15	SiO2	SiO2	M37	60.0848	2.6500	0.0000	0.0000
16	C5H8	C5H8	SI1	68.1195	0.6879	0.2491	0.2690
17	C5H8	C5H8	GC8	68.1195	0.0030	0.2491	0.2690

ROW	CNM	SOL	A	B	C	pH	Wi	COV A B C		
1	CaO	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	CaO	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	CO	23.77	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	CO2	1950.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	C	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	Fe	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	FeO	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8	Fe2O3	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	Fe3O4	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
10	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
12	N2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13	O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14	SiO2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	SiO2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
16	C5H8	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
17	C5H8	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

ROW	CNM	CRIT T	CRIT P	CRIT V	ANTOINE VAPOR PRES A B C			HENRY
1	CaO	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
2	CaO	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
3	CO	133.400	35.4638	93.100	6.24020	230.27	260.010	63426.0
4	CO2	304.200	74.8792	94.800	9.81060	1347.79	273.000	1215.7
5	C	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
6	Fe	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
7	FeO	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
8	Fe2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
9	Fe3O4	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
10	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
11	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
12	N2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
13	O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
14	SiO2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
15	SiO2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
16	C5H8	503.000	41.2393	276.000	6.91820	1104.99	228.851	0.0
17	C5H8	503.000	41.2393	276.000	6.91820	1104.99	228.851	0.0

REDSMELT PROCESS

COMPONENT DATA

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	CaO	B672098	-151790	-4315	12.0730	0.4606	2.0088
2	CaO	B672098	-151790	-4315	12.0730	0.4606	2.0088
3	CO	YAWS	-26420	-1787	6.0661	0.9368	-0.3112
4	CO2	YAWS	-94050	-3105	8.4720	2.5871	1.0415
5	C	B672086	0	-2999	5.1802	0.2246	4.3597
6	Fe	B672151	0	-7903	14.0914	-1.3293	11.6233
7	FeO	B672157	-65000	-3998	12.1207	1.0479	0.8685
8	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
9	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
10	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
11	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
12	N2	B672244	0	-2846	7.5728	0.2525	1.7794
13	O2	B672277	0	-2979	7.9696	0.2720	1.7697
14	SiO2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
15	SiO2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
16	C5H8	YAWS	27950	-8316	19.7382	30.7726	-0.9067
17	C5H8	YAWS	27950	-8316	19.7382	30.7726	-0.9067

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	CaO	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
2	CaO	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
3	CO	298.0	700.0	-25393	-46.6664	-5.1645	-2.2650
4	CO2	298.0	700.0	-93224	-48.5944	-8.4916	-2.4252
5	C	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
6	Fe	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
7	FeO	298.2	1600.0	-60048	-19.0598	-5.9536	-9.2221
8	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
9	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
10	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
11	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
12	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
13	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
14	SiO2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
15	SiO2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
16	C5H8	135.9	318.0	23803	-68.4779	-61.0649	-1.8797
17	C5H8	135.9	318.0	23803	-68.4779	-61.0649	-1.8797

ROW	CNM	PRES RANGE kPa	
1	CaO	0.0	0.0
2	CaO	0.0	0.0
3	CO	0.0	0.0
4	CO2	0.0	0.0
5	C	0.0	0.0
6	Fe	0.0	0.0
7	FeO	0.0	0.0
8	Fe2O3	0.0	0.0
9	Fe3O4	0.0	0.0
10	H2O	0.0	0.0
11	H2O	50.0	120.0
12	N2	0.0	0.0
13	O2	0.0	0.0
14	SiO2	0.0	0.0
15	SiO2	0.0	0.0
16	C5H8	0.0	0.0
17	C5H8	0.0	0.0

REDSMELT PROCESS

FLOWSHEET DATA

NO	OPR	UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC	REDSMELT PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	MIX	PELLETIZER	1	2	3	4	0	0	0	5	0	0	0	0	0
3	SPP	RHF ZONE 1	6	5	0	0	0	0	0	7	8	0	0	0	0
4	SPP	RHF ZONE 2	9	0	0	8	7	0	0	10	11	0	0	0	0
5	SPP	RHF ZONE 3	12	0	0	11	10	0	0	13	14	0	0	0	0
6	SPP	SUBMERGED ARC FURNACE	16	17	0	13	0	0	0	18	19	20	0	0	0

REDSMELT PROCESS

HEAT BALANCE SUMMARY - 1000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	REDSMELT PROCESS	0	0	0	0	0	0	0	0
2	PELLETIZER	1	0	0	0	0	0	-1	0
3	RHF ZONE 1	85	637	0	0	0	561	-1283	0
4	RHF ZONE 2	1283	-148	0	0	0	126	-1261	0
5	RHF ZONE 3	1261	-709	0	0	0	598	-1151	0
6	SUBMERGED ARC FU	226	-101	0	0	-6	0	-118	0

REDSMELT PROCESS

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1	Iron Ore	25.00	77.00	240.00	953.0	1004.0
2	Coal	25.00	77.00	856.00	3395.0	3580.0
3	Binder	25.00	77.00	0.00	-1.0	-1.0
4	Water	25.00	77.00	0.00	0.0	0.0
5	Green Pellets	25.00	77.00	1096.00	4347.0	4584.0
6	Combustion Air	300.00	572.00	83455.00	331177.0	349177.0
7	Pellets from Zone 1	1400.00	2552.00	587002.00	2329413.0	2456017.0
8	Gases from Zone 1	1400.00	2552.00	696261.00	2762986.0	2913155.0
9	Combustion Air	300.00	572.00	0.00	0.0	0.0
10	Pellets from Zone 2	1400.00	2552.00	511340.00	2029162.0	2139448.0
11	Gases from Zone 2	1400.00	2552.00	750057.00	2976465.0	3138237.0
12	Combustion Air	300.00	572.00	58.00	228.0	241.0
13	DRI	1100.00	2012.00	225639.00	895408.0	944074.0
14	Gases from RHF	1400.00	2552.00	925556.00	3672902.0	3872525.0
15	Air	25.00	77.00	418.00	1658.0	1748.0
16	Coal	25.00	77.00	70.00	277.0	292.0
17	Lime	25.00	77.00	-1.00	-2.0	-2.0
18	Hot Metal	576.54	1069.78	85718.00	340156.0	358644.0
19	Slag	576.54	1069.78	18878.00	74914.0	78986.0
20	Gases from SAF	576.54	1069.78	13735.00	54505.0	57468.0

REDSMELT PROCESS

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
6	Combustion Air	100.0000	1210.822	577.050	2057.20	980.413
8	Gases from Zone 1	100.0000	4831.826	788.789	8209.33	1340.161
9	Combustion Air	100.0000	0.001	0.000	0.00	0.001
11	Gases from Zone 2	100.0000	5068.443	827.413	8611.34	1405.784
12	Combustion Air	100.0000	0.835	0.398	1.42	0.676
14	Gases from RHF	100.0000	6537.567	1067.204	11107.40	1813.190
15	Air	100.0000	219.851	201.416	373.53	342.209
20	Gases from SAF	100.0000	111.951	35.982	190.21	61.134

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore	100.0000	1.245816	0.078599	0.282957	6.79098
2	Coal	100.0000	1.456539	0.091894	0.330818	7.93963
3	Binder	100.0000	0.021283	0.001343	0.004834	0.11601
4	Water	100.0000	0.441558	0.027858	0.100289	2.40694
5	Green Pellets	100.0000	3.165196	0.199694	0.718898	17.25356
7	Pellets from Zone 1	100.0000	1.866596	0.117765	0.423953	10.17486
10	Pellets from Zone 2	100.0000	1.620290	0.102225	0.368010	8.83224
13	DRI	100.0000	0.832248	0.052507	0.189025	4.53661
16	Coal	100.0000	0.109557	0.006912	0.024883	0.59720
17	Lime	100.0000	0.079810	0.005035	0.018127	0.43505
18	Hot Metal	100.0000	0.629199	0.039697	0.142907	3.42978
19	Slag	100.0000	0.221230	0.013958	0.050247	1.20593

MASS FLOW RATES - KG/HR

NO.	STREAM	KG/HR-SI	KG/HR-LI	KG/HR-M3	KG/HR-GC	KG/HR-TC
1	Iron Ore	1446.000	0.0000	0.0000	0.000	1446.000
2	Coal	490.200	25.8000	0.0000	0.000	516.000
3	Binder	16.000	0.0000	0.0000	0.000	16.000
4	Water	0.000	100.0000	0.0000	0.000	100.000
5	Green Pellets	1952.200	125.8000	0.0000	0.000	2078.000
6	Combustion Air	0.000	0.0000	0.0000	1261.474	1261.474
7	Pellets from Zone 1	1739.331	0.0000	0.0000	0.000	1739.331
8	Gases from Zone 1	0.000	0.0000	0.0000	1600.143	1600.143
9	Combustion Air	0.000	0.0000	0.0000	0.001	0.001
10	Pellets from Zone 2	1610.480	0.0000	0.0000	0.000	1610.480
11	Gases from Zone 2	0.000	0.0000	0.0000	1728.994	1728.994
12	Combustion Air	0.000	0.0000	0.0000	0.870	0.870
13	DRI	1153.627	0.0000	0.0000	0.000	1153.627
14	Gases from RHF	0.000	0.0000	0.0000	2186.718	2186.718
15	Air	0.000	0.0000	0.0000	440.311	440.311
16	Coal	40.000	0.0000	0.0000	0.000	40.000
17	Lime	60.000	0.0000	0.0000	0.000	60.000
18	Hot Metal	1021.797	0.0000	0.0000	0.000	1021.797
19	Slag	0.000	0.0000	151.1920	0.000	151.192
20	Gases from SAF	0.000	0.0000	0.0000	80.638	80.638

REDSMELT PROCESS

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-M3	SG-GC	SG-TC
1	Iron Ore	100.0000	5.1103	0.0000	0.0000	0.0000	5.1103
2	Coal	95.0000	1.6075	0.9971	0.0000	0.0000	1.5598
3	Binder	100.0000	3.3100	0.0000	0.0000	0.0000	3.3100
4	Water	0.0000	0.0000	0.9971	0.0000	0.0000	0.9971
5	Green Pellets	93.9461	3.2935	0.9971	0.0000	0.0000	2.8905
6	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
7	Pellets from Zone 1	100.0000	4.1027	0.0000	0.0000	0.0000	4.1027
8	Gases from Zone 1	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
9	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
10	Pellets from Zone 2	100.0000	4.3762	0.0000	0.0000	0.0000	4.3762
11	Gases from Zone 2	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
12	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
13	DRI	100.0000	6.1030	0.0000	0.0000	0.0000	6.1030
14	Gases from RHF	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
15	Air	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
16	Coal	100.0000	1.6075	0.0000	0.0000	0.0000	1.6075
17	Lime	100.0000	3.3100	0.0000	0.0000	0.0000	3.3100
18	Hot Metal	100.0000	7.1501	0.0000	0.0000	0.0000	7.1501
19	Slag	0.0000	0.0000	0.0000	3.0090	0.0000	3.0090
20	Gases from SAF	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004

REDSMELT PROCESS

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
6	Combustion Air	100.0000	1210.822	577.050	2057.20	980.413
8	Gases from Zone 1	100.0000	4831.826	788.789	8209.33	1340.161
9	Combustion Air	100.0000	0.001	0.000	0.00	0.001
11	Gases from Zone 2	100.0000	5068.443	827.413	8611.34	1405.784
12	Combustion Air	100.0000	0.835	0.398	1.42	0.676
14	Gases from RHF	100.0000	6537.567	1067.204	11107.40	1813.190
15	Air	100.0000	219.851	201.416	373.53	342.209
20	Gases from SAF	100.0000	111.951	35.982	190.21	61.134

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore	100.0000	1.245816	0.078599	0.282957	6.79098
2	Coal	100.0000	1.456539	0.091894	0.330818	7.93963
3	Binder	100.0000	0.021283	0.001343	0.004834	0.11601
4	Water	100.0000	0.441558	0.027858	0.100289	2.40694
5	Green Pellets	100.0000	3.165196	0.199694	0.718898	17.25356
7	Pellets from Zone 1	100.0000	1.866596	0.117765	0.423953	10.17486
10	Pellets from Zone 2	100.0000	1.620290	0.102225	0.368010	8.83224
13	DRI	100.0000	0.832248	0.052507	0.189025	4.53661
16	Coal	100.0000	0.109557	0.006912	0.024883	0.59720
17	Lime	100.0000	0.079810	0.005035	0.018127	0.43505
18	Hot Metal	100.0000	0.629199	0.039697	0.142907	3.42978
19	Slag	100.0000	0.221230	0.013958	0.050247	1.20593

MASS FLOW RATES - KG/HR

NO.	STREAM	KG/HR-SI	KG/HR-LI	KG/HR-M3	KG/HR-GC	KG/HR-TC
1	Iron Ore	1446.000	0.0000	0.0000	0.000	1446.000
2	Coal	490.200	25.8000	0.0000	0.000	516.000
3	Binder	16.000	0.0000	0.0000	0.000	16.000
4	Water	0.000	100.0000	0.0000	0.000	100.000
5	Green Pellets	1952.200	125.8000	0.0000	0.000	2078.000
6	Combustion Air	0.000	0.0000	0.0000	1261.474	1261.474
7	Pellets from Zone 1	1739.331	0.0000	0.0000	0.000	1739.331
8	Gases from Zone 1	0.000	0.0000	0.0000	1600.143	1600.143
9	Combustion Air	0.000	0.0000	0.0000	0.001	0.001
10	Pellets from Zone 2	1610.480	0.0000	0.0000	0.000	1610.480
11	Gases from Zone 2	0.000	0.0000	0.0000	1728.994	1728.994
12	Combustion Air	0.000	0.0000	0.0000	0.870	0.870
13	DRI	1153.627	0.0000	0.0000	0.000	1153.627
14	Gases from RHF	0.000	0.0000	0.0000	2186.718	2186.718
15	Air	0.000	0.0000	0.0000	440.311	440.311
16	Coal	40.000	0.0000	0.0000	0.000	40.000
17	Lime	60.000	0.0000	0.0000	0.000	60.000
18	Hot Metal	1021.797	0.0000	0.0000	0.000	1021.797
19	Slag	0.000	0.0000	151.1920	0.000	151.192
20	Gases from SAF	0.000	0.0000	0.0000	80.638	80.638

REDSMELT PROCESS

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-M3	SG-GC	SG-TC
1	Iron Ore	100.0000	5.1103	0.0000	0.0000	0.0000	5.1103
2	Coal	95.0000	1.6075	0.9971	0.0000	0.0000	1.5598
3	Binder	100.0000	3.3100	0.0000	0.0000	0.0000	3.3100
4	Water	0.0000	0.0000	0.9971	0.0000	0.0000	0.9971
5	Green Pellets	93.9461	3.2935	0.9971	0.0000	0.0000	2.8905
6	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
7	Pellets from Zone 1	100.0000	4.1027	0.0000	0.0000	0.0000	4.1027
8	Gases from Zone 1	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
9	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
10	Pellets from Zone 2	100.0000	4.3762	0.0000	0.0000	0.0000	4.3762
11	Gases from Zone 2	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
12	Combustion Air	0.0000	0.0000	0.0000	0.0000	0.0006	0.0006
13	DRI	100.0000	6.1030	0.0000	0.0000	0.0000	6.1030
14	Gases from RHF	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002
15	Air	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
16	Coal	100.0000	1.6075	0.0000	0.0000	0.0000	1.6075
17	Lime	100.0000	3.3100	0.0000	0.0000	0.0000	3.3100
18	Hot Metal	100.0000	7.1501	0.0000	0.0000	0.0000	7.1501
19	Slag	0.0000	0.0000	0.0000	3.0090	0.0000	3.0090
20	Gases from SAF	0.0000	0.0000	0.0000	0.0000	0.0004	0.0004

REDSMELT PROCESS

STREAM DATA

SOLIDS - KG/HR

NO.	STREAM	CaO	C	Fe	FeO	Fe2O3	Fe3O4	SiO2
1	Iron Ore	14.4600	0.000	0.000	0.00	1402.62	0.00	28.9200
2	Coal	0.0000	372.552	0.000	0.00	0.00	0.00	29.4120
3	Binder	16.0000	0.000	0.000	0.00	0.00	0.00	0.0000
5	Green Pellets	30.4600	372.552	0.000	0.00	1402.62	0.00	58.3320
7	Pellets from Zone 1	30.4600	294.761	0.000	0.00	0.00	1355.78	58.3320
10	Pellets from Zone 2	30.4600	259.595	0.000	1262.09	0.00	0.00	58.3320
13	DRI	30.4600	41.638	833.883	189.31	0.00	0.00	58.3320
16	Coal	0.0000	30.400	0.000	0.00	0.00	0.00	2.4000
17	Lime	60.0000	0.000	0.000	0.00	0.00	0.00	0.0000
18	Hot Metal	0.0000	40.547	980.303	0.95	0.00	0.00	0.0000

SOLIDS - KG/HR

NO.	STREAM	C5H8
2	Coal	88.2360
5	Green Pellets	88.2360
16	Coal	7.2000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	CaO	C	Fe	FeO	Fe2O3	Fe3O4	SiO2
1	Iron Ore	1.000	0.0000	0.0000	0.0000	97.0000	0.0000	2.00000
2	Coal	0.000	76.0000	0.0000	0.0000	0.0000	0.0000	6.00000
3	Binder	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
5	Green Pellets	1.560	19.0837	0.0000	0.0000	71.8482	0.0000	2.98801
7	Pellets from Zone 1	1.751	16.9468	0.0000	0.0000	0.0000	77.9482	3.35370
10	Pellets from Zone 2	1.891	16.1191	0.0000	78.3675	0.0000	0.0000	3.62203
13	DRI	2.640	3.6093	72.2836	16.4103	0.0000	0.0000	5.05640
16	Coal	0.000	76.0000	0.0000	0.0000	0.0000	0.0000	6.00000
17	Lime	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
18	Hot Metal	0.000	3.9682	95.9391	0.0926	0.0000	0.0000	0.00000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	C5H8
2	Coal	18.0000
5	Green Pellets	4.5198
16	Coal	18.0000

AQUEOUS - KG/HR

NO.	STREAM	H2O
2	Coal	25.800
4	Water	100.000
5	Green Pellets	125.800

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
2	Coal	100.000
4	Water	100.000
5	Green Pellets	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
2	Coal	997.116
4	Water	997.116
5	Green Pellets	997.116

REDSMELT PROCESS

STREAM DATA

MOLTEN3 - KG/HR

NO.	STREAM	CaO	SiO2
19	Slag	90.4600	60.7320

MOLTEN3 - WEIGHT PERCENT

NO.	STREAM	CaO	SiO2
19	Slag	59.8312	40.1688

GASEOUS - KG/HR

NO.	STREAM	CO	CO2	H2O	N2	O2	C5H8
6	Combustion Air	0.000	0.000	0.000	971.335	290.139	0.00000
8	Gases from Zone 1	280.816	128.850	219.142	971.335	0.000	0.00000
9	Combustion Air	0.000	0.000	0.000	0.001	0.000	0.00000
11	Gases from Zone 2	280.816	257.701	219.142	971.336	0.000	0.00000
12	Combustion Air	0.000	0.000	0.000	0.670	0.200	0.00000
14	Gases from RHF	879.147	116.223	219.142	972.005	0.200	0.00000
15	Air	0.000	0.000	0.000	339.040	101.272	0.00000
20	Gases from SAF	73.438	0.000	0.000	0.000	0.000	7.20000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	CO	CO2	H2O	N2	O2	C5H8
6	Combustion Air	0.0000	0.0000	0.0000	77.0000	23.0000	0.00000
8	Gases from Zone 1	17.5494	8.0524	13.6951	60.7030	0.0000	0.00000
9	Combustion Air	0.0000	0.0000	0.0000	77.0000	23.0000	0.00000
11	Gases from Zone 2	16.2416	14.9047	12.6745	56.1792	0.0000	0.00000
12	Combustion Air	0.0000	0.0000	0.0000	77.0000	23.0000	0.00000
14	Gases from RHF	40.2040	5.3149	10.0215	44.4504	0.0092	0.00000
15	Air	0.0000	0.0000	0.0000	77.0000	23.0000	0.00000
20	Gases from SAF	91.0712	0.0000	0.0000	0.0000	0.0000	8.92877

GASEOUS - VOLUME PERCENT

NO.	STREAM	CO	CO2	H2O	N2	O2	C5H8
6	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
8	Gases from Zone 1	16.7673	4.89663	20.3444	57.9917	0.0000	0.00000
9	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
11	Gases from Zone 2	15.9846	9.33611	19.3947	55.2846	0.0000	0.00000
12	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
14	Gases from RHF	38.7986	3.26450	15.0369	42.8922	0.0077	0.00000
15	Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
20	Gases from SAF	96.1248	0.00000	0.0000	0.0000	0.0000	3.87521

REDSMELT PROCESS

STREAM DATA IN MOLES

SOLIDS - KG MOLES/HR

NO.	STREAM	CaO	C	Fe	FeO	Fe2O3	Fe3O4	SiO2
1	Iron Ore	0.25785	0.0000	0.0000	0.0000	8.78327	0.00000	0.48132
2	Coal	0.00000	31.0172	0.0000	0.0000	0.00000	0.00000	0.48951
3	Binder	0.28531	0.0000	0.0000	0.0000	0.00000	0.00000	0.00000
5	Green Pellets	0.54316	31.0172	0.0000	0.0000	8.78327	0.00000	0.97083
7	Pellets from Zone 1	0.54316	24.5406	0.0000	0.0000	0.00000	5.85551	0.97083
10	Pellets from Zone 2	0.54316	21.6129	0.0000	17.5665	0.00000	0.00000	0.97083
13	DRI	0.54316	3.4666	14.9316	2.6350	0.00000	0.00000	0.97083
16	Coal	0.00000	2.5310	0.0000	0.0000	0.00000	0.00000	0.03994
17	Lime	1.06991	0.0000	0.0000	0.0000	0.00000	0.00000	0.00000
18	Hot Metal	0.00000	3.3758	17.5534	0.0132	0.00000	0.00000	0.00000

SOLIDS - KG MOLES/HR

NO.	STREAM	C5H8
2	Coal	1.29531
5	Green Pellets	1.29531
16	Coal	0.10570

SOLIDS - MOLE PERCENT

NO.	STREAM	CaO	C	Fe	FeO	Fe2O3	Fe3O4	SiO2
1	Iron Ore	2.708	0.0000	0.0000	0.0000	92.2376	0.0000	5.05458
2	Coal	0.000	94.5588	0.0000	0.0000	0.0000	0.0000	1.49231
3	Binder	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
5	Green Pellets	1.275	72.7936	0.0000	0.0000	20.6133	0.0000	2.27842
7	Pellets from Zone 1	1.702	76.9054	0.0000	0.0000	0.0000	18.3500	3.04238
10	Pellets from Zone 2	1.335	53.1115	0.0000	43.1680	0.0000	0.0000	2.38571
13	DRI	2.409	15.3750	66.2237	11.6865	0.0000	0.0000	4.30577
16	Coal	0.000	94.5588	0.0000	0.0000	0.0000	0.0000	1.49231
17	Lime	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
18	Hot Metal	0.000	16.1195	83.8176	0.0629	0.0000	0.0000	0.00000

SOLIDS - MOLE PERCENT

NO.	STREAM	C5H8
2	Coal	3.94888
5	Green Pellets	3.03994
16	Coal	3.94888

MOLTEN3 - KG MOLES/HR

NO.	STREAM	CaO	SiO2
19	Slag	1.61307	1.01077

MOLTEN3 - MOLE PERCENT

NO.	STREAM	CaO	SiO2
19	Slag	61.4774	38.5226

GASEOUS - KG MOLES/HR

NO.	STREAM	CO	CO2	H2O	N2	O2	C5H8
6	Combustion Air	0.0000	0.00000	0.0000	34.6739	9.06718	0.00000
8	Gases from Zone 1	10.0254	2.92776	12.1642	34.6739	0.00000	0.00000
9	Combustion Air	0.0000	0.00000	0.0000	0.0000	0.00001	0.00000
11	Gases from Zone 2	10.0254	5.85551	12.1642	34.6740	0.00001	0.00000
12	Combustion Air	0.0000	0.00000	0.0000	0.0239	0.00625	0.00000
14	Gases from RHF	31.3863	2.64083	12.1642	34.6979	0.00626	0.00000
15	Air	0.0000	0.00000	0.0000	12.1028	3.16486	0.00000
20	Gases from SAF	2.6218	0.00000	0.0000	0.0000	0.00000	0.10570

REDSMELT PROCESS

STREAM DATA IN MOLES

GASEOUS - MOLE PERCENT

NO.	STREAM	CO	CO2	H2O	N2	O2	C5H8
6	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
8	Gases from Zone 1	16.7673	4.89663	20.3444	57.9917	0.0000	0.00000
9	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
11	Gases from Zone 2	15.9846	9.33611	19.3947	55.2846	0.0000	0.00000
12	Combustion Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
14	Gases from RHF	38.7986	3.26450	15.0369	42.8922	0.0077	0.00000
15	Air	0.0000	0.00000	0.0000	79.2708	20.7292	0.00000
20	Gases from SAF	96.1248	0.00000	0.0000	0.0000	0.0000	3.87521

APPENDIX E-6:

CIRCORED FLUID-BED REDUCTION PROCESS

(NATURAL GAS REDUCTANT)

CIRCORED PROCESS

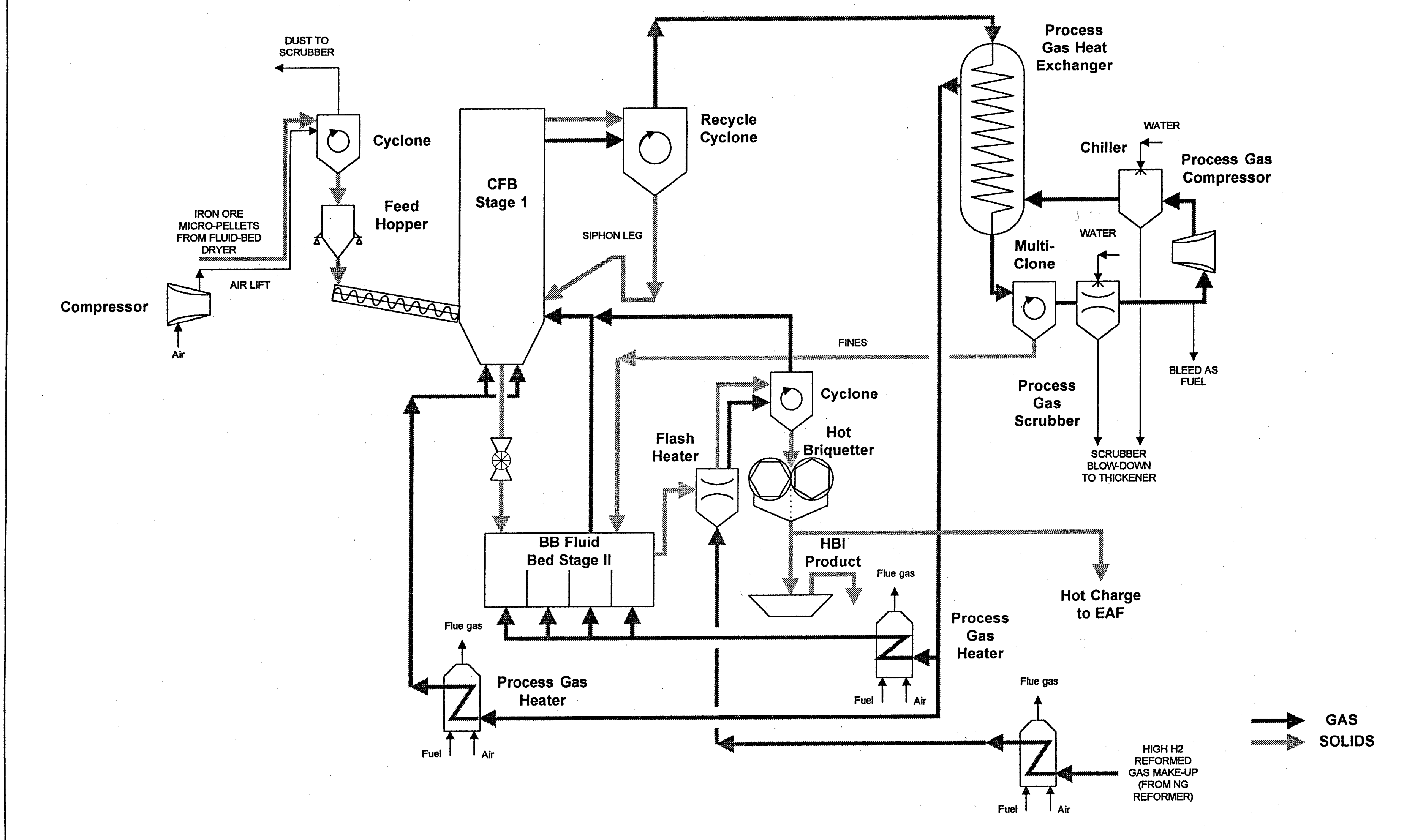
PROCESS BACKGROUND:
The Circored process is a two stage fluidized bed process that operates at low reducing temperatures and uses natural gas to produce reducing gas by means of reforming. The process uses ore fines that have a particle size between 1mm and 0.03mm and produces HBI.

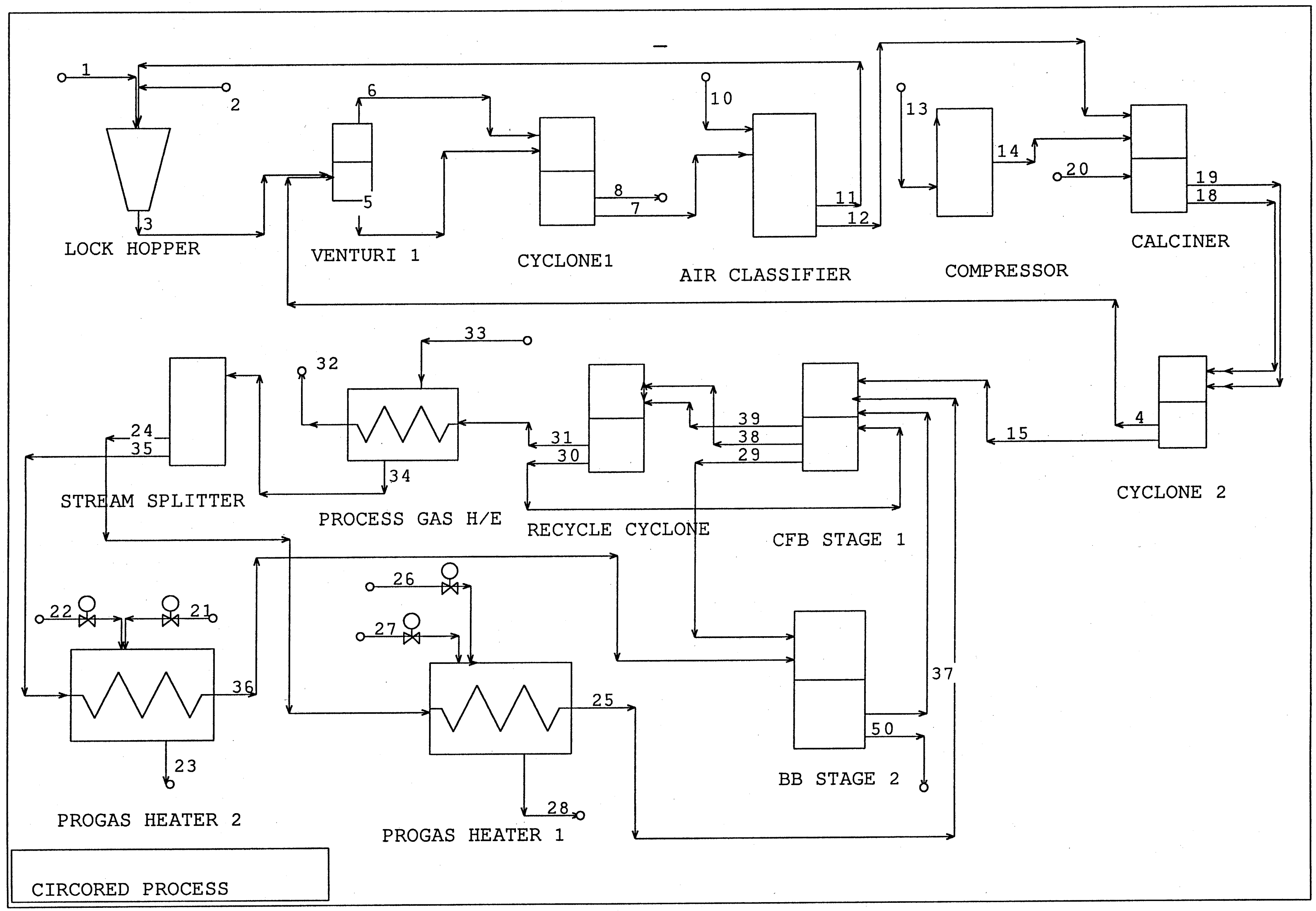
PROCESS DESCRIPTION:
The iron ore fines are first dried and heated to about 800C in a fluid bed preheater system. The dried fines are then charged to a circulating fluidized bed (CFB). The heat required is generated by the combustion of natural gas and air that is introduced into the CFB. The fines are reduced to about 70% metallization in CFB. The process reactions are endothermic and the required energy is introduced in the form of preheated iron ore fines and process gases. The pressure in the CFB is about 4 bars and the reaction temperature is about 630C. This temperature is lower than that used for other reduction processes, and hence avoids the sticking problems that occur with high temperature fines-based processes. The fluidizing gas in the CFB is a mixture of heated process gas which enters the lower part of the CFB, and the off-gas from the second stage conventional fluidized bed reactor, Stage II Reactor, FB. The retention time in the CFB is relatively short, of the order of 15 to 20 minutes.

A portion of the partially metallized fines are withdrawn from CFB and enter the FB reactor. The FB reactor is compartmentalized into several sections, and has gas velocities in the range of 0.5 to 0.6 m/s. The fines reach a final metallization of 92 to 93% in the FB reactor. The off-gas leaving the top of the FB passes on to the CFB. The product leaves the FB reactor at about 630C, is then heated to about 680C, and briquetted.

PROCESS ADVANTAGES
Ability to process directly low cost fine ore
Excellent heat and mass transfer conditions in CFB
Low investment costs
Low operating cost

LURGI CIRCORED PROCESS FLOWSHEET




LOCK HOPPER
VENTURI 1
CYCLONE1
AIR CLASSIFIER
COMPRESSOR
CALCINER
CYCLONE 2
CFB STAGE 1
RECYCLE CYCLONE
PROCESS GAS H/E
STREAM SPLITTER
PROGAS HEATER 2
PROGAS HEATER 1
BB STAGE 2
CIRCORED PROCESS

Circored Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a production flowsheet for SAIDR, Maputo by Lurgi.

Flowsheet Description

For this case, in the MetSim model several unit operations (from Lock hopper through Cyclone 2) are shown. These are based on a flowsheet developed by Lurgi on the micro-pelletization of iron ore fines. Some of these unit operations are not included in the process flowsheet as the main stress is on the conversion of iron ore to DRI. In this early portion of the process, the Iron Ore Fines (Stream 1) enter into the Lockhopper along with some air (Stream 2) and then moves towards Venturi 1 along with a recycle stream where moisture from the ore fines is absorbed by air as Stream 6. Stream 5, containing dried iron ore fines is separated as Stream 7 in Cyclone 1 from Stream 8. The stream 7 passes through an Air Classifier where under-sized particles are removed from ore fines and micropelletized and sent back to the Lockhopper. With the help of compressed air (Stream 14) Fuel is burnt (not shown) to heat the ore fines to about 870C. Again very fine iron ore is separated in Cyclone 2 and remaining ore at 750C (Stream 15) now enters the CFB Stage 1 Reactor.

In the Circulating Fluidized Bed, iron ore is partially reduced with the help of one-third of fresh reformed gas (Stream 25) and the upcoming gases (Stream 37) from the Stage 2 reactor called Bubbling Bed reactor. The partially reduced ore (Stream 29) is sent to BB Stage 2 reactor. Very fine iron ore (Stream 38) gets entrapped in the outgoing top gas (Stream 39). The Recycle Cyclone separates solid particles from the gas and recycles them back to CFB reactor as Stream 30. Stream 31, Top gas is used to preheat incoming reformed gas (Stream 33). The cooled top gas (Stream 32) can either be used for reforming reactions or any other purpose as the stream has high calorific value. The preheated reforming gas stream (90% H2 and 10% CO) is split in two parts: Stream 24 (one-third portion) for CFB and Stream 35 (two-thirds portion) for BB. Both these are further heated to 675C in two Process Gas Heaters by burning Natural gas and Air. These hot streams then enter the reactors and perform reduction of iron ore fines. Stream 50 is the final reduced iron or called Direct Reduced Iron containing almost no carbon but almost all slag.

Model Assumptions:

Cyclone 1: 100% efficiency is assumed.

Air Classifier: 15% very fine particles are assumed.

Compressor: No temperature increase during compression.

Calciner: The output temperature is 870C.

Cyclone 2: 100% efficiency is assumed. The output temperature is 750C.

CFB Stage 1: Partial reduction takes place in this reactor. Out of that only 1% reduction takes place with CO. Rest takes place with H2.

Recycle Cyclone: 100% efficiency is assumed.

Process Gas Heat Exchanger: 100% efficient; No heat losses are assumed. Both outlet temperatures are same.

BB Stage 2: 97% reduction of FeO to Fe takes place. No carry over of particles in top gas is assumed.

Results

It was decided to achieve same operating conditions as were outlined in the SAIDR proposal by Lurgi. Assumptions were made about the composition of the ore fines. The model results are very close to the numbers provided by Lurgi.

CIRCORED PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8	10	11
Description	Iron Ore to L	Conveyor Air	Iron Ore from	Fine Iron Ore	Dried Iron Or	Moist Air	Coarse Iron	Moist Air	Air for Classif	Fines
MT/HR SOLIDS	1095.6	0	1323.1	193.34	1516.4	0	1516.4	0	0	227.46
MT/HR AQUEOUS	95.3	0	95.3	0	0	0	0	0	0	0
MT/HR GASEOUS	0	1	1.15	2.85	0	99.3	0	99.3	1	0.15
MT/HR TOTAL	1190.9	1	1419.5	196.19	1516.4	99.3	1516.4	99.3	1	227.61
Percent Solids	91.998	0	93.205	98.547	100	0	100	0	0	99.934
Sp.Gr.SOLIDS	5.0205	0	5.0205	5.0205	5.0205	0	5.0205	0	0	5.0205
Sp.Gr.AQUEOUS	0.99507	0	0.97631	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0.001152	0.0010176	0.0014224	0	0.00038893	0	0.00038893	0.001152	0.00061356
Sp.Gr.TOTAL	3.7927	0.001152	0.9519	0.09607	5.0205	0.00038893	5.0205	0.00038893	0.001152	0.78545
Temperature C	32	32	72.313	-26	300	300	300	300	32	299.81
Pressure kPa	101.33	101.33	101.33	101.33	101.33	1.01E+02	101.33	1.01E+02	101.33	101.33
Gas nm3/hr	0	777	893.55	2214.4	0	1.22E+05	0	1.22E+05	777	116.55
Sol/Liq lps	8.72E+01	0	1.00E+02	10.697	8.39E+01	0	8.39E+01	0	0	12.585
Sol/Liq lph	3.14E+05	0	3.61E+05	38510	3.02E+05	0	3.02E+05	0	0	45306
Component Mass Flow Rates										
1 Fe2O3 MT/HR	101.12	0	122.12	17.845	139.96	0	139.96	0	0	20.995
2 Fe3O4 MT/HR	918.22	0	1108.9	162.04	1270.9	0	1270.9	0	0	190.64
3 FeO MT/HR	0	0	0	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	11.723	0	14.157	2.0688	16.226	0	16.226	0	0	2.4338
6 Al2O3 MT/HR	8.8744	0	10.717	1.5661	12.283	0	12.283	0	0	1.8424
7 P1 MT/HR	0.66832	0	0.80707	0.11794	0.92501	0	0.92501	0	0	0.13875
8 Cu1 MT/HR	0.39442	0	0.4763	0.069603	0.54591	0	0.54591	0	0	0.081886
9 Ca1O1 MT/HR	7.7788	0	9.3938	1.3727	10.767	0	10.767	0	0	1.615
10 Mg1O1 MT/HR	31.992	0	38.634	5.6456	44.279	0	44.279	0	0	6.6419
11 Ti1O2 MT/HR	12.052	0	14.554	2.1268	16.681	0	16.681	0	0	2.5021
12 S1 MT/HR	0.32868	0	0.39692	0.058003	0.45492	0	0.45492	0	0	0.068238
13 V1 MT/HR	0.71214	0	0.85999	0.12567	0.98567	0	0.98567	0	0	0.14785
14 Co1 MT/HR	0.28486	0	0.344	0.050269	0.39427	0	0.39427	0	0	0.05914
15 Ni1 MT/HR	0.32868	0	0.39692	0.058003	0.45492	0	0.45492	0	0	0.068238
16 Zn1 MT/HR	0.4492	0	0.54246	0.07927	0.62173	0	0.62173	0	0	0.093259
17 Pb1 MT/HR	0.66832	0	0.80707	0.11794	0.92501	0	0.92501	0	0	0.13875
19 H2O MT/HR	95.3	0	95.3	0	0	0	0	0	0	0
20 H2O MT/HR	0	0	0	0	0	95.3	0	95.3	0	0
21 N2 MT/HR	0	0.768	0.8832	2.1888	0	3.072	0	3.072	0.768	0.1152
22 O2 MT/HR	0	0.232	0.2668	0.6612	0	0.928	0	0.928	0.232	0.0348
23 C1H4 MT/HR	0	0	0	0	0	0	0	0	0	0
24 C1O2 MT/HR	0	0	0	0	0	0	0	0	0	0
25 H2 MT/HR	0	0	0	0	0	0	0	0	0	0
26 CO MT/HR	0	0	0	0	0	0	0	0	0	0
Element Mass flow Rates										
1 H 1	10.664	0	10.664	0	0	10.664	0	10.664	0	0
2 C 6	0	0	0	0	0	0	0	0	0	0
3 N 7	0	0.768	0.8832	2.1888	0	3.072	0	3.072	0.768	0.1152
4 O 8	398.99	0.232	464.53	56.136	435.1	85.564	435.1	85.564	0.232	65.299
5 Mg 12	19.294	0	23.3	3.4049	26.705	0	26.705	0	0	4.0057
6 Al 13	4.6968	0	5.6719	0.82884	6.5007	0	6.5007	0	0	0.97511
7 Si 14	5.4798	0	6.6175	0.96702	7.5845	0	7.5845	0	0	1.1377
8 P 15	0.66832	0	0.80707	0.11794	0.92501	0	0.92501	0	0	0.13875
9 S 16	0.32868	0	0.39692	0.058003	0.45492	0	0.45492	0	0	0.068238
10 Ca 20	5.5595	0	6.7137	0.98109	7.6948	0	7.6948	0	0	1.1542
11 Ti 22	7.225	0	8.7251	1.275	10	0	10	0	0	1.5
12 V 23	0.71214	0	0.85999	0.12567	0.98567	0	0.98567	0	0	0.14785
13 Fe 26	735.15	0	887.79	129.73	1017.5	0	1017.5	0	0	152.63
14 Co 27	0.28486	0	0.344	0.050269	0.39427	0	0.39427	0	0	0.05914
15 Ni 28	0.32868	0	0.39692	0.058003	0.45492	0	0.45492	0	0	0.068238
16 Cu 29	0.39442	0	0.4763	0.069603	0.54591	0	0.54591	0	0	0.081886
17 Zn 30	0.4492	0	0.54246	0.07927	0.62173	0	0.62173	0	0	0.093259
18 Pb 82	0.66832	0	0.80707	0.11794	0.92501	0	0.92501	0	0	0.13875

CIRCORED PROCESS --- STREAM SUMMARY

Stream Number	12	13	14	15	18	19	20	21	22	23	24
Description	Coarse Iron	Air to Compr	Compressed	Iron Ore from	Iron Ore to C	Air to Cyclon	Air to Calcine	Combustion	Natural gas t	Exhaust from	Preheated R
MT/HR SOLIDS	1288.9	0	0	1095.6	1288.9	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
MT/HR GASEOUS	0.85	1	1	0	0	2.85	1	4187.3	205.47	4392.7	772.2
MT/HR TOTAL	1289.8	1	1	1095.6	1288.9	2.85	1	4187.3	205.47	4392.7	772.2
Percent Solids	99.934	0	0	100	100	0	0	0	0	0	0
Sp.Gr.SOLIDS	5.0205	0	0	5.0205	5.0205	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0.00061356	0.001152	0.001152	0	0	0.00030752	0.001152	0.001152	0.0006407	0.00035743	4.3836E-05
Sp.Gr.TOTAL	0.78545	0.001152	0.001152	5.0205	5.0205	0.00030752	0.001152	0.001152	0.0006407	0.00035743	4.3836E-05
Temperature C	299.81	32	32	750	870	870	32	32	32	675	344.62
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	1.01E+02	1.01E+02
Gas nm3/hr	660.45	777	777	0	0	2214.4	777	3.25E+06	2.87E+05	3.54E+06	7.79E+06
Sol/Liq lps	71.316	0	0	6.06E+01	7.13E+01	0	0.00E+00	0	0	0	0
Sol/Liq lph	2.57E+05	0	0	2.18E+05	2.57E+05	0	0	0	0	0	0
Component Mass Flow Rates											
1 Fe2O3 MT/HR	118.97	0	0	101.12	118.97	0	0	0	0	0	0
2 Fe3O4 MT/HR	1080.3	0	0	918.23	1080.3	0	0	0	0	0	0
3 FeO MT/HR	0	0	0	0	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	13.792	0	0	11.723	13.792	0	0	0	0	0	0
6 Al2O3 MT/HR	10.44	0	0	8.8744	10.44	0	0	0	0	0	0
7 P1 MT/HR	0.78626	0	0	0.66832	0.78626	0	0	0	0	0	0
8 Cu1 MT/HR	0.46402	0	0	0.39442	0.46402	0	0	0	0	0	0
9 Ca1O1 MT/HR	9.1515	0	0	7.7788	9.1515	0	0	0	0	0	0
10 Mg1O1 MT/HR	37.637	0	0	31.992	37.637	0	0	0	0	0	0
11 Ti1O2 MT/HR	14.178	0	0	12.052	14.178	0	0	0	0	0	0
12 S1 MT/HR	0.38668	0	0	0.32868	0.38668	0	0	0	0	0	0
13 V1 MT/HR	0.83782	0	0	0.71214	0.83782	0	0	0	0	0	0
14 Co1 MT/HR	0.33513	0	0	0.28486	0.33513	0	0	0	0	0	0
15 Ni1 MT/HR	0.38668	0	0	0.32868	0.38668	0	0	0	0	0	0
16 Zn1 MT/HR	0.52847	0	0	0.4492	0.52847	0	0	0	0	0	0
17 Pb1 MT/HR	0.78626	0	0	0.66832	0.78626	0	0	0	0	0	0
19 H2O MT/HR	0	0	0	0	0	0	0	0	0	0	0
20 H2O MT/HR	0	0	0	0	0	0	0	0	0	461.45	0
21 N2 MT/HR	0.6528	0.768	0.768	0	0	2.1888	0.768	3215.8	0	3215.8	0
22 O2 MT/HR	0.1972	0.232	0.232	0	0	0.6612	0.232	971.45	0	151.81	0
23 C1H4 MT/HR	0	0	0	0	0	0	0	0	205.47	0	0
24 C1O2 MT/HR	0	0	0	0	0	0	0	0	0	563.65	0
25 H2 MT/HR	0	0	0	0	0	0	0	0	0	0	694.98
26 CO MT/HR	0	0	0	0	0	0	0	0	0	0	77.22
Element Mass flow Rates											
1 H 1	0	0	0	0	0	0	0	0	51.637	51.637	694.98
2 C 6	0	0	0	0	0	0	0	0	153.83	153.83	33.113
3 N 7	0.6528	0.768	0.768	0	0	2.1888	0.768	3215.8	0	3215.8	0
4 O 8	370.03	0.232	0.232	314.36	369.83	0.6612	0.232	971.45	0	971.45	44.107
5 Mg 12	22.699	0	0	19.294	22.699	0	0	0	0	0	0
6 Al 13	5.5256	0	0	4.6968	5.5256	0	0	0	0	0	0
7 Si 14	6.4468	0	0	5.4798	6.4468	0	0	0	0	0	0
8 P 15	0.78626	0	0	0.66832	0.78626	0	0	0	0	0	0
9 S 16	0.38668	0	0	0.32868	0.38668	0	0	0	0	0	0
10 Ca 20	6.5406	0	0	5.5595	6.5406	0	0	0	0	0	0
11 Ti 22	8.5001	0	0	7.2251	8.5001	0	0	0	0	0	0
12 V 23	0.83782	0	0	0.71214	0.83782	0	0	0	0	0	0
13 Fe 26	864.89	0	0	735.16	864.89	0	0	0	0	0	0
14 Co 27	0.33513	0	0	0.28486	0.33513	0	0	0	0	0	0
15 Ni 28	0.38668	0	0	0.32868	0.38668	0	0	0	0	0	0
16 Cu 29	0.46402	0	0	0.39442	0.46402	0	0	0	0	0	0
17 Zn 30	0.52847	0	0	0.4492	0.52847	0	0	0	0	0	0
18 Pb 82	0.78626	0	0	0.66832	0.78626	0	0	0	0	0	0

CIRCORED PROCESS --- STREAM SUMMARY

Stream Number	25	26	27	28	29	30	31	32	33	34	35
Description	Reducing ga	Natural gas f	Combustion	Exhaust for	Partially Red	Fines to CFB	Top Gas	Cooled Top	High H2 Refo	Preheated R	Preheated R
MT/HR SOLIDS	0	0	0	0	1063.6	10.743	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
MT/HR GASEOUS	772.2	101.19	2061.8	2163	0	0	2613.7	2613.7	2340	2340	1567.8
MT/HR TOTAL	772.2	101.19	2061.8	2163	1063.6	10.743	2613.7	2613.7	2340	2340	1567.8
Percent Solids	0	0	0	0	100	100	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	0	5.1765	5.1765	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	2.8561E-05	0.0006407	0.001152	0.00035742	0	0	3.2766E-05	4.8963E-05	8.9331E-05	4.3836E-05	4.3836E-05
Sp.Gr.TOTAL	2.8561E-05	0.0006407	0.001152	0.00035742	5.1765	5.1765	3.2766E-05	4.8963E-05	8.9331E-05	4.3836E-05	4.3836E-05
Temperature C	675	32	32	675	650	650	650	344.62	30	344.62	344.62
Pressure kPa	101.33	1.01E+02	1.01E+02	1.01E+02	1.01E+02	1.01E+02	1.01E+02	101.33	101.33	1.01E+02	1.01E+02
Gas nm3/hr	7.79E+06	1.41E+05	1.60E+06	1.74E+06	0	0	2.36E+07	2.36E+07	2.36E+07	2.36E+07	1.58E+07
Sol/Liq lps	0	0	0	0	57.072	0.57648	0	0.00E+00	0	0	0
Sol/Liq lph	0	0	0	0	2.05E+05	2075.3	0	0	0	0	0
Component Mass Flow Rates											
1 Fe2O3 MT/HR	0	0	0	0	0	0	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	0	0	601.02	6.0709	0	0	0	0	0
3 FeO MT/HR	0	0	0	0	386.28	3.9018	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	0	0	0	0	11.723	0.11841	0	0	0	0	0
6 Al2O3 MT/HR	0	0	0	0	8.8744	0.08964	0	0	0	0	0
7 P1 MT/HR	0	0	0	0	0.66832	0.0067507	0	0	0	0	0
8 Cu1 MT/HR	0	0	0	0	0.39442	0.003984	0	0	0	0	0
9 Ca1O1 MT/HR	0	0	0	0	7.7788	0.078574	0	0	0	0	0
10 Mg1O1 MT/HR	0	0	0	0	31.992	0.32315	0	0	0	0	0
11 Ti1O2 MT/HR	0	0	0	0	12.052	0.12173	0	0	0	0	0
12 S1 MT/HR	0	0	0	0	0.32868	0.00332	0	0	0	0	0
13 V1 MT/HR	0	0	0	0	0.71214	0.0071934	0	0	0	0	0
14 Co1 MT/HR	0	0	0	0	0.28486	0.0028773	0	0	0	0	0
15 Ni1 MT/HR	0	0	0	0	0.32868	0.00332	0	0	0	0	0
16 Zn1 MT/HR	0	0	0	0	0.4492	0.0045374	0	0	0	0	0
17 Pb1 MT/HR	0	0	0	0	0.66832	0.0067507	0	0	0	0	0
19 H2O MT/HR	0	0	0	0	0	0	0	0	0	0	0
20 H2O MT/HR	0	0	0	227.26	0	0	307.31	307.31	0	0	0
21 N2 MT/HR	0	0	1583.4	1583.4	0	0	0	0	0	0	0
22 O2 MT/HR	0	0	478.33	74.666	0	0	0	0	0	0	0
23 C1H4 MT/HR	0	101.19	0	0	0	0	0	0	0	0	0
24 C1O2 MT/HR	0	0	0	277.59	0	0	2.0356	2.0356	0	0	0
25 H2 MT/HR	694.98	0	0	0	0	0	2071.6	2071.6	2106	2106	1411
26 CO MT/HR	77.22	0	0	0	0	0	232.7	232.7	234	234	156.78
Element Mass flow Rates											
1 H 1	694.98	25.431	0	25.431	0	0	2106	2106	2106	2106	1411
2 C 6	33.113	75.76	0	75.76	0	0	100.34	100.34	100.34	100.34	67.229
3 N 7	0	0	1583.4	1583.4	0	0	0	0	0	0	0
4 O 8	44.107	0	478.33	478.33	282.31	2.8516	407.32	407.32	133.66	133.66	89.551
5 Mg 12	0	0	0	0	19.294	0.19489	0	0	0	0	0
6 Al 13	0	0	0	0	4.6968	0.047442	0	0	0	0	0
7 Si 14	0	0	0	0	5.4798	0.055351	0	0	0	0	0
8 P 15	0	0	0	0	0.66832	0.0067507	0	0	0	0	0
9 S 16	0	0	0	0	0.32868	0.00332	0	0	0	0	0
10 Ca 20	0	0	0	0	5.5595	0.056157	0	0	0	0	0
11 Ti 22	0	0	0	0	7.2251	0.072981	0	0	0	0	0
12 V 23	0	0	0	0	0.71214	0.0071934	0	0	0	0	0
13 Fe 26	0	0	0	0	735.16	7.4258	0	0	0	0	0
14 Co 27	0	0	0	0	0.28486	0.0028773	0	0	0	0	0
15 Ni 28	0	0	0	0	0.32868	0.00332	0	0	0	0	0
16 Cu 29	0	0	0	0	0.39442	0.003984	0	0	0	0	0
17 Zn 30	0	0	0	0	0.4492	0.0045374	0	0	0	0	0
18 Pb 82	0	0	0	0	0.66832	0.006751	0	0	0	0	0

CIRCORED PROCESS --- STREAM SUMMARY

Stream Number	36	37	38	39	50
Description	Hot Reducin	Reducing ga	Partially Red	Top Gas with	DRI
MT/HR SOLIDS	0	0	10.743	0	821.94
MT/HR AQUEOUS	0	0	0	0	0
MT/HR GASEOUS	1567.8	1809.4	0	2613.7	0
MT/HR TOTAL	1567.8	1809.4	10.743	2613.7	821.94
Percent Solids	0	0	100	0	100
Sp.Gr.SOLIDS	0	0	5.1765	0	6.9179
Sp.Gr.AQUEOUS	0	0	0	0	0
Sp.Gr.GASEOUS	2.8561E-05	0.00003358	0	3.2766E-05	0
Sp.Gr.TOTAL	2.8561E-05	0.00003358	5.1765	3.2766E-05	6.9179
Temperature C	675	657.59	650	650	660
Pressure kPa	101.33	1.01E+02	1.01E+02	1.01E+02	1.01E+02
Gas nm3/hr	1.58E+07	1.58E+07	0	2.36E+07	0
Sol/Liq lps	0	0	0.57648	0	33.004
Sol/Liq lph	0	0	2075.3	0	1.19E+05
Component Mass Flow Rates					
1 Fe2O3 MT/HR	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	6.0709	0	0
3 FeO MT/HR	0	0	3.9018	0	47.289
4 Fe1 MT/HR	0	0	0	0	698.4
5 Si1O2 MT/HR	0	0	0.11841	0	11.723
6 Al2O3 MT/HR	0	0	0.08964	0	8.8744
7 P1 MT/HR	0	0	0.0067507	0	0.66832
8 Cu1 MT/HR	0	0	0.003984	0	0.39442
9 Ca1O1 MT/HR	0	0	0.078574	0	7.7788
10 Mg1O1 MT/HR	0	0	0.32315	0	31.992
11 Ti1O2 MT/HR	0	0	0.12173	0	12.052
12 S1 MT/HR	0	0	0.00332	0	0.32868
13 V1 MT/HR	0	0	0.0071934	0	0.71214
14 Co1 MT/HR	0	0	0.0028773	0	0.28486
15 Ni1 MT/HR	0	0	0.00332	0	0.32868
16 Zn1 MT/HR	0	0	0.0045374	0	0.4492
17 Pb1 MT/HR	0	0	0.0067507	0	0.66832
19 H2O MT/HR	0	0	0	0	0
20 H2O MT/HR	0	272.06	0	307.31	0
21 N2 MT/HR	0	0	0	0	0
22 O2 MT/HR	0	0	0	0	0
23 C1H4 MT/HR	0	0	0	0	0
24 C1O2 MT/HR	0	0	0	2.0356	0
25 H2 MT/HR	1411	1380.6	0	2071.6	0
26 CO MT/HR	156.78	156.78	0	232.7	0
Element Mass flow Rates					
1 H 1	1411	1411	0	2106	0
2 C 6	67.229	67.229	0	100.34	0
3 N 7	0	0	0	0	0
4 O 8	89.551	331.16	2.8516	407.32	40.695
5 Mg 12	0	0	0.19489	0	19.294
6 Al 13	0	0	0.047442	0	4.6968
7 Si 14	0	0	0.055351	0	5.4798
8 P 15	0	0	0.0067507	0	0.66832
9 S 16	0	0	0.00332	0	0.32868
10 Ca 20	0	0	0.056157	0	5.5595
11 Ti 22	0	0	0.072981	0	7.2251
12 V 23	0	0	0.0071934	0	0.71214
13 Fe 26	0	0	7.4258	0	735.16
14 Co 27	0	0	0.0028773	0	0.28486
15 Ni 28	0	0	0.00332	0	0.32868
16 Cu 29	0	0	0.003984	0	0.39442
17 Zn 30	0	0	0.0045374	0	0.4492
18 Pb 82	0	0	0.006751	0	0.66832

CIRCORED MODEL

CASE DEFINITION

Title : CIRCORED MODEL
Case :

Data Storage File Name	:	CIRCORED4.sfw
Mass Balance Option	:	ON
Heat Balance Option	:	ON
Size Analysis Option	:	ON
Units of Mass	:	metric tonne
Units of Time	:	hour
Ambient Air Pressure	:	101.325 kPa
Standard Pressure	:	101.325 kPa
Ambient Air Temperature	:	20.00 C
Standard Temperature	:	0.00 C
Plant Site Latitude	:	0.00 Degrees
Plant Site Elevation	:	0.00 Meters

CIRCORED MODEL

COMPONENT DATA

ROW	CNM	CHF			PHC	CMW	SGF
1	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
2	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
3	FeO	FeO	SI1	71.8464	5.7000	0.0000	0.0000
4	Fe1	Fe1	SI1	55.8470	7.8600	0.0000	0.0000
5	Si1O2	Si1O2	SI1	60.0848	2.6500	0.0000	0.0000
6	Al2O3	Al2O3	SI1	101.9612	3.9650	0.0000	0.0000
7	P1	P1	SI1	30.9738	1.8200	0.0000	0.0000
8	Cu1	Cu1	SI1	63.5400	8.9200	0.0000	0.0000
9	Ca1O1	Ca1O1	SI1	56.0794	3.3100	0.0000	0.0000
10	Mg1O1	Mg1O1	SI1	40.3114	3.5800	0.0000	0.0000
11	Ti1O2	Ti1O2	SI1	79.8988	4.2600	0.0000	0.0000
12	S1	S1	SI1	32.0640	2.0000	0.0000	0.0000
13	V1	V1	SI1	50.9420	5.9600	0.0000	0.0000
14	Co1	Co1	SI1	58.9330	8.9000	0.0000	0.0000
15	Ni1	Ni1	SI1	58.7100	8.9000	0.0000	0.0000
16	Zn1	Zn1	SI1	65.3800	7.1400	0.0000	0.0000
17	Pb1	Pb1	SI1	207.1900	11.3400	0.0000	0.0000
18	Ca1C1O3	Ca1C1O3	SI1	100.0894	1.0000	0.0000	0.0000
19	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
20	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
21	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
22	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
23	C1H4	C1H4	GC8	16.0430	0.0007	0.0000	0.0000
24	C1O2	C1O2	GC8	44.0100	0.0020	0.0000	0.0000
25	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
26	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000

ROW	CNM	SOL	A	B	C	pH	Wi	COV A B C	
1	Fe2O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	Fe3O4	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	FeO	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	Fe1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	Si1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	Al2O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	P1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8	Cu1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	Ca1O1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
10	Mg1O1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	Ti1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
12	S1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13	V1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14	Co1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	Ni1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
16	Zn1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
17	Pb1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	Ca1C1O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
19	H2O	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
20	H2O	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	N2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
22	O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
23	C1H4	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	C1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
25	H2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
26	CO	23.7700	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

CIRCORED MODEL

COMPONENT DATA

ROW	CNM	CRIT T	CRIT P	CRIT V	ANTOINE VAPOR PRES A	B	C	HENRY
1	Fe2O3	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
2	Fe3O4	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
3	FeO	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
4	Fe1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
5	Si1O2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
6	Al2O3	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
7	P1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
8	Cu1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
9	Ca1O1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
10	Mg1O1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
11	Ti1O2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
12	S1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
13	V1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
14	Co1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
15	Ni1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
16	Zn1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
17	Pb1	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
18	Ca1C1O3	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
19	H2O	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
20	H2O	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
21	N2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
22	O2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
23	C1H4	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
24	C1O2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
25	H2	0.000	0.0000	0.0000	0.00000	0.000	0.000	0.0
26	CO	133.400	35.4638	93.1000	6.24020	230.270	260.010	63426.0

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
2	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
3	FeO	BAK2248	-62382	8754	-8.5950	9.1416	-21.4692
4	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
5	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
6	Al2O3	B672042	-400500	-12425	28.9653	1.0071	11.1085
7	P1	B672282	0	-2816	12.9239	-11.6659	0.0000
8	Cu1	B672129	0	-1423	5.0156	0.9276	-0.4694
9	Ca1O1	B672098	-151790	-4315	12.0730	0.4606	2.0088
10	Mg1O1	B672227	-143760	-4612	11.8081	0.3610	3.1765
11	Ti1O2	B672431	-225670	-6260	16.8540	0.6334	3.4762
12	S1	B672335	0	13015	-44.4133	56.5440	-14.3084
13	V1	B672454	0	-999	4.4929	1.2791	-1.3985
14	Co1	B672113	0	-3885	7.9629	0.8444	4.4112
15	Ni1	B672270	0	-1763	6.2394	0.7740	-0.5571
16	Zn1	B672480	0	-1445	4.7430	1.6445	-0.3435
17	Pb1	B672294	0	-1512	4.9651	1.6774	-0.3504
18	Ca1C1O3	B6771413	-288610	-9122	23.8351	3.2146	5.1569
19	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
20	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
21	N2	B672244	0	-2846	7.5728	0.2525	1.7794
22	O2	B672277	0	-2979	7.9696	0.2720	1.7697
23	C1H4	B6772217	-17880	-6424	11.8424	2.9907	8.0422
24	C1O2	B672094	-94051	-5911	12.9357	0.3891	6.1869
25	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
26	CO	YAWS	-26420	-1787	6.0661	0.9368	-0.3112

CIRCORED MODEL

COMPONENT DATA

ROW	CNM	TEMP	RANGE oK	HTG-A	HTG-B	HTG-C	HTG-D
1	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
2	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
3	FeO	298.2	1650.0	-58450	-19.5576	-4.9564	-7.3814
4	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
5	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
6	Al2O3	298.2	2327.0	-386441	-25.8901	-10.0349	-27.6544
7	P1	298.2	317.3	-2534	6.8556	-27.4268	0.0000
8	Cu1	298.2	1357.6	1948	-9.4355	-3.1931	-3.6331
9	Ca1O1	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
10	Mg1O1	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
11	Ti1O2	298.2	2000.0	-217923	-19.7530	-6.5095	-14.7172
12	S1	298.2	388.4	-5700	12.4302	-23.6630	5.4073
13	V1	298.2	2190.0	2969	-9.8550	-2.7412	-5.5855
14	Co1	298.2	1768.0	2071	-8.3546	-3.9177	-4.1323
15	Ni1	298.2	1728.0	3122	-10.1656	-3.1379	-5.8385
16	Zn1	298.2	692.7	834	-9.1557	-4.7988	-1.9233
17	Pb1	298.2	600.7	544	-13.9080	-5.5553	-1.5560
18	Ca1C1O3	298.2	1200.0	-283124	-23.3813	-15.1456	-11.0884
19	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
20	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
21	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
22	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
23	C1H4	298.2	2000.0	-14673	-45.4106	-7.1789	-6.9854
24	C1O2	298.2	3000.0	-86430	-58.7976	-3.7771	-15.3476
25	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
26	CO	298.0	700.0	-25393	-46.6664	-5.1645	-2.2650

CIRCORED MODEL

FLOWSHEET DATA

NO	OPR	UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC	CIRCORED PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	HPR	LOCK HOPPER	1	2	11	0	0	0	0	3	0	0	0	0	0
3	SPP	VENTURI 1	3	4	0	0	0	0	0	5	6	0	0	0	0
4	SPP	CYCLONE1	6	5	0	0	0	0	0	7	8	0	0	0	0
5	SPS	AIR CLASSIFIER	10	7	0	0	0	0	0	12	11	0	0	0	0
6	MIX	COMPRESSOR	13	0	0	0	0	0	0	14	0	0	0	0	0
7	SPP	CALCINER	12	14	0	20	0	0	0	18	19	0	0	0	0
8	SPP	CYCLONE 2	18	19	0	0	0	0	0	15	4	0	0	0	0
9	SPP	CFB STAGE 1	15	25	37	30	0	0	0	29	38	39	0	0	0
10	SPP	RECYCLE CYCLONE	39	38	0	0	0	0	0	30	31	0	0	0	0
11	HTX	PROCESS GAS H/E	31	0	0	33	0	0	0	32	34	0	0	0	0
12	SPS	STREAM SPLITTER	34	0	0	0	0	0	0	35	24	0	0	0	0
13	HTX	PROGAS HEATER 2	35	0	0	21	22	0	0	36	23	0	0	0	0
14	HTX	PROGAS HEATER 1	24	0	0	26	27	0	0	25	28	0	0	0	0
15	SPP	BB STAGE 2	29	36	0	0	0	0	0	50	37	0	0	0	0

CIRCORED MODEL

HEAT BALANCE SUMMARY - 1000000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	CIRCORED PROCESS	0	0	0	0	0	0	0	0
2	LOCK HOPPER	14	0	0	0	0	0	-14	0
3	VENTURI 1	-40	-56	0	0	0	190	-94	0
4	CYCLONE1	94	0	0	0	0	0	-94	0
5	AIR CLASSIFIER	82	0	0	0	0	0	-82	0
6	COMPRESSOR	0	0	0	0	0	0	0	0
7	CALCINER	70	0	0	0	0	170	-239	0
8	CYCLONE 2	239	0	0	0	-120	0	-120	0
9	CFB STAGE 1	4913	-39	0	0	0	-107	-4766	0
10	RECYCLE CYCLONE	4640	0	0	0	0	0	-4640	0
11	PROCESS GAS H/E	4680	0	0	0	0	0	-4680	0
12	STREAM SPLITTER	2336	0	0	0	0	0	-2336	0
13	PROGAS HEATER 2	1577	2458	0	0	0	0	-4032	2
14	PROGAS HEATER 1	777	1211	0	0	0	0	-1986	1
15	BB STAGE 2	3349	-115	0	0	0	0	-3234	0

CIRCORED MODEL

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/H
1	Iron Ore to Lockhopper	32.000	89.60	1455227.0	5774809	608867
2	Conveyor Air	32.000	89.60	2369.0	9400	991
3	Iron Ore from Lockhopper	72.313	162.16	13750979.0	54568295	5753409
4	Fine Iron Ore from Cyclone 2	-26.000	-14.80	-53567526.0	-212573124	-22412653
5	Dried Iron Ore	300.000	572.00	81951615.0	325210290	34288555
6	Moist Air	300.000	572.00	12250507.0	48613940	5125612
7	Coarse Iron Ore	300.000	572.00	81951615.0	325210290	34288555
8	Moist Air	300.000	572.00	12250507.0	48613940	5125612
9		0.000	32.00	27223107.0	108030018	11390147
10	Air for Classifier	32.000	89.60	2369.0	9400	991
11	Fines	299.815	571.67	12293098.0	48782953	5143432
12	Coarse Iron Ore Feed	299.815	571.67	69660886.0	276436736	29146114
13	Air to Compressor	32.000	89.60	2369.0	9400	991
14	Compressed Air	32.000	89.60	2369.0	9400	991
15	Iron Ore from Cyclone 2	750.000	1382.00	173218033.0	687384708	72474425
16	Feed to CFB	750.000	1382.00	142215195.0	564355503	59502837
17	Iron Ore Recycle	750.000	1382.00	47405065.0	188118501	19834279
18	Iron Ore to Cyclone 2	870.000	1598.00	238671842.0	947126412	99860298
19	Air to Cyclone 2	870.000	1598.00	629172.0	2496755	263245
20	Air to Calciner	32.000	89.60	2369.0	9400	991
21	Combustion Air to Heater 2	32.000	89.60	9918111.0	39358247	4149737
22	Natural gas to Heater 2	32.000	89.60	1333293.0	5290933	557849
23	Exhaust from Heater 2	675.000	1247.00	809492155.0	3212324474	338691517
24	Preheated Reformed gas for CFB	344.620	652.32	770969189.0	3059452993	322573508
25	Reducing gas for CFB	675.000	1247.00	1587444530.0	6299488990	664186791
26	Natural gas for Heater 1	32.000	89.60	656639.0	2605756	274737
27	Combustion Air for Heater 1	32.000	89.60	4883594.0	19379667	2043295
28	Exhaust for Heater 1	675.000	1247.00	398598647.0	1581767262	166773674
29	Partially Reduced Ore	650.000	1202.00	126085243.0	500346678	52754065
30	Fines to CFB	650.000	1202.00	1273588.0	5054007	532869
31	Top Gas	650.000	1202.00	4638735895.0	18407991673	1940847098
32	Cooled Top Gas	344.620	652.32	2343776800.0	9300857992	980636213
33	High H2 Reformed gas makeup	30.000	86.00	41311176.0	163935994	17284596
34	Preheated Reformed Gas	344.620	652.32	2336270270.0	9271069675	977495481
35	Preheated Reformed Gas for BB	344.620	652.32	1565301081.0	6211616682	654921972
36	Hot Reducing gas for BB	675.000	1247.00	3222993441.0	12789871586	1348500455
37	Reducing gas from BB	657.589	1215.66	3150840386.0	12503545126	1318311617
38	Partially Reduced Fines	650.000	1202.00	1273588.0	5054007	532869
39	Top Gas with Fines	650.000	1202.00	4638735895.0	18407991673	1940847098
40	Natural gas for Reformer	32.000	89.60	1622269.0	6437683	678757
41	Reformed Gas	600.000	1112.00	4332245513.0	17191739546	1812611522
42	Cold water for Chiller	32.000	89.60	209587.0	831707	87691
43	Waste Water from Chiller	238.769	461.78	14967617.0	59396305	6262451
44	Calcium Oxide	32.000	89.60	377168.0	1496725	157807
45	Calcium Carbonate	550.000	1022.00	33056359.0	131178235	13830780
46	Reformed Gas w/o CO2	600.000	1112.00	29725648.0	117960903	12437210
47	Excess Reformed Gas	600.000	1112.00	0.0	0	
50	DRI	660.000	1220.00	82836032.0	328719939	34658595

CIRCORED MODEL

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
2	Conveyor Air	100.0000	511	457	868	777
3	Iron Ore from Lockhopper	100.0000	878	737	1491	1252
4	Fine Iron Ore from Cyclone 2	100.0000	1202	1326	2042	2253
6	Moist Air	100.0000	150272	71616	255314	121677
8	Moist Air	100.0000	150272	71616	255314	121677
9		100.0000	449493	449493	763694	763694
10	Air for Classifier	100.0000	511	457	868	777
11	Fines	100.0000	171	95	290	162
12	Coarse Iron Ore Feed	100.0000	967	540	1642	917
13	Air to Compressor	100.0000	511	457	868	777
14	Compressed Air	100.0000	511	457	868	777
19	Air to Cyclone 2	100.0000	5455	1303	9268	2214
20	Air to Calciner	100.0000	511	457	868	777
21	Combustion Air to Heater 2	100.0000	2139273	1914935	3634648	3253496
22	Natural gas to Heater 2	100.0000	188752	168958	320692	287062
23	Exhaust from Heater 2	100.0000	7233548	2083894	12289876	3540558
24	Preheated Reformed gas for CFB	100.0000	10368202	4584343	17615688	7788848
25	Reducing gas for CFB	100.0000	15913063	4584343	27036466	7788848
26	Natural gas for Heater 1	100.0000	92959	83211	157939	141376
27	Combustion Air for Heater 1	100.0000	1053360	942898	1789670	1601994
28	Exhaust for Heater 1	100.0000	3561798	1026109	6051533	1743370
31	Top Gas	100.0000	46949943	13891947	79768460	23602568
32	Cooled Top Gas	100.0000	31418795	13891947	53380871	23602568
33	High H2 Reformed gas makeup	100.0000	15417604	13891947	26194676	23602568
34	Preheated Reformed Gas	100.0000	31418795	13891947	53380872	23602568
35	Preheated Reformed Gas for BB	100.0000	21050593	9307605	35765184	15813721
36	Hot Reducing gas for BB	100.0000	32308341	9307605	54892219	15813721
37	Reducing gas from BB	100.0000	31715067	9307605	53884241	15813721
39	Top Gas with Fines	100.0000	46949943	13891947	79768460	23602568
40	Natural gas for Reformer	100.0000	229662	205578	390198	349279
41	Reformed Gas	100.0000	44386805	13885650	75413661	23591869
43	Waste Water from Chiller	100.0000	103277	55113	175469	93637
46	Reformed Gas w/o CO2	100.0000	176116	55095	299223	93607

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore to Lockhopper	100.0000	1382.480	87.22143	313.9972	7535.932
5	Dried Iron Ore	100.0000	1329.846	83.90074	302.0427	7249.024
7	Coarse Iron Ore	100.0000	1329.846	83.90074	302.0427	7249.024
15	Iron Ore from Cyclone 2	100.0000	960.814	60.61829	218.2258	5237.420
18	Iron Ore to Cyclone 2	100.0000	1130.369	71.31563	256.7363	6161.671
29	Partially Reduced Ore	100.0000	904.604	57.07196	205.4591	4931.018
30	Fines to CFB	100.0000	9.137	0.57648	2.0753	49.808
38	Partially Reduced Fines	100.0000	9.137	0.57648	2.0753	49.808
50	DRI	100.0000	523.121	33.00403	118.8145	2851.548

CIRCORED MODEL

MASS FLOW RATES - MT/HR

NO.	STREAM	MT/HR-SI	MT/HR-LI	MT/HR-GC	MT/HR-TC
1	Iron Ore to Lockhopper	1095.600	95.30000	0.000	1190.900
2	Conveyor Air	0.000	0.00000	1.000	1.000
3	Iron Ore from Lockhopper	1323.067	95.30000	1.150	1419.517
4	Fine Iron Ore from Cyclone 2	193.342	0.00000	2.850	196.192
5	Dried Iron Ore	1516.409	0.00000	0.000	1516.409
6	Moist Air	0.000	0.00000	99.300	99.300
7	Coarse Iron Ore	1516.409	0.00000	0.000	1516.409
8	Moist Air	0.000	0.00000	99.300	99.300
9		0.000	0.00000	364.892	364.892
10	Air for Classifier	0.000	0.00000	1.000	1.000
11	Fines	227.461	0.00000	0.150	227.611
12	Coarse Iron Ore Feed	1288.948	0.00000	0.850	1289.798
13	Air to Compressor	0.000	0.00000	1.000	1.000
14	Compressed Air	0.000	0.00000	1.000	1.000
15	Iron Ore from Cyclone 2	1095.606	0.00000	0.000	1095.606
18	Iron Ore to Cyclone 2	1288.948	0.00000	0.000	1288.948
19	Air to Cyclone 2	0.000	0.00000	2.850	2.850
20	Air to Calciner	0.000	0.00000	1.000	1.000
21	Combustion Air to Heater 2	0.000	0.00000	4187.266	4187.266
22	Natural gas to Heater 2	0.000	0.00000	205.467	205.467
23	Exhaust from Heater 2	0.000	0.00000	4392.734	4392.734
24	Preheated Reformed gas for CFB	0.000	0.00000	772.200	772.200
25	Reducing gas for CFB	0.000	0.00000	772.200	772.200
26	Natural gas for Heater 1	0.000	0.00000	101.192	101.192
27	Combustion Air for Heater 1	0.000	0.00000	2061.774	2061.774
28	Exhaust for Heater 1	0.000	0.00000	2162.966	2162.966
29	Partially Reduced Ore	1063.555	0.00000	0.000	1063.555
30	Fines to CFB	10.743	0.00000	0.000	10.743
31	Top Gas	0.000	0.00000	2613.663	2613.663
32	Cooled Top Gas	0.000	0.00000	2613.663	2613.663
33	High H2 Reformed gas makeup	0.000	0.00000	2340.000	2340.000
34	Preheated Reformed Gas	0.000	0.00000	2340.000	2340.000
35	Preheated Reformed Gas for BB	0.000	0.00000	1567.800	1567.800
36	Hot Reducing gas for BB	0.000	0.00000	1567.800	1567.800
37	Reducing gas from BB	0.000	0.00000	1809.413	1809.413
38	Partially Reduced Fines	10.743	0.00000	0.000	10.743
39	Top Gas with Fines	0.000	0.00000	2613.663	2613.663
40	Natural gas for Reformer	0.000	0.00000	250.000	250.000
41	Reformed Gas	0.000	0.00000	2817.159	2817.159
43	Waste Water from Chiller	0.000	30.00000	67.000	97.000
46	Reformed Gas w/o CO2	0.000	0.00000	67.000	67.000
50	DRI	821.942	0.00000	0.000	821.942

CIRCORED MODEL

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-GC	SG-TC
1	Iron Ore to Lockhopper	91.9976	5.0205	0.9951	0.0000	3.7927
2	Conveyor Air	0.0000	0.0000	0.0000	0.0012	0.0012
3	Iron Ore from Lockhopper	93.2054	5.0205	0.9763	0.0010	0.9519
4	Fine Iron Ore from Cyclone 2	98.5473	5.0205	0.0000	0.0014	0.0961
5	Dried Iron Ore	100.0000	5.0205	0.0000	0.0000	5.0205
6	Moist Air	0.0000	0.0000	0.0000	0.0004	0.0004
7	Coarse Iron Ore	100.0000	5.0205	0.0000	0.0000	5.0205
8	Moist Air	0.0000	0.0000	0.0000	0.0004	0.0004
9		0.0000	0.0000	0.0000	0.0005	0.0005
10	Air for Classifier	0.0000	0.0000	0.0000	0.0012	0.0012
11	Fines	99.9341	5.0205	0.0000	0.0006	0.7855
12	Coarse Iron Ore Feed	99.9341	5.0205	0.0000	0.0006	0.7855
13	Air to Compressor	0.0000	0.0000	0.0000	0.0012	0.0012
14	Compressed Air	0.0000	0.0000	0.0000	0.0012	0.0012
15	Iron Ore from Cyclone 2	100.0000	5.0205	0.0000	0.0000	5.0205
18	Iron Ore to Cyclone 2	100.0000	5.0205	0.0000	0.0000	5.0205
19	Air to Cyclone 2	0.0000	0.0000	0.0000	0.0003	0.0003
20	Air to Calciner	0.0000	0.0000	0.0000	0.0012	0.0012
21	Combustion Air to Heater 2	0.0000	0.0000	0.0000	0.0012	0.0012
22	Natural gas to Heater 2	0.0000	0.0000	0.0000	0.0006	0.0006
23	Exhaust from Heater 2	0.0000	0.0000	0.0000	0.0004	0.0004
24	Preheated Reformed gas for CFB	0.0000	0.0000	0.0000	0.0000	0.0000
25	Reducing gas for CFB	0.0000	0.0000	0.0000	0.0000	0.0000
26	Natural gas for Heater 1	0.0000	0.0000	0.0000	0.0006	0.0006
27	Combustion Air for Heater 1	0.0000	0.0000	0.0000	0.0012	0.0012
28	Exhaust for Heater 1	0.0000	0.0000	0.0000	0.0004	0.0004
29	Partially Reduced Ore	100.0000	5.1765	0.0000	0.0000	5.1765
30	Fines to CFB	100.0000	5.1765	0.0000	0.0000	5.1765
31	Top Gas	0.0000	0.0000	0.0000	0.0000	0.0000
32	Cooled Top Gas	0.0000	0.0000	0.0000	0.0000	0.0000
33	High H2 Reformed gas makeup	0.0000	0.0000	0.0000	0.0001	0.0001
34	Preheated Reformed Gas	0.0000	0.0000	0.0000	0.0000	0.0000
35	Preheated Reformed Gas for BB	0.0000	0.0000	0.0000	0.0000	0.0000
36	Hot Reducing gas for BB	0.0000	0.0000	0.0000	0.0000	0.0000
37	Reducing gas from BB	0.0000	0.0000	0.0000	0.0000	0.0000
38	Partially Reduced Fines	100.0000	5.1765	0.0000	0.0000	5.1765
39	Top Gas with Fines	0.0000	0.0000	0.0000	0.0000	0.0000
40	Natural gas for Reformer	0.0000	0.0000	0.0000	0.0006	0.0006
41	Reformed Gas	0.0000	0.0000	0.0000	0.0000	0.0000
43	Waste Water from Chiller	0.0000	0.0000	0.8154	0.0004	0.0006
46	Reformed Gas w/o CO2	0.0000	0.0000	0.0000	0.0002	0.0002
50	DRI	100.0000	6.9179	0.0000	0.0000	6.9179

CIRCORED MODEL

STREAM DATA

SOLIDS - MT/HR

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	101.124	918.22	0.000	0.000	11.7229
3	Iron Ore from Lockhopper	122.119	1108.86	0.000	0.000	14.1568
4	Fine Iron Ore from Cyclone 2	17.845	162.04	0.000	0.000	2.0688
5	Dried Iron Ore	139.965	1270.90	0.000	0.000	16.2256
7	Coarse Iron Ore	139.965	1270.90	0.000	0.000	16.2256
11	Fines	20.995	190.64	0.000	0.000	2.4338
12	Coarse Iron Ore Feed	118.970	1080.27	0.000	0.000	13.7917
15	Iron Ore from Cyclone 2	101.124	918.23	0.000	0.000	11.7230
16	Feed to CFB	83.025	753.88	0.000	0.000	9.6248
17	Iron Ore Recycle	27.675	251.29	0.000	0.000	3.2083
18	Iron Ore to Cyclone 2	118.970	1080.27	0.000	0.000	13.7917
29	Partially Reduced Ore	0.000	601.02	386.277	0.000	11.7230
30	Fines to CFB	0.000	6.07	3.902	0.000	0.1184
38	Partially Reduced Fines	0.000	6.07	3.902	0.000	0.1184
50	DRI	0.000	0.00	47.289	698.400	11.7230

SOLIDS - MT/HR

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	8.8744	0.66832	0.39442	7.779	31.9915
3	Iron Ore from Lockhopper	10.7168	0.80707	0.47630	9.394	38.6335
4	Fine Iron Ore from Cyclone 2	1.5661	0.11794	0.06960	1.373	5.6456
5	Dried Iron Ore	12.2829	0.92501	0.54591	10.767	44.2792
7	Coarse Iron Ore	12.2829	0.92501	0.54591	10.767	44.2792
11	Fines	1.8424	0.13875	0.08189	1.615	6.6419
12	Coarse Iron Ore Feed	10.4405	0.78626	0.46402	9.152	37.6373
15	Iron Ore from Cyclone 2	8.8744	0.66832	0.39442	7.779	31.9917
16	Feed to CFB	7.2861	0.54870	0.32382	6.387	26.2658
17	Iron Ore Recycle	2.4287	0.18290	0.10794	2.129	8.7553
18	Iron Ore to Cyclone 2	10.4405	0.78626	0.46402	9.152	37.6373
29	Partially Reduced Ore	8.8744	0.66832	0.39442	7.779	31.9917
30	Fines to CFB	0.0896	0.00675	0.00398	0.079	0.3231
38	Partially Reduced Fines	0.0896	0.00675	0.00398	0.079	0.3231
44	Calcium Oxide	0.0000	0.00000	0.00000	300.000	0.0000
45	Calcium Carbonate	0.0000	0.00000	0.00000	300.000	0.0000
50	DRI	8.8744	0.66832	0.39442	7.779	31.9917

SOLIDS - MT/HR

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	12.0516	0.32868	0.71214	0.28486	0.32868
3	Iron Ore from Lockhopper	14.5537	0.39692	0.85999	0.34400	0.39692
4	Fine Iron Ore from Cyclone 2	2.1268	0.05800	0.12567	0.05027	0.05800
5	Dried Iron Ore	16.6805	0.45492	0.98567	0.39427	0.45492
7	Coarse Iron Ore	16.6805	0.45492	0.98567	0.39427	0.45492
11	Fines	2.5021	0.06824	0.14785	0.05914	0.06824
12	Coarse Iron Ore Feed	14.1784	0.38668	0.83782	0.33513	0.38668
15	Iron Ore from Cyclone 2	12.0517	0.32868	0.71214	0.28486	0.32868
16	Feed to CFB	9.8946	0.26985	0.58468	0.23387	0.26985
17	Iron Ore Recycle	3.2982	0.08995	0.19489	0.07796	0.08995
18	Iron Ore to Cyclone 2	14.1784	0.38668	0.83782	0.33513	0.38668
29	Partially Reduced Ore	12.0517	0.32868	0.71214	0.28486	0.32868
30	Fines to CFB	0.1217	0.00332	0.00719	0.00288	0.00332
38	Partially Reduced Fines	0.1217	0.00332	0.00719	0.00288	0.00332
50	DRI	12.0517	0.32868	0.71214	0.28486	0.32868

CIRCORED MODEL

STREAM DATA

SOLIDS - MT/HR

NO.	STREAM	Zn1	Pb1	Ca1C1O3
1	Iron Ore to Lockhopper	0.44920	0.66832	0.00000
3	Iron Ore from Lockhopper	0.54246	0.80707	0.00000
4	Fine Iron Ore from Cyclone 2	0.07927	0.11794	0.00000
5	Dried Iron Ore	0.62173	0.92501	0.00000
7	Coarse Iron Ore	0.62173	0.92501	0.00000
11	Fines	0.09326	0.13875	0.00000
12	Coarse Iron Ore Feed	0.52847	0.78626	0.00000
15	Iron Ore from Cyclone 2	0.44920	0.66832	0.00000
16	Feed to CFB	0.36880	0.54870	0.00000
17	Iron Ore Recycle	0.12293	0.18290	0.00000
18	Iron Ore to Cyclone 2	0.52847	0.78626	0.00000
29	Partially Reduced Ore	0.44920	0.66832	0.00000
30	Fines to CFB	0.00454	0.00675	0.00000
38	Partially Reduced Fines	0.00454	0.00675	0.00000
50	DRI	0.44920	0.66832	0.00000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	9.23000	83.8100	0.0000	0.0000	1.07000
3	Iron Ore from Lockhopper	9.23000	83.8100	0.0000	0.0000	1.07000
4	Fine Iron Ore from Cyclone 2	9.23000	83.8100	0.0000	0.0000	1.07000
5	Dried Iron Ore	9.23000	83.8100	0.0000	0.0000	1.07000
7	Coarse Iron Ore	9.23000	83.8100	0.0000	0.0000	1.07000
11	Fines	9.23000	83.8100	0.0000	0.0000	1.07000
12	Coarse Iron Ore Feed	9.23000	83.8100	0.0000	0.0000	1.07000
15	Iron Ore from Cyclone 2	9.23000	83.8100	0.0000	0.0000	1.07000
16	Feed to CFB	9.23000	83.8100	0.0000	0.0000	1.07000
17	Iron Ore Recycle	9.23000	83.8100	0.0000	0.0000	1.07000
18	Iron Ore to Cyclone 2	9.23000	83.8100	0.0000	0.0000	1.07000
29	Partially Reduced Ore	0.00000	56.5108	36.3194	0.0000	1.10224
30	Fines to CFB	0.00000	56.5108	36.3194	0.0000	1.10224
38	Partially Reduced Fines	0.00000	56.5108	36.3194	0.0000	1.10224
50	DRI	0.00000	0.0000	5.7533	84.9694	1.42625

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	0.81000	0.06100	0.03600	0.710	2.92000
3	Iron Ore from Lockhopper	0.81000	0.06100	0.03600	0.710	2.92000
4	Fine Iron Ore from Cyclone 2	0.81000	0.06100	0.03600	0.710	2.92000
5	Dried Iron Ore	0.81000	0.06100	0.03600	0.710	2.92000
7	Coarse Iron Ore	0.81000	0.06100	0.03600	0.710	2.92000
11	Fines	0.81000	0.06100	0.03600	0.710	2.92000
12	Coarse Iron Ore Feed	0.81000	0.06100	0.03600	0.710	2.92000
15	Iron Ore from Cyclone 2	0.81000	0.06100	0.03600	0.710	2.92000
16	Feed to CFB	0.81000	0.06100	0.03600	0.710	2.92000
17	Iron Ore Recycle	0.81000	0.06100	0.03600	0.710	2.92000
18	Iron Ore to Cyclone 2	0.81000	0.06100	0.03600	0.710	2.92000
29	Partially Reduced Ore	0.83441	0.06284	0.03708	0.731	3.00799
30	Fines to CFB	0.83441	0.06284	0.03708	0.731	3.00799
38	Partially Reduced Fines	0.83441	0.06284	0.03708	0.731	3.00799
44	Calcium Oxide	0.00000	0.00000	0.00000	100.000	0.00000
45	Calcium Carbonate	0.00000	0.00000	0.00000	100.000	0.00000
50	DRI	1.07969	0.08131	0.04799	0.946	3.89221

CIRCORED MODEL

STREAM DATA

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	1.10000	0.03000	0.06500	0.02600	0.03000
3	Iron Ore from Lockhopper	1.10000	0.03000	0.06500	0.02600	0.03000
4	Fine Iron Ore from Cyclone 2	1.10000	0.03000	0.06500	0.02600	0.03000
5	Dried Iron Ore	1.10000	0.03000	0.06500	0.02600	0.03000
7	Coarse Iron Ore	1.10000	0.03000	0.06500	0.02600	0.03000
11	Fines	1.10000	0.03000	0.06500	0.02600	0.03000
12	Coarse Iron Ore Feed	1.10000	0.03000	0.06500	0.02600	0.03000
15	Iron Ore from Cyclone 2	1.10000	0.03000	0.06500	0.02600	0.03000
16	Feed to CFB	1.10000	0.03000	0.06500	0.02600	0.03000
17	Iron Ore Recycle	1.10000	0.03000	0.06500	0.02600	0.03000
18	Iron Ore to Cyclone 2	1.10000	0.03000	0.06500	0.02600	0.03000
29	Partially Reduced Ore	1.13315	0.03090	0.06696	0.02678	0.03090
30	Fines to CFB	1.13315	0.03090	0.06696	0.02678	0.03090
38	Partially Reduced Fines	1.13315	0.03090	0.06696	0.02678	0.03090
50	DRI	1.46624	0.03999	0.08664	0.03466	0.03999

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Zn1	Pb1	Ca1C1O3
1	Iron Ore to Lockhopper	0.04100	0.06100	0.00000
3	Iron Ore from Lockhopper	0.04100	0.06100	0.00000
4	Fine Iron Ore from Cyclone 2	0.04100	0.06100	0.00000
5	Dried Iron Ore	0.04100	0.06100	0.00000
7	Coarse Iron Ore	0.04100	0.06100	0.00000
11	Fines	0.04100	0.06100	0.00000
12	Coarse Iron Ore Feed	0.04100	0.06100	0.00000
15	Iron Ore from Cyclone 2	0.04100	0.06100	0.00000
16	Feed to CFB	0.04100	0.06100	0.00000
17	Iron Ore Recycle	0.04100	0.06100	0.00000
18	Iron Ore to Cyclone 2	0.04100	0.06100	0.00000
29	Partially Reduced Ore	0.04224	0.06284	0.00000
30	Fines to CFB	0.04224	0.06284	0.00000
38	Partially Reduced Fines	0.04224	0.06284	0.00000
50	DRI	0.05465	0.08131	0.00000

AQUEOUS - MT/HR

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	95.3000
3	Iron Ore from Lockhopper	95.3000
42	Cold water for Chiller	30.0000
43	Waste Water from Chiller	30.0000

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	100.000
3	Iron Ore from Lockhopper	100.000
42	Cold water for Chiller	100.000
43	Waste Water from Chiller	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	995.067
3	Iron Ore from Lockhopper	976.314
42	Cold water for Chiller	995.067
43	Waste Water from Chiller	815.430

CIRCORED MODEL

STREAM DATA

GASEOUS - MT/HR

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
2	Conveyor Air	0.000	0.77	0.232	0.000	0.000
3	Iron Ore from Lockhopper	0.000	0.88	0.267	0.000	0.000
4	Fine Iron Ore from Cyclone 2	0.000	2.19	0.661	0.000	0.000
6	Moist Air	95.300	3.07	0.928	0.000	0.000
8	Moist Air	95.300	3.07	0.928	0.000	0.000
9		38.786	0.00	0.000	0.000	274.324
10	Air for Classifier	0.000	0.77	0.232	0.000	0.000
11	Fines	0.000	0.12	0.035	0.000	0.000
12	Coarse Iron Ore Feed	0.000	0.65	0.197	0.000	0.000
13	Air to Compressor	0.000	0.77	0.232	0.000	0.000
14	Compressed Air	0.000	0.77	0.232	0.000	0.000
19	Air to Cyclone 2	0.000	2.19	0.661	0.000	0.000
20	Air to Calciner	0.000	0.77	0.232	0.000	0.000
21	Combustion Air to Heater 2	0.000	3215.82	971.446	0.000	0.000
22	Natural gas to Heater 2	0.000	0.00	0.000	205.467	0.000
23	Exhaust from Heater 2	461.454	3215.82	151.812	0.000	563.647
26	Natural gas for Heater 1	0.000	0.00	0.000	101.192	0.000
27	Combustion Air for Heater 1	0.000	1583.44	478.332	0.000	0.000
28	Exhaust for Heater 1	227.264	1583.44	74.666	0.000	277.593
31	Top Gas	307.312	0.00	0.000	0.000	2.036
32	Cooled Top Gas	307.312	0.00	0.000	0.000	2.036
37	Reducing gas from BB	272.056	0.00	0.000	0.000	0.000
39	Top Gas with Fines	307.312	0.00	0.000	0.000	2.036
40	Natural gas for Reformer	0.000	0.00	0.000	250.000	0.000
41	Reformed Gas	400.136	0.00	0.000	378.829	0.763
43	Waste Water from Chiller	0.000	0.00	0.000	67.000	0.000
46	Reformed Gas w/o CO2	0.000	0.00	0.000	67.000	0.000

GASEOUS - MT/HR

NO.	STREAM	H2	CO
9		51.78	0.000
24	Preheated Reformed gas for CFB	694.98	77.220
25	Reducing gas for CFB	694.98	77.220
31	Top Gas	2071.61	232.704
32	Cooled Top Gas	2071.61	232.704
33	High H2 Reformed gas makeup	2106.00	234.000
34	Preheated Reformed Gas	2106.00	234.000
35	Preheated Reformed Gas for BB	1411.02	156.780
36	Hot Reducing gas for BB	1411.02	156.780
37	Reducing gas from BB	1380.58	156.780
39	Top Gas with Fines	2071.61	232.704
41	Reformed Gas	2028.85	8.583

CIRCORED MODEL

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
2	Conveyor Air	0.0000	76.8000	23.2000	0.000	0.0000
3	Iron Ore from Lockhopper	0.0000	76.8000	23.2000	0.000	0.0000
4	Fine Iron Ore from Cyclone 2	0.0000	76.8000	23.2000	0.000	0.0000
6	Moist Air	95.9718	3.0937	0.9345	0.000	0.0000
8	Moist Air	95.9718	3.0937	0.9345	0.000	0.0000
9		10.6295	0.0000	0.0000	0.000	75.1796
10	Air for Classifier	0.0000	76.8000	23.2000	0.000	0.0000
11	Fines	0.0000	76.8000	23.2000	0.000	0.0000
12	Coarse Iron Ore Feed	0.0000	76.8000	23.2000	0.000	0.0000
13	Air to Compressor	0.0000	76.8000	23.2000	0.000	0.0000
14	Compressed Air	0.0000	76.8000	23.2000	0.000	0.0000
19	Air to Cyclone 2	0.0000	76.8000	23.2000	0.000	0.0000
20	Air to Calciner	0.0000	76.8000	23.2000	0.000	0.0000
21	Combustion Air to Heater 2	0.0000	76.8000	23.2000	0.000	0.0000
22	Natural gas to Heater 2	0.0000	0.0000	0.0000	100.000	0.0000
23	Exhaust from Heater 2	10.5049	73.2077	3.4560	0.000	12.8313
26	Natural gas for Heater 1	0.0000	0.0000	0.0000	100.000	0.0000
27	Combustion Air for Heater 1	0.0000	76.8000	23.2000	0.000	0.0000
28	Exhaust for Heater 1	10.5070	73.2070	3.4520	0.000	12.8339
31	Top Gas	11.7579	0.0000	0.0000	0.000	0.0779
32	Cooled Top Gas	11.7579	0.0000	0.0000	0.000	0.0779
37	Reducing gas from BB	15.0356	0.0000	0.0000	0.000	0.0000
39	Top Gas with Fines	11.7579	0.0000	0.0000	0.000	0.0779
40	Natural gas for Reformer	0.0000	0.0000	0.0000	100.000	0.0000
41	Reformed Gas	14.2035	0.0000	0.0000	13.447	0.0271
43	Waste Water from Chiller	0.0000	0.0000	0.0000	100.000	0.0000
46	Reformed Gas w/o CO2	0.0000	0.0000	0.0000	100.000	0.0000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2	CO
9		14.1909	0.0000
24	Preheated Reformed gas for CFB	90.0000	10.0000
25	Reducing gas for CFB	90.0000	10.0000
31	Top Gas	79.2608	8.9034
32	Cooled Top Gas	79.2608	8.9034
33	High H2 Reformed gas makeup	90.0000	10.0000
34	Preheated Reformed Gas	90.0000	10.0000
35	Preheated Reformed Gas for BB	90.0000	10.0000
36	Hot Reducing gas for BB	90.0000	10.0000
37	Reducing gas from BB	76.2997	8.6647
39	Top Gas with Fines	79.2608	8.9034
41	Reformed Gas	72.0175	0.3047

CIRCORED MODEL

STREAM DATA

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
2	Conveyor Air	0.0000	79.0852	20.9148	0.000	0.0000
3	Iron Ore from Lockhopper	0.0000	79.0852	20.9148	0.000	0.0000
4	Fine Iron Ore from Cyclone 2	0.0000	79.0852	20.9148	0.000	0.0000
6	Moist Air	97.4457	2.0201	0.5342	0.000	0.0000
8	Moist Air	97.4457	2.0201	0.5342	0.000	0.0000
9		6.3188	0.0000	0.0000	0.000	18.2942
10	Air for Classifier	0.0000	79.0852	20.9148	0.000	0.0000
11	Fines	0.0000	79.0852	20.9148	0.000	0.0000
12	Coarse Iron Ore Feed	0.0000	79.0852	20.9148	0.000	0.0000
13	Air to Compressor	0.0000	79.0852	20.9148	0.000	0.0000
14	Compressed Air	0.0000	79.0852	20.9148	0.000	0.0000
19	Air to Cyclone 2	0.0000	79.0852	20.9148	0.000	0.0000
20	Air to Calciner	0.0000	79.0852	20.9148	0.000	0.0000
21	Combustion Air to Heater 2	0.0000	79.0852	20.9148	0.000	0.0000
22	Natural gas to Heater 2	0.0000	0.0000	0.0000	100.000	0.0000
23	Exhaust from Heater 2	16.2156	72.6731	3.0034	0.000	8.1078
26	Natural gas for Heater 1	0.0000	0.0000	0.0000	100.000	0.0000
27	Combustion Air for Heater 1	0.0000	79.0852	20.9148	0.000	0.0000
28	Exhaust for Heater 1	16.2188	72.6719	3.0000	0.000	8.1094
31	Top Gas	1.6199	0.0000	0.0000	0.000	0.0044
32	Cooled Top Gas	1.6199	0.0000	0.0000	0.000	0.0044
37	Reducing gas from BB	2.1404	0.0000	0.0000	0.000	0.0000
39	Top Gas with Fines	1.6199	0.0000	0.0000	0.000	0.0044
40	Natural gas for Reformer	0.0000	0.0000	0.0000	100.000	0.0000
41	Reformed Gas	2.1102	0.0000	0.0000	2.243	0.0016
43	Waste Water from Chiller	0.0000	0.0000	0.0000	100.000	0.0000
46	Reformed Gas w/o CO2	0.0000	0.0000	0.0000	100.000	0.0000

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2	CO
9		75.3870	0.00000
24	Preheated Reformed gas for CFB	99.2067	0.79333
25	Reducing gas for CFB	99.2067	0.79333
31	Top Gas	97.5867	0.78894
32	Cooled Top Gas	97.5867	0.78894
33	High H2 Reformed gas makeup	99.2067	0.79333
34	Preheated Reformed Gas	99.2067	0.79333
35	Preheated Reformed Gas for BB	99.2067	0.79333
36	Hot Reducing gas for BB	99.2067	0.79333
37	Reducing gas from BB	97.0662	0.79333
39	Top Gas with Fines	97.5867	0.78894
41	Reformed Gas	95.6156	0.02911

APPENDIX E-7:

CIRCOFER FLUID-BED REDUCTION PROCESS

(COAL REDUCTANT)

CIRCOFER PROCESS

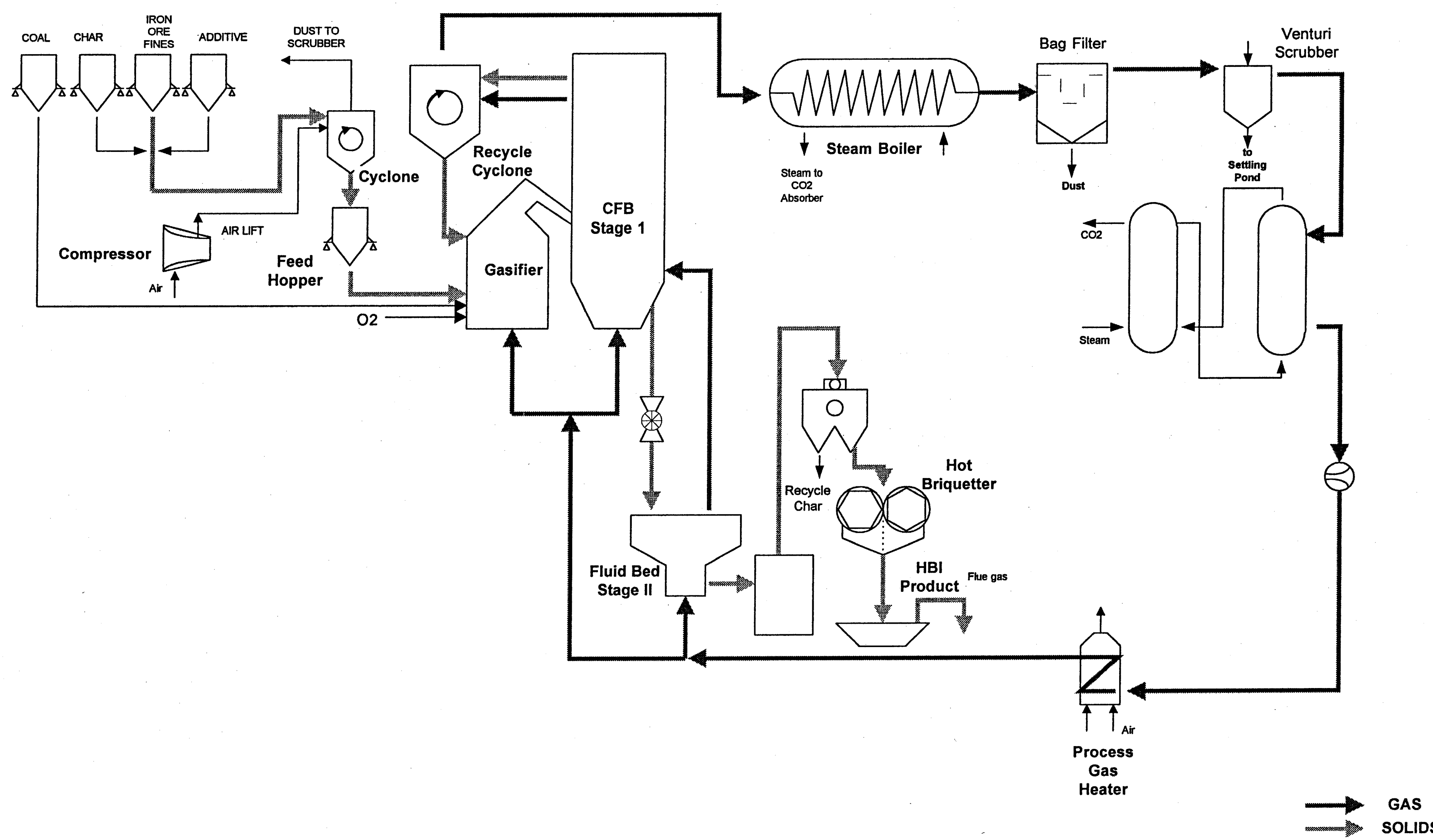
PROCESS BACKGROUND:
The Circofer process is a two stage fluidized bed process that uses iron ore fines and a solid carbon source such as coal to produce reducing gas. Reduction is carried out at high reduction temperatures. The process produces hot briquetted iron, HBI.

PROCESS DESCRIPTION:
The iron oxide feed to the Circofer process is in the form of iron fines between 1mm and 0.03mm in size. The coal to be used as the energy source and reductant must have an ash softening temperature above 1500C due to operating temperature of the gasifying process. The fines, lime and char are first preheated by the hot exhaust gases. These then enter the gasifier, where O2 is injected and coal is fed in from the charge hopper. The gasifier operates at about 1000C and at these conditions, the O2 partially combusts the carbon contained in the coal, producing heat and a CO/CO2 gas mixture. The heat produced in the gasifier heats the ore and char to process temperatures. In the CFB, the ore fines are reduced to about 70% metallization. The fluidizing gas in the CFB is a mixture of heated recycle gas which enters the lower part of the CFB, and the offgas from the second reducer (FB) which enters further up in the CFB. The fines and char are carried out of the CFB due to the high gas velocity in the reactor, are captured by the cyclone, and returned to the CFB via the gasifier. Thus a circulation pattern is set up which allows the heat to be transferred to the CFB reactor.

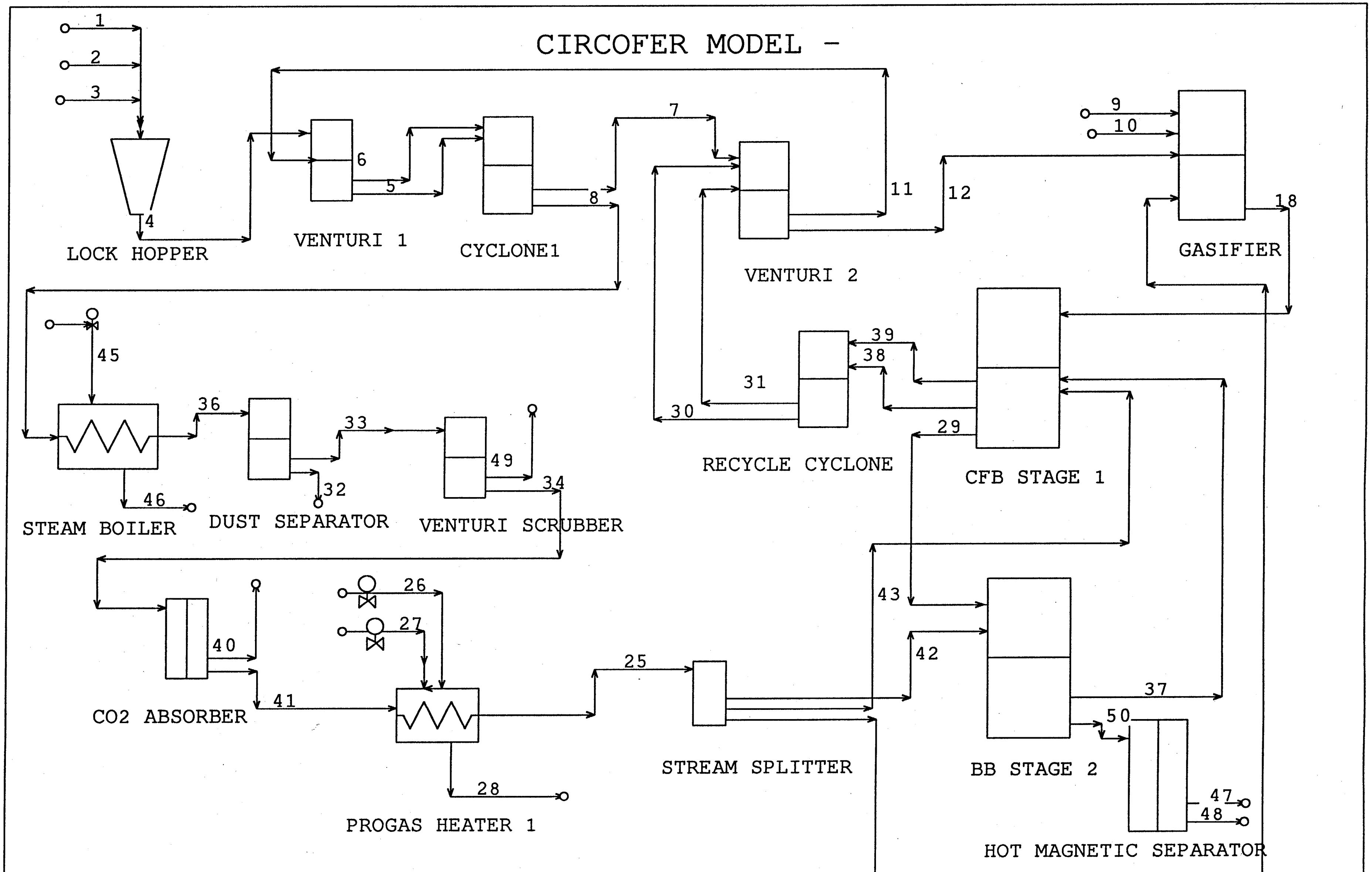
Reduced solids from the CFB enter the FB reactor, which is a conventional bubbling bed. In this second reduction stage, the fines reach a final metallization of 92 to 93%. The gas leaving the top of the FB passes on to the CFB. The product from the second reducer is partially cooled, the char and ash are removed by magnetic separation, and the product is briquetted and cooled.

PROCESS ADVANTAGES
Direct use of low cost iron ore fines
Proven fluid bed technology
High quality product

LURGI CIRCOFER PROCESS FLOWSHEET



CIRCOFER MODEL –



CIRCOFER PROCESS

Circofer Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon information from Lurgi. This process is at the pilot-plant development stage. Hence, only conceptual information is available.

Flowsheet Description

In this process, the Iron Ore Fines (Stream 1) along with Char (Stream 2) and Additive (Stream 3) enter into the Lockhopper and move towards Venturi 1 along with a recycle stream (Stream 11) where moisture from the ore fines is absorbed by the recycle gases as Stream 6. Stream 5, containing dried iron ore fines is separated as Stream 7 in Cyclone 1 from gases, Stream 8. The stream 7 along with top gas (Stream 30) and reduced solid particles (Stream 31) from CFB passes through Venturi 2 where solids are separated from gases and sent forward to the Gasifier. In the Gasifier, Coal (Stream 9) and Oxygen (Stream 10) are injected. The heat produced in the Gasifier by the reaction between Coal and Oxygen heats the ore and char to 1000C. The combined ore and gases (Stream 18) enters into the CFB Stage 1 where hot gases from BB Stage 2 (Stream 37) and fresh reducing gases from Process Gas Heater (Stream 43) are also injected. Here, partial reduction of iron ore takes place and the partially reduced ore (Stream 29) is sent to the Bubbling Bed Stage 2 reactor. Very fine iron ore (Stream 38) gets entrapped in the outgoing top gas (Stream 39). The Recycle Cyclone separates solid particles from the gas and recycles them back to Ventui 2 as Stream 30. Stream 31, Top gas is also sent to the Venturi 2, Venturi 1 and then finally it comes out as Stream 8 from the Cyclone 1. It is then cooled by using a steam boiler to about 220C. The cooled gas (Stream 36) is then passed through a Dust Separator to remove dust if any. Then it is stripped of water and CO2 and preheated. The preheating is done in a Process Gas Heater by burning natural gas with air. Then this hot stream at 750C is divided into three parts to be used in two reducing reactors (Streams 42 and 43) and the gasifier (Stream 44). Final reduction takes place in the BB Stage 2 reactor. Stream 50 is the final reduced iron or called Direct Reduced Iron containing char and all slag. It is passed through a Hot Magnetic Separator for separation of DRI (Stream 47) from char and slag (Stream 48).

Model Assumptions:

Cyclone 1: 100% efficiency is assumed.

Gasifier: No reduction of ore in the gasifier is assumed. The output temperature is 1000C.

CFB Stage 1: Partial reduction takes place in this reactor.

Recycle Cyclone: 100% efficiency is assumed.

Process Gas Heat Exchanger: 100% efficient; No heat losses are assumed. Both outlet temperatures are same.

BB Stage 2: 95% reduction of FeO to Fe takes place. No carry over of particles in top gas is assumed.

Results

Since not much information is available in terms of operation data, it was decided to achieve same operating conditions as were outlined by Lurgi in their articles. Assumptions were made about the composition of the ore fines, reduced ore, ash coal and char, etc. The model results are qualitatively close to the those provided by Lurgi.

CIRCOFER PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8	9	10	11
Description	Iron Ore to L	Char	Additive	Iron Ore from	Dried Iron Or	top gas from	Iron Ore	Top Gas to S	Coal	Oxygen	Top gas recy
MT/HR SOLIDS	1095.6	200	50	1345.6	1345.6	0	1345.6	0	200	0	0
MT/HR AQUEOUS	95.3	0	0	95.3	0	0	0	0	0	0	0
MT/HR GASEOUS	0	0	0	0	0	13204	0	13204	0	190	13109
MT/HR TOTAL	1190.9	200	50	1440.9	1345.6	13204	1345.6	13204	200	190	13109
Percent Solids	91.998	100	100	93.386	100	0	100	0	100	0	0
Sp.Gr.SOLIDS	5.0205	2.1034	3.31	4.0973	4.0973	0	4.0973	0	1.232	0	0
Sp.Gr.AQUEOUS	0.99507	0	0	0.99514	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0	0	0	0	0.00060097	0	0.00060097	0	0.0012779	0.00032591
Sp.Gr.TOTAL	3.7927	2.1034	3.31	3.3969	4.0973	0.00060097	4.0973	0.00060097	1.232	0.0012779	0.00032591
Temperature C	32	32	25	31.768	300	300	300	300	25	32	788.05
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	0	0	0	0	1.05E+07	0	1.05E+07	0	1.33E+05	1.04E+07
Sol/Liq lps	87.221	26.412	4.196	117.83	91.226	0	91.226	0	45.093	0	0
Sol/Liq lph	3.14E+05	95083	15106	4.24E+05	3.28E+05	0	3.28E+05	0	1.62E+05	0	0
Sol/Liq m3/hr	314	95.083	15.106	424.18	328.41	0	328.41	0	162.34	0	0
Component Mass Flow Rates											
1 Fe2O3 MT/HR	101.12	-4.44E-14	2.78E-14	101.12	101.12	0	101.12	0	0	0	0
2 Fe3O4 MT/HR	918.22	0	0	918.22	918.22	0	918.22	0	0	0	0
3 FeO MT/HR	0	0	0	0	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	11.723	19	0	30.723	30.723	0	30.723	0	12.4	0	0
6 Al2O3 MT/HR	8.8744	0	0	8.8744	8.8744	0	8.8744	0	0	0	0
7 P1 MT/HR	0.66832	0	0	0.66832	0.66832	0	0.66832	0	0	0	0
8 Cu1 MT/HR	0.39442	0	0	0.39442	0.39442	0	0.39442	0	0	0	0
9 Ca1O1 MT/HR	7.7788	0	50	57.779	57.779	0	57.779	0	0	0	0
10 Mg1O1 MT/HR	31.992	0	0	31.992	31.992	0	31.992	0	0	0	0
11 Ti1O2 MT/HR	12.052	0	0	12.052	12.052	0	12.052	0	0	0	0
12 S1 MT/HR	0.32868	0	0	0.32868	0.32868	0	0.32868	0	0	0	0
13 V1 MT/HR	0.71214	0	0	0.71214	0.71214	0	0.71214	0	0	0	0
14 Co1 MT/HR	0.28486	0	0	0.28486	0.28486	0	0.28486	0	0	0	0
15 Ni1 MT/HR	0.32868	0	0	0.32868	0.32868	0	0.32868	0	0	0	0
16 Zn1 MT/HR	0.4492	0	0	0.4492	0.4492	0	0.4492	0	0	0	0
17 Pb1 MT/HR	0.66832	0	0	0.66832	0.66832	0	0.66832	0	0	0	0
19 H2O MT/HR	95.3	0	0	95.3	0	0	0	0	0	0	0
20 H2O MT/HR	0	0	0	0	0	190.6	0	190.6	0	2.11E-14	95.3
21 N2 MT/HR	0	0	0	0	0	0	0	0	0	0	0
22 O2 MT/HR	0	0	0	0	0	0	0	0	0	190	0
23 C1H4 MT/HR	0	0	0	0	0	67	0	67	0	0	67
24 C1O2 MT/HR	0	0	0	0	0	760.37	0	760.37	0	0	760.37
26 CO MT/HR	0	0	0	0	0	12186	0	12186	0	0	12186
27 C MT/HR	0	173.6	0	173.6	173.6	0	173.6	0	114	0	0
28 C5H8 MT/HR	0	7.4	0	7.4	7.4	0	7.4	0	73.6	0	0
Element Mass Flow Rates											
1 H 1	10.664	0.87599	0	11.54	0.87599	38.167	0.87599	38.167	8.7125	2.36E-15	27.502
2 C 6	0	180.12	0	180.12	180.12	5483.1	180.12	5483.1	178.89	0	5483.1
3 N 7	0	0	0	0	0	0	0	0	0	0	0
4 O 8	398.99	10.119	14.265	423.38	338.74	7682.6	338.74	7682.6	6.6038	190	7598
5 Mg 12	19.294	0	0	19.294	19.294	0	19.294	0	0	0	0
6 Al 13	4.6968	0	0	4.6968	4.6968	0	4.6968	0	0	0	0
7 Si 14	5.4798	8.8813	0	14.361	14.361	0	14.361	0	5.7962	0	0
8 P 15	0.66832	0	0	0.66832	0.66832	0	0.66832	0	0	0	0
9 S 16	0.32868	0	0	0.32868	0.32868	0	0.32868	0	0	0	0
10 Ca 20	5.5595	0	35.735	41.295	41.295	0	41.295	0	0	0	0
11 Ti 22	7.225	0	0	7.225	7.225	0	7.225	0	0	0	0
12 V 23	0.71214	0	0	0.71214	0.71214	0	0.71214	0	0	0	0
13 Fe 26	735.15	-3.11E-14	1.94E-14	735.15	735.15	0	735.15	0	0	0	0
14 Co 27	0.28486	0	0	0.28486	0.28486	0	0.28486	0	0	0	0
15 Ni 28	0.32868	0	0	0.32868	0.32868	0	0.32868	0	0	0	0
16 Cu 29	0.39442	0	0	0.39442	0.39442	0	0.39442	0	0	0	0
17 Zn 30	0.4492	0	0	0.4492	0.4492	0	0.4492	0	0	0	0
18 Pb 82	0.66832	0	0	0.66832	0.66832	0	0.66832	0	0	0	0

CIRCOFER PROCESS --- STREAM SUMMARY

Stream Number	12	18	25	26	27	28	29	30	31	32	33
Description	Iron Ore Fee	Iron Ore to C	Reducing ga	Natural gas f	Combustion	Exhaust for	Partially Red	Top gas	Recycle solid	Dust	Clean cool to
MT/HR SOLIDS	1359.5	1416.8	0	0	0	0	1371.3	0	13.852	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
MT/HR GASEOUS	0	4533.6	12356	232.32	4733.5	4965.9	0	12962	0	0	13204
MT/HR TOTAL	1359.5	5950.4	12356	232.32	4733.5	4965.9	1371.3	12962	13.852	0	13204
Percent Solids	100	23.81	0	0	0	0	100	0	100	0	0
Sp.Gr.SOLIDS	4.0873	3.2831	0	0	0	0	3.3063	0	3.3063	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	0.00026606	0.00033087	0.0006407	0.001152	0.00033122	0	0.00031304	0	0	0.00069852
Sp.Gr.TOTAL	4.0873	0.0003492	0.00033087	0.0006407	0.001152	0.00033122	3.3063	0.00031304	3.3063	0	0.00069852
Temperature C	788.05	1000	750	32	32	750	950	831.83	831.83	220	220
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	3.66E+06	9.97E+06	3.25E+05	3.68E+06	4.00E+06	0	1.02E+07	0	0	1.05E+07
Sol/Liq lps	92.39	119.87	0	0	0	0	115.21	0	1.1638	0	0
Sol/Liq lph	3.33E+05	4.32E+05	0	0	0	0	4.15E+05	0	4189.6	0	0
Sol/Liq m3/hr	332.6	431.54	0	0	0	0	414.77	0	4.1896	0	0
Component Mass Flow Rates											
1 Fe2O3 MT/HR	101.12	101.12	0	0	0	0	0	0	0	0	0
2 Fe3O4 MT/HR	924.35	924.35	0	0	0	0	607.13	0	6.1326	0	0
3 FeO MT/HR	3.8443	3.8443	0	0	0	0	380.59	0	3.8443	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	31.159	43.559	0	0	0	0	43.123	0	0.43559	0	0
6 Al2O3 MT/HR	8.964	8.964	0	0	0	0	8.8744	0	0.08964	0	0
7 P1 MT/HR	0.67507	0.67507	0	0	0	0	0.66832	0	0.0067507	0	0
8 Cu1 MT/HR	0.3984	0.3984	0	0	0	0	0.39442	0	0.003984	0	0
9 Ca1O1 MT/HR	58.362	58.362	0	0	0	0	57.779	0	0.58362	0	0
10 Mg1O1 MT/HR	32.315	32.315	0	0	0	0	31.992	0	0.32315	0	0
11 Ti1O2 MT/HR	12.173	12.173	0	0	0	0	12.052	0	0.12173	0	0
12 S1 MT/HR	0.332	0.332	0	0	0	0	0.32868	0	0.00332	0	0
13 V1 MT/HR	0.71933	0.71933	0	0	0	0	0.71214	0	0.0071933	0	0
14 Co1 MT/HR	0.28773	0.28773	0	0	0	0	0.28486	0	0.0028773	0	0
15 Ni1 MT/HR	0.332	0.332	0	0	0	0	0.32868	0	0.00332	0	0
16 Zn1 MT/HR	0.45373	0.45373	0	0	0	0	0.4492	0	0.0045373	0	0
17 Pb1 MT/HR	0.67507	0.67507	0	0	0	0	0.66832	0	0.0067507	0	0
19 H2O MT/HR	0	0	0	0	0	0	0	0	0	0	0
20 H2O MT/HR	0	32.402	95.3	0	0	521.76	0	95.3	0	0	190.6
21 N2 MT/HR	0	0	0	0	3635.4	3635.4	0	0	0	0	0
22 O2 MT/HR	0	0	0	0	1098.2	171.42	0	0	0	0	0
23 C1H4 MT/HR	0	22.78	67	232.32	0	0	0	67	0	0	67
24 C1O2 MT/HR	0	2.5853	7.6037	0	0	637.31	0	760.37	0	0	760.37
26 CO MT/HR	0	4475.8	12186	0	0	0	0	12039	0	0	12186
27 C MT/HR	175.06	146.43	0	0	0	0	144.96	0	1.4643	0	0
28 C5H8 MT/HR	8.2182	81.818	0	0	0	0	81	0	0.81818	0	0
Element Mass Flow Rates											
1 H 1	0.97284	19.036	27.502	58.386	0	58.386	9.5885	27.502	0.096854	0	38.167
2 C 6	182.31	2155.6	5277.6	173.93	0	173.93	216.37	5420.3	2.1856	0	5483.1
3 N 7	0	0	0	0	3635.4	3635.4	0	0	0	0	0
4 O 8	341.91	2935.7	7050.6	0	1098.2	1098.2	313.72	7514.3	3.1688	0	7682.6
5 Mg 12	19.489	19.489	0	0	0	0	19.294	0	0.19489	0	0
6 Al 13	4.7442	4.7442	0	0	0	0	4.6968	0	0.047442	0	0
7 Si 14	14.565	20.361	0	0	0	0	20.157	0	0.20361	0	0
8 P 15	0.67507	0.67507	0	0	0	0	0.66832	0	0.0067507	0	0
9 S 16	0.332	0.332	0	0	0	0	0.32868	0	0.00332	0	0
10 Ca 20	41.712	41.712	0	0	0	0	41.295	0	0.41712	0	0
11 Ti 22	7.298	7.298	0	0	0	0	7.225	0	0.07298	0	0
12 V 23	0.71933	0.71933	0	0	0	0	0.71214	0	0.0071933	0	0
13 Fe 26	742.58	742.58	0	0	0	0	735.15	0	7.4258	0	0
14 Co 27	0.28773	0.28773	0	0	0	0	0.28486	0	0.0028773	0	0
15 Ni 28	0.332	0.332	0	0	0	0	0.32868	0	0.00332	0	0
16 Cu 29	0.3984	0.3984	0	0	0	0	0.39442	0	0.003984	0	0
17 Zn 30	0.45373	0.45373	0	0	0	0	0.4492	0	0.0045373	0	0
18 Pb 82	0.67507	0.67507	0	0	0	0	0.66832	0	0.0067507	0	0

CIRCOFER PROCESS --- STREAM SUMMARY

Stream Number	34	36	37	38	39	40	41	42	43	44	45
Description	Dry top gas	Cold top gas	Reducing ga	Partially Red	Top Gas with	CO2	Cold Recycle	Recycle gas f	Recycle gas f	Recycle gas f	Water
MT/HR SOLIDS	0	0	0	13.852	0	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0	0	0	1379.8
MT/HR GASEOUS	13109	13204	4319.4	0	12962	752.77	12356	4077.4	4077.4	4201	0
MT/HR TOTAL	13109	13204	4319.4	13.852	12962	752.77	12356	4077.4	4077.4	4201	1379.8
Percent Solids	0	0	0	100	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	3.3063	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0	0	0.99712
Sp.Gr.GASEOUS	0.00068356	0.00069852	0.00032639	0	0.0003025	0.0010599	0.00066908	0.00033087	0.00033087	0.00033087	0
Sp.Gr.TOTAL	0.00068356	0.00069852	0.00032639	3.3063	0.0003025	0.0010599	0.00066908	0.00033087	0.00033087	0.00033087	0.99712
Temperature C	232.88	220	825.64	870.33	870.33	232.88	232.88	750	750	750	25
Pressure kPa	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	1.04E+07	1.05E+07	3.29E+06	0	1.02E+07	3.83E+05	9.97E+06	3.29E+06	3.29E+06	3.39E+06	0
Sol/Liq lps	0	0	0	1.1638	0	0	0	0	0	0	384.37
Sol/Liq lph	0	0	0	4189.6	0	0	0	0	0	0	1.38E+06
Sol/Liq m3/hr	0	0	0	4.1896	0	0	0	0	0	0	1383.7
Component Mass Flow Rates											
1 Fe2O3 MT/HR	0	0	0	0	0	0	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	0	6.1326	0	0	0	0	0	0	0
3 FeO MT/HR	0	0	0	3.8443	0	0	0	0	0	0	0
4 Fe1 MT/HR	0	0	0	0	0	0	0	0	0	0	0
5 Si1O2 MT/HR	0	0	0	0.43559	0	0	0	0	0	0	0
6 Al2O3 MT/HR	0	0	0	0.08964	0	0	0	0	0	0	0
7 P1 MT/HR	0	0	0	0.0067507	0	0	0	0	0	0	0
8 Cu1 MT/HR	0	0	0	0.003984	0	0	0	0	0	0	0
9 Ca1O1 MT/HR	0	0	0	0.58362	0	0	0	0	0	0	0
10 Mg1O1 MT/HR	0	0	0	0.32315	0	0	0	0	0	0	0
11 Ti1O2 MT/HR	0	0	0	0.12173	0	0	0	0	0	0	0
12 S1 MT/HR	0	0	0	0.00332	0	0	0	0	0	0	0
13 V1 MT/HR	0	0	0	0.0071933	0	0	0	0	0	0	0
14 Co1 MT/HR	0	0	0	0.0028773	0	0	0	0	0	0	0
15 Ni1 MT/HR	0	0	0	0.00332	0	0	0	0	0	0	0
16 Zn1 MT/HR	0	0	0	0.0045373	0	0	0	0	0	0	0
17 Pb1 MT/HR	0	0	0	0.0067507	0	0	0	0	0	0	0
19 H2O MT/HR	0	0	0	0	0	0	0	0	0	0	1379.8
20 H2O MT/HR	95.3	190.6	31.449	0	95.3	0	95.3	31.449	31.449	32.402	0
21 N2 MT/HR	0	0	0	0	0	0	0	0	0	0	0
22 O2 MT/HR	0	0	0	0	0	0	0	0	0	0	0
23 C1H4 MT/HR	67	67	22.11	0	67	0	67	22.11	22.11	22.78	0
24 C1O2 MT/HR	760.37	760.37	668.28	0	760.37	752.77	7.6037	2.5092	2.5092	2.5853	0
26 CO MT/HR	12186	12186	3597.6	0	12039	0	12186	4021.3	4021.3	4143.2	0
27 C MT/HR	0	0	0	1.4643	0	0	0	0	0	0	0
28 C5H8 MT/HR	0	0	0	0.81818	0	0	0	0	0	0	0
Element Mass Flow Rates											
1 H 1	27.502	38.167	9.0758	0.096854	27.502	0	27.502	9.0758	9.0758	9.3508	154.4
2 C 6	5483.1	5483.1	1741.6	2.1856	5420.3	205.44	5277.6	1741.6	1741.6	1794.4	0
3 N 7	0	0	0	0	0	0	0	0	0	0	0
4 O 8	7598	7682.6	2568.7	3.1688	7514.3	547.32	7050.6	2326.7	2326.7	2397.2	1225.4
5 Mg 12	0	0	0	0.19489	0	0	0	0	0	0	0
6 Al 13	0	0	0	0.047442	0	0	0	0	0	0	0
7 Si 14	0	0	0	0.20361	0	0	0	0	0	0	0
8 P 15	0	0	0	0.0067507	0	0	0	0	0	0	0
9 S 16	0	0	0	0.00332	0	0	0	0	0	0	0
10 Ca 20	0	0	0	0.41712	0	0	0	0	0	0	0
11 Ti 22	0	0	0	0.07298	0	0	0	0	0	0	0
12 V 23	0	0	0	0.0071933	0	0	0	0	0	0	0
13 Fe 26	0	0	0	7.4258	0	0	0	0	0	0	0
14 Co 27	0	0	0	0.0028773	0	0	0	0	0	0	0
15 Ni 28	0	0	0	0.00332	0	0	0	0	0	0	0
16 Cu 29	0	0	0	0.003984	0	0	0	0	0	0	0
17 Zn 30	0	0	0	0.0045373	0	0	0	0	0	0	0
18 Pb 82	0	0	0	0.0067507	0	0	0	0	0	0	0

CIRCOFER PROCESS --- STREAM SUMMARY

Stream Number	46	47	48	49	50
Description	Steam	DRI	Char and As	Water	Reduced Iron
MT/HR SOLIDS	0	738.23	391.07	0	1129.3
MT/HR AQUEOUS	1379.8	0	0	95.3	0
MT/HR GASEOUS	0	0	0	0	0
MT/HR TOTAL	1379.8	738.23	391.07	95.3	1129.3
Percent Solids	0	100	100	0	100
Sp.Gr.SOLIDS	0	7.6755	1.6874	0	3.4436
Sp.Gr.AQUEOUS	0.84013	0	0	0.82339	0
Sp.Gr.GASEOUS	0	0	0	0	0
Sp.Gr.TOTAL	0.84013	7.6755	1.6874	0.82339	3.4436
Temperature C	220	484.03	484.03	232.88	825.64
Pressure kPa	101.33	101.33	101.33	101.33	101.33
Gas nm3/hr	0	0	0	0	0
Sol/Liq lps	456.2	26.716	64.379	32.15	91.095
Sol/Liq lph	1.64E+06	96179	2.32E+05	1.16E+05	3.28E+05
Sol/Liq m3/hr	1642.3	96.179	231.76	115.74	327.94
Component Mass Flow Rates					
1 Fe2O3 MT/HR	0	0	0	0	0
2 Fe3O4 MT/HR	0	0	0	0	0
3 FeO MT/HR	0	46.815	0.47288	0	47.288
4 Fe1 MT/HR	0	691.41	6.984	0	698.4
5 Si1O2 MT/HR	0	0	43.123	0	43.123
6 Al2O3 MT/HR	0	0	8.8744	0	8.8744
7 P1 MT/HR	0	0	0.66832	0	0.66832
8 Cu1 MT/HR	0	0	0.39442	0	0.39442
9 Ca1O1 MT/HR	0	0	57.779	0	57.779
10 Mg1O1 MT/HR	0	0	31.992	0	31.992
11 Ti1O2 MT/HR	0	0	12.052	0	12.052
12 S1 MT/HR	0	0	0.32868	0	0.32868
13 V1 MT/HR	0	0	0.71214	0	0.71214
14 Co1 MT/HR	0	0	0.28486	0	0.28486
15 Ni1 MT/HR	0	0	0.32868	0	0.32868
16 Zn1 MT/HR	0	0	0.4492	0	0.4492
17 Pb1 MT/HR	0	0	0.66832	0	0.66832
19 H2O MT/HR	1379.8	0	0	95.3	0
20 H2O MT/HR	0	0	0	0	0
21 N2 MT/HR	0	0	0	0	0
22 O2 MT/HR	0	0	0	0	0
23 C1H4 MT/HR	0	0	0	0	0
24 C1O2 MT/HR	0	0	0	0	0
26 CO MT/HR	0	0	0	0	0
27 C MT/HR	0	0	144.96	0	144.96
28 C5H8 MT/HR	0	0	81	0	81
Element Mass Flow Rates					
1 H 1	154.4	0	9.5885	10.664	9.5885
2 C 6	0	0	216.37	0	216.37
3 N 7	0	0	0	0	0
4 O 8	1225.4	10.425	61.257	84.636	71.682
5 Mg 12	0	0	19.294	0	19.294
6 Al 13	0	0	4.6968	0	4.6968
7 Si 14	0	0	20.157	0	20.157
8 P 15	0	0	0.66832	0	0.66832
9 S 16	0	0	0.32868	0	0.32868
10 Ca 20	0	0	41.295	0	41.295
11 Ti 22	0	0	7.225	0	7.225
12 V 23	0	0	0.71214	0	0.71214
13 Fe 26	0	727.8	7.3515	0	735.15
14 Co 27	0	0	0.28486	0	0.28486
15 Ni 28	0	0	0.32868	0	0.32868
16 Cu 29	0	0	0.39442	0	0.39442
17 Zn 30	0	0	0.4492	0	0.4492
18 Pb 82	0	0	0.66832	0	0.66832

CIRCOFER MODEL

CASE DEFINITION

Title : CIRCOFER MODEL
Case :

Data Storage File Name	: Circofer.sfw
Mass Balance Option	: ON
Heat Balance Option	: ON
Units of Mass	: metric tonne
Units of Time	: hour
Ambient Air Pressure	: 101.325 kPa
Standard Pressure	: 101.325 kPa
Ambient Air Temperature	: 20.00 C
Standard Temperature	: 0.00 C
Plant Site Latitude	: 0.00 Degrees
Plant Site Elevation	: 0.00 Meters

CIRCOFER MODEL

COMPONENT DATA

ROW	CNM	CHF			PHC	CMW	SGF
1	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
2	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
3	FeO	FeO	SI1	71.8464	5.7000	0.0000	0.0000
4	Fe1	Fe1	SI1	55.8470	7.8600	0.0000	0.0000
5	Si1O2	Si1O2	SI1	60.0848	2.6500	0.0000	0.0000
6	Al2O3	Al2O3	SI1	101.9612	3.9650	0.0000	0.0000
7	P1	P1	SI1	30.9738	1.8200	0.0000	0.0000
8	Cu1	Cu1	SI1	63.5400	8.9200	0.0000	0.0000
9	Ca1O1	Ca1O1	SI1	56.0794	3.3100	0.0000	0.0000
10	Mg1O1	Mg1O1	SI1	40.3114	3.5800	0.0000	0.0000
11	Ti1O2	Ti1O2	SI1	79.8988	4.2600	0.0000	0.0000
12	S1	S1	SI1	32.0640	2.0000	0.0000	0.0000
13	V1	V1	SI1	50.9420	5.9600	0.0000	0.0000
14	Co1	Co1	SI1	58.9330	8.9000	0.0000	0.0000
15	Ni1	Ni1	SI1	58.7100	8.9000	0.0000	0.0000
16	Zn1	Zn1	SI1	65.3800	7.1400	0.0000	0.0000
17	Pb1	Pb1	SI1	207.1900	11.3400	0.0000	0.0000
18	Ca1C1O3	Ca1C1O3	SI1	100.0894	1.0000	0.0000	0.0000
19	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
20	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
21	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
22	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
23	C1H4	C1H4	GC8	16.0430	0.0007	0.0000	0.0000
24	C1O2	C1O2	GC8	44.0100	0.0020	0.0000	0.0000
25	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
26	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000
27	C	C	SI1	12.0112	2.2500	0.0000	0.0000
28	C5H8	C5H8	SI1	68.1195	0.6879	0.2491	0.2690

ROW	CNM	SOL	A	B	C	pH	Wi	COV A B C	
1	Fe2O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	Fe3O4	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	FeO	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	Fe1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	Si1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	Al2O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	P1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8	Cu1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
9	Ca1O1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
10	Mg1O1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	Ti1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
12	S1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13	V1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
14	Co1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
15	Ni1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
16	Zn1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
17	Pb1	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
18	Ca1C1O3	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
19	H2O	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
20	H2O	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
21	N2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
22	O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
23	C1H4	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
24	C1O2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
25	H2	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
26	CO	23.7700	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
27	C	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
28	C5H8	0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

CIRCOFER MODEL

COMPONENT DATA

ROW	CNM	CRIT T	CRIT P	CRIT V	ANTOINE VAPOR PRES A	B	C	HENRY
1	Fe2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
2	Fe3O4	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
3	FeO	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
4	Fe1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
5	Si1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
6	Al2O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
7	P1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
8	Cu1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
9	Ca1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
10	Mg1O1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
11	Ti1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
12	S1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
13	V1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
14	Co1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
15	Ni1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
16	Zn1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
17	Pb1	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
18	Ca1C1O3	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
19	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
20	H2O	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
21	N2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
22	O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
23	C1H4	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
24	C1O2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
25	H2	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
26	CO	133.400	35.4638	93.100	6.24020	230.27	260.010	63426.0
27	C	0.000	0.0000	0.000	0.00000	0.00	0.000	0.0
28	C5H8	503.000	41.2393	276.000	6.91820	1104.99	228.851	0.0

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
2	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
3	FeO	BAK2248	-62382	8754	-8.5950	9.1416	-21.4692
4	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
5	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
6	Al2O3	B672042	-400500	-12425	28.9653	1.0071	11.1085
7	P1	B672282	0	-2816	12.9239	-11.6659	0.0000
8	Cu1	B672129	0	-1423	5.0156	0.9276	-0.4694
9	Ca1O1	B672098	-151790	-4315	12.0730	0.4606	2.0088
10	Mg1O1	B672227	-143760	-4612	11.8081	0.3610	3.1765
11	Ti1O2	B672431	-225670	-6260	16.8540	0.6334	3.4762
12	S1	B672335	0	13015	-44.4133	56.5440	-14.3084
13	V1	B672454	0	-999	4.4929	1.2791	-1.3985
14	Co1	B672113	0	-3885	7.9629	0.8444	4.4112
15	Ni1	B672270	0	-1763	6.2394	0.7740	-0.5571
16	Zn1	B672480	0	-1445	4.7430	1.6445	-0.3435
17	Pb1	B672294	0	-1512	4.9651	1.6774	-0.3504
18	Ca1C1O3	B6771413	-288610	-9122	23.8351	3.2146	5.1569
19	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
20	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
21	N2	B672244	0	-2846	7.5728	0.2525	1.7794
22	O2	B672277	0	-2979	7.9696	0.2720	1.7697
23	C1H4	B6772217	-17880	-6424	11.8424	2.9907	8.0422
24	C1O2	B672094	-94051	-5911	12.9357	0.3891	6.1869
25	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
26	CO	YAWS	-26420	-1787	6.0661	0.9368	-0.3112
27	C	B672086	0	-2999	5.1802	0.2246	4.3597
28	C5H8	YAWS	27950	-8316	19.7382	30.7726	-0.9067

CIRCOFER MODEL

COMPONENT DATA

ROW	CNM	TEMP	RANGE oK	HTG-A	HTG-B	HTG-C	HTG-D
1	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
2	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
3	FeO	298.2	1650.0	-58450	-19.5576	-4.9564	-7.3814
4	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
5	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
6	Al2O3	298.2	2327.0	-386441	-25.8901	-10.0349	-27.6544
7	P1	298.2	317.3	-2534	6.8556	-27.4268	0.0000
8	Cu1	298.2	1357.6	1948	-9.4355	-3.1931	-3.6331
9	Ca1O1	298.2	2000.0	-146099	-14.8629	-4.7096	-10.7418
10	Mg1O1	298.2	2000.0	-138544	-11.5487	-4.4916	-9.9661
11	Ti1O2	298.2	2000.0	-217923	-19.7530	-6.5095	-14.7172
12	S1	298.2	388.4	-5700	12.4302	-23.6630	5.4073
13	V1	298.2	2190.0	2969	-9.8550	-2.7412	-5.5855
14	Co1	298.2	1768.0	2071	-8.3546	-3.9177	-4.1323
15	Ni1	298.2	1728.0	3122	-10.1656	-3.1379	-5.8385
16	Zn1	298.2	692.7	834	-9.1557	-4.7988	-1.9233
17	Pb1	298.2	600.7	544	-13.9080	-5.5553	-1.5560
18	Ca1C1O3	298.2	1200.0	-283124	-23.3813	-15.1456	-11.0884
19	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
20	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
21	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
22	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
23	C1H4	298.2	2000.0	-14673	-45.4106	-7.1789	-6.9854
24	C1O2	298.2	3000.0	-86430	-58.7976	-3.7771	-15.3476
25	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
26	CO	298.0	700.0	-25393	-46.6664	-5.1645	-2.2650
27	C	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
28	C5H8	135.9	318.0	23803	-68.4779	-61.0649	-1.8797

CIRCOFER MODEL

FLOWSHEET DATA

NO	OPR	UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC	CIRCOFER PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	HPR	LOCK HOPPER	1	2	3	0	0	0	0	4	0	0	0	0	0
3	SPP	VENTURI 1	4	0	11	0	0	0	0	5	6	0	0	0	0
4	SPP	CYCLONE1	6	5	0	0	0	0	0	8	7	0	0	0	0
5	SPP	VENTURI 2	7	30	31	0	0	0	0	12	11	0	0	0	0
6	SPP	GASIFIER	9	10	12	0	44	0	0	18	0	0	0	0	0
7	SPP	CFB STAGE 1	18	0	37	43	0	0	0	29	38	39	0	0	0
8	SPP	RECYCLE CYCLONE	39	38	0	0	0	0	0	30	31	0	0	0	0
9	HTX	STEAM BOILER	8	0	0	45	0	0	0	36	46	0	0	0	0
10	HTX	PROGAS HEATER 1	41	0	0	26	27	0	0	25	28	0	0	0	0
11	SPP	BB STAGE 2	29	42	0	0	0	0	0	50	37	0	0	0	0
12	SPP	DUST SEPARATOR	36	0	0	0	0	0	0	32	33	0	0	0	0
13	SPP	VENTURI SCRUBBER	33	0	0	0	0	0	0	34	49	0	0	0	0
14	SPS	STREAM SPLITTER	25	0	0	0	0	0	0	44	43	42	0	0	0
15	SPC	CO2 ABSORBER	34	0	0	0	0	0	0	41	40	0	0	0	0
16	SPC	HOT MAGNETIC SEPARATOR	50	0	0	0	0	0	0	48	47	0	0	0	0

CIRCOFER MODEL

HEAT BALANCE SUMMARY - 1000000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	CIRCOFER PROCESS	0	0	0	0	0	0	0	0
2	LOCK HOPPER	2	0	0	0	0	0	-2	0
3	VENTURI 1	2703	-56	0	0	0	-1643	-1004	0
4	CYCLONE1	1004	0	0	0	0	0	-1004	0
5	VENTURI 2	2949	0	0	0	0	0	-2949	0
6	GASIFIER	1069	314	0	0	0	229	-1612	0
7	CFB STAGE 1	3345	-20	0	0	0	0	-3326	0
8	RECYCLE CYCLONE	2992	0	0	0	-150	0	-2842	0
9	STEAM BOILER	927	0	0	0	0	0	-927	0
10	PROGAS HEATER 1	665	2777	0	0	0	0	-3442	0
11	BB STAGE 2	1129	33	0	0	0	0	-1162	0
12	DUST SEPARATOR	651	0	0	0	0	0	-651	0
13	VENTURI SCRUBBER	651	56	0	0	0	0	-707	0
14	STREAM SPLITTER	2412	0	0	0	0	0	-2412	0
15	CO2 ABSORBER	686	0	0	0	0	0	-686	0
16	HOT MAGNETIC SEP	225	0	0	0	-112	0	-112	0

CIRCOFER MODEL

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/H
1	Iron Ore to Lockhopper	32.00	89.60	1455227.0	5774809	608867
2	Char	32.00	89.60	501240.0	1989080	209718
3	Additive	25.00	77.00	-443.0	-1756	-185
4	Iron Ore from Lockhopper	31.77	89.18	1956024.0	7762132	818400
5	Dried Iron Ore	300.00	572.00	76183568.0	302320830	31875204
6	top gas from Venturi 1	300.00	572.00	927454477.0	3680436798	388046953
7	Iron Ore	300.00	572.00	76183568.0	302320830	31875204
8	Top Gas to Steam boiler	300.00	572.00	927454477.0	3680436798	388046953
9	Coal	25.00	77.00	261576.0	1038016	109443
10	Oxygen	32.00	89.60	346590.0	1375380	145013
11	Top gas recycled	788.05	1450.49	2700813369.0	10717693601	1130020313
12	Iron Ore Feed to Gasifier	788.05	1450.49	248165743.0	984801255	103832546
13	Air for Classifier	32.00	89.60	2369.0	9400	991
14	Compressed Air	32.00	89.60	2369.0	9400	991
15	Iron Ore from Cyclone 2	750.00	1382.00	173218033.0	687384708	72474425
16	Feed to CFB	750.00	1382.00	142215195.0	564355503	59502837
17	Iron Ore Recycle	750.00	1382.00	47405065.0	188118501	19834279
18	Iron Ore to Cyclone 2	1000.00	1832.00	1611926247.0	6396640294	674429941
19	Air to Cyclone 2	870.00	1598.00	629172.0	2496755	263245
20	Air to Calciner	32.00	89.60	2369.0	9400	991
21	Combustion Air to Heater 2	32.00	89.60	9918111.0	39358247	4149737
22	Natural gas to Heater 2	32.00	89.60	1333293.0	5290933	557849
23	Exhaust from Heater 2	675.00	1247.00	809492155.0	3212324474	338691517
24	Preheated Reformed gas for CFB	344.62	652.32	770969189.0	3059452993	322573508
25	Reducing gas for CFB	750.00	1382.00	2411598512.0	9569996297	1009012817
26	Natural gas for Heater 1	32.00	89.60	1507548.0	5982433	630758
27	Combustion Air for Heater 1	32.00	89.60	11212015.0	44492873	4691107
28	Exhaust for Heater 1	750.00	1382.00	1030746480.0	4090332592	431264327
29	Partially Reduced Ore	950.00	1742.00	333510716.0	1323477477	139540883
30	Top gas	831.83	1529.30	2839569431.0	11268322150	1188075849
31	Recycle solids	831.83	1529.30	2863614.0	11363740	1198136
32	Dust	220.00	428.00	0.0	0	
33	Clean cool top gas	220.00	428.00	651000067.0	2583377042	272378428
34	Dry top gas	232.88	451.19	686185734.0	2723005054	287100111
35	35	344.62	652.32	1565301081.0	6211616682	654921972
36	Cold top gas	220.00	428.00	651000067.0	2583377042	272378428
37	Reducing gas from BB	825.64	1518.15	937533667.0	3720434258	392264086
38	Partially Reduced Fines	870.33	1598.59	3026007.0	12008166	1266081
39	Top Gas with Fines	870.33	1598.59	2989008777.0	11861345403	1250601272
40	CO2	232.88	451.19	33472450.0	132829416	14004873
41	Cold Recycle gas	232.88	451.19	652713285.0	2590175638	273095238
42	Recycle gas for BB	750.00	1382.00	795827509.0	3158098778	332974229
43	Recycle gas for CFB	750.00	1382.00	795827509.0	3158098778	332974229
44	Recycle gas for Gasifier	750.00	1382.00	819943494.0	3253798741	343064358
45	Water	25.00	77.00	-220.0	-874	-92
46	Steam	220.00	428.00	276454189.0	1097058882	115668432
47	DRI	484.03	903.26	46850596.0	185918192	19602289
48	Char and Ash	484.03	903.26	65453819.0	259741743	27385877
49	Water	232.88	451.19	20464462.0	81209548	8562330
50	Reduced Iron	825.64	1518.15	224608830.0	891319870	93976334

CIRCOFER MODEL

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
6	top gas from Venturi 1	100.0000	12931532	6161888	21970812	10469114
8	Top Gas to Steam boiler	100.0000	12931532	6161888	21970812	10469114
10	Oxygen	100.0000	87510	78333	148680	133088
11	Top gas recycled	100.0000	23673628	6092101	40221749	10350546
13	Air for Classifier	100.0000	511	457	868	777
14	Compressed Air	100.0000	511	457	868	777
18	Iron Ore to Cyclone 2	100.0000	10029545	2151513	17040305	3655444
19	Air to Cyclone 2	100.0000	5455	1303	9268	2214
20	Air to Calciner	100.0000	511	457	868	777
21	Combustion Air to Heater 2	100.0000	2139273	1914935	3634648	3253496
22	Natural gas to Heater 2	100.0000	188752	168958	320692	287062
23	Exhaust from Heater 2	100.0000	7233548	2083894	12289876	3540558
24	Preheated Reformed gas for CFB	100.0000	10368202	4584343	17615688	7788848
25	Reducing gas for CFB	100.0000	21979638	5866452	37343642	9967165
26	Natural gas for Heater 1	100.0000	213421	191040	362605	324580
27	Combustion Air for Heater 1	100.0000	2418360	2164755	4108820	3677942
28	Exhaust for Heater 1	100.0000	8824207	2355796	14992423	4002522
30	Top gas	100.0000	24371199	6023117	41406930	10233342
33	Clean cool top gas	100.0000	11125605	6161888	18902524	10469114
34	Dry top gas	100.0000	11287139	6092101	19176972	10350546
35	35	100.0000	21050593	9307605	35765184	15813721
36	Cold top gas	100.0000	11125605	6161888	18902524	10469114
37	Reducing gas from BB	100.0000	7789251	1935929	13234022	3289165
39	Top Gas with Fines	100.0000	25220140	6023117	42849290	10233342
40	CO2	100.0000	418033	225649	710243	383380
41	Cold Recycle gas	100.0000	10869106	5866452	18466729	9967165
42	Recycle gas for BB	100.0000	7253281	1935929	12323402	3289165
43	Recycle gas for CFB	100.0000	7253281	1935929	12323402	3289165
44	Recycle gas for Gasifier	100.0000	7473077	1994594	12696838	3388836

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore to Lockhopper	100.0000	1382.480	87.2214	313.997	7535.93
2	Char	100.0000	418.633	26.4118	95.083	2281.98
3	Additive	100.0000	66.508	4.1960	15.106	362.54
4	Iron Ore from Lockhopper	100.0000	1867.591	117.8273	424.178	10180.28
5	Dried Iron Ore	100.0000	1445.950	91.2258	328.413	7881.91
7	Iron Ore	100.0000	1445.950	91.2258	328.413	7881.91
9	Coal	100.0000	714.739	45.0933	162.336	3896.06
12	Iron Ore Feed to Gasifier	100.0000	1464.396	92.3896	332.603	7982.46
29	Partially Reduced Ore	100.0000	1826.163	115.2136	414.769	9954.46
31	Recycle solids	100.0000	18.446	1.1638	4.190	100.55
38	Partially Reduced Fines	100.0000	18.446	1.1638	4.190	100.55
45	Water	100.0000	6092.407	384.3734	1383.744	33209.86
46	Steam	100.0000	7230.858	456.1989	1642.316	39415.59
47	DRI	100.0000	423.462	26.7164	96.179	2308.30
48	Char and Ash	100.0000	1020.421	64.3790	231.764	5562.34
49	Water	100.0000	509.588	32.1502	115.741	2777.78
50	Reduced Iron	100.0000	1443.883	91.0954	327.943	7870.64

CIRCOFER MODEL

MASS FLOW RATES - MT/HR

NO.	STREAM	MT/HR-SI	MT/HR-LI	MT/HR-GC	MT/HR-TC
1	Iron Ore to Lockhopper	1095.600	95.300	0.00	1190.90
2	Char	200.000	0.000	0.00	200.00
3	Additive	50.000	0.000	0.00	50.00
4	Iron Ore from Lockhopper	1345.600	95.300	0.00	1440.90
5	Dried Iron Ore	1345.600	0.000	0.00	1345.60
6	top gas from Venturi 1	0.000	0.000	13203.85	13203.85
7	Iron Ore	1345.600	0.000	0.00	1345.60
8	Top Gas to Steam boiler	0.000	0.000	13203.85	13203.85
9	Coal	200.000	0.000	0.00	200.00
10	Oxygen	0.000	0.000	190.00	190.00
11	Top gas recycled	0.000	0.000	13108.55	13108.55
12	Iron Ore Feed to Gasifier	1359.452	0.000	0.00	1359.45
13	Air for Classifier	0.000	0.000	1.00	1.00
14	Compressed Air	0.000	0.000	1.00	1.00
18	Iron Ore to Cyclone 2	1416.814	0.000	4533.60	5950.42
19	Air to Cyclone 2	0.000	0.000	2.85	2.85
20	Air to Calciner	0.000	0.000	1.00	1.00
21	Combustion Air to Heater 2	0.000	0.000	4187.27	4187.27
22	Natural gas to Heater 2	0.000	0.000	205.47	205.47
23	Exhaust from Heater 2	0.000	0.000	4392.73	4392.73
24	Preheated Reformed gas for CFB	0.000	0.000	772.20	772.20
25	Reducing gas for CFB	0.000	0.000	12355.78	12355.78
26	Natural gas for Heater 1	0.000	0.000	232.32	232.32
27	Combustion Air for Heater 1	0.000	0.000	4733.53	4733.53
28	Exhaust for Heater 1	0.000	0.000	4965.85	4965.85
29	Partially Reduced Ore	1371.334	0.000	0.00	1371.33
30	Top gas	0.000	0.000	12962.08	12962.08
31	Recycle solids	13.852	0.000	0.00	13.85
33	Clean cool top gas	0.000	0.000	13203.85	13203.85
34	Dry top gas	0.000	0.000	13108.55	13108.55
35	35	0.000	0.000	1567.80	1567.80
36	Cold top gas	0.000	0.000	13203.85	13203.85
37	Reducing gas from BB	0.000	0.000	4319.44	4319.44
38	Partially Reduced Fines	13.852	0.000	0.00	13.85
39	Top Gas with Fines	0.000	0.000	12962.08	12962.08
40	CO2	0.000	0.000	752.77	752.77
41	Cold Recycle gas	0.000	0.000	12355.78	12355.78
42	Recycle gas for BB	0.000	0.000	4077.41	4077.41
43	Recycle gas for CFB	0.000	0.000	4077.41	4077.41
44	Recycle gas for Gasifier	0.000	0.000	4200.96	4200.96
45	Water	0.000	1379.753	0.00	1379.75
46	Steam	0.000	1379.753	0.00	1379.75
47	DRI	738.227	0.000	0.00	738.23
48	Char and Ash	391.073	0.000	0.00	391.07
49	Water	0.000	95.300	0.00	95.30
50	Reduced Iron	1129.300	0.000	0.00	1129.30

CIRCOFER MODEL

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-GC	SG-TC
1	Iron Ore to Lockhopper	91.9976	5.0205	0.9951	0.0000	3.7927
2	Char	100.0000	2.1034	0.0000	0.0000	2.1034
3	Additive	100.0000	3.3100	0.0000	0.0000	3.3100
4	Iron Ore from Lockhopper	93.3861	4.0973	0.9951	0.0000	3.3969
5	Dried Iron Ore	100.0000	4.0973	0.0000	0.0000	4.0973
6	top gas from Venturi 1	0.0000	0.0000	0.0000	0.0006	0.0006
7	Iron Ore	100.0000	4.0973	0.0000	0.0000	4.0973
8	Top Gas to Steam boiler	0.0000	0.0000	0.0000	0.0006	0.0006
9	Coal	100.0000	1.2320	0.0000	0.0000	1.2320
10	Oxygen	0.0000	0.0000	0.0000	0.0013	0.0013
11	Top gas recycled	0.0000	0.0000	0.0000	0.0003	0.0003
12	Iron Ore Feed to Gasifier	100.0000	4.0873	0.0000	0.0000	4.0873
13	Air for Classifier	0.0000	0.0000	0.0000	0.0012	0.0012
14	Compressed Air	0.0000	0.0000	0.0000	0.0012	0.0012
18	Iron Ore to Cyclone 2	23.8103	3.2831	0.0000	0.0003	0.0003
19	Air to Cyclone 2	0.0000	0.0000	0.0000	0.0003	0.0003
20	Air to Calciner	0.0000	0.0000	0.0000	0.0012	0.0012
21	Combustion Air to Heater 2	0.0000	0.0000	0.0000	0.0012	0.0012
22	Natural gas to Heater 2	0.0000	0.0000	0.0000	0.0006	0.0006
23	Exhaust from Heater 2	0.0000	0.0000	0.0000	0.0004	0.0004
24	Preheated Reformed gas for CFB	0.0000	0.0000	0.0000	0.0000	0.0000
25	Reducing gas for CFB	0.0000	0.0000	0.0000	0.0003	0.0003
26	Natural gas for Heater 1	0.0000	0.0000	0.0000	0.0006	0.0006
27	Combustion Air for Heater 1	0.0000	0.0000	0.0000	0.0012	0.0012
28	Exhaust for Heater 1	0.0000	0.0000	0.0000	0.0003	0.0003
29	Partially Reduced Ore	100.0000	3.3063	0.0000	0.0000	3.3063
30	Top gas	0.0000	0.0000	0.0000	0.0003	0.0003
31	Recycle solids	100.0000	3.3063	0.0000	0.0000	3.3063
33	Clean cool top gas	0.0000	0.0000	0.0000	0.0007	0.0007
34	Dry top gas	0.0000	0.0000	0.0000	0.0007	0.0007
35	35	0.0000	0.0000	0.0000	0.0000	0.0000
36	Cold top gas	0.0000	0.0000	0.0000	0.0007	0.0007
37	Reducing gas from BB	0.0000	0.0000	0.0000	0.0003	0.0003
38	Partially Reduced Fines	100.0000	3.3063	0.0000	0.0000	3.3063
39	Top Gas with Fines	0.0000	0.0000	0.0000	0.0003	0.0003
40	CO2	0.0000	0.0000	0.0000	0.0011	0.0011
41	Cold Recycle gas	0.0000	0.0000	0.0000	0.0007	0.0007
42	Recycle gas for BB	0.0000	0.0000	0.0000	0.0003	0.0003
43	Recycle gas for CFB	0.0000	0.0000	0.0000	0.0003	0.0003
44	Recycle gas for Gasifier	0.0000	0.0000	0.0000	0.0003	0.0003
45	Water	0.0000	0.0000	0.9971	0.0000	0.9971
46	Steam	0.0000	0.0000	0.8401	0.0000	0.8401
47	DRI	100.0000	7.6755	0.0000	0.0000	7.6755
48	Char and Ash	100.0000	1.6874	0.0000	0.0000	1.6874
49	Water	0.0000	0.0000	0.8234	0.0000	0.8234
50	Reduced Iron	100.0000	3.4436	0.0000	0.0000	3.4436

CIRCOFER MODEL

STREAM DATA

SOLIDS - MT/HR

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	101.124	918.222	0.000	0.000	11.7229
2	Char	0.000	0.000	0.000	0.000	19.0000
3	Additive	0.000	0.000	0.000	0.000	0.0000
4	Iron Ore from Lockhopper	101.124	918.222	0.000	0.000	30.7229
5	Dried Iron Ore	101.124	918.222	0.000	0.000	30.7229
7	Iron Ore	101.124	918.222	0.000	0.000	30.7229
9	Coal	0.000	0.000	0.000	0.000	12.4000
12	Iron Ore Feed to Gasifier	101.124	924.355	3.844	0.000	31.1585
15	Iron Ore from Cyclone 2	101.124	918.227	0.000	0.000	11.7230
16	Feed to CFB	83.025	753.881	0.000	0.000	9.6248
17	Iron Ore Recycle	27.675	251.294	0.000	0.000	3.2083
18	Iron Ore to Cyclone 2	101.124	924.355	3.844	0.000	43.5585
29	Partially Reduced Ore	0.000	607.128	380.590	0.000	43.1229
31	Recycle solids	0.000	6.133	3.844	0.000	0.4356
38	Partially Reduced Fines	0.000	6.133	3.844	0.000	0.4356
47	DRI	0.000	0.000	46.815	691.412	0.0000
48	Char and Ash	0.000	0.000	0.473	6.984	43.1229
50	Reduced Iron	0.000	0.000	47.288	698.396	43.1229

SOLIDS - MT/HR

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	8.87436	0.66832	0.39442	7.7788	31.9915
3	Additive	0.00000	0.00000	0.00000	50.0000	0.0000
4	Iron Ore from Lockhopper	8.87436	0.66832	0.39442	57.7788	31.9915
5	Dried Iron Ore	8.87436	0.66832	0.39442	57.7788	31.9915
7	Iron Ore	8.87436	0.66832	0.39442	57.7788	31.9915
12	Iron Ore Feed to Gasifier	8.96400	0.67507	0.39840	58.3624	32.3147
15	Iron Ore from Cyclone 2	8.87441	0.66832	0.39442	7.7788	31.9917
16	Feed to CFB	7.28605	0.54870	0.32382	6.3865	26.2658
17	Iron Ore Recycle	2.42868	0.18290	0.10794	2.1288	8.7553
18	Iron Ore to Cyclone 2	8.96400	0.67507	0.39840	58.3624	32.3147
29	Partially Reduced Ore	8.87436	0.66832	0.39442	57.7788	31.9915
31	Recycle solids	0.08964	0.00675	0.00398	0.5836	0.3231
38	Partially Reduced Fines	0.08964	0.00675	0.00398	0.5836	0.3231
48	Char and Ash	8.87436	0.66832	0.39442	57.7788	31.9915
50	Reduced Iron	8.87436	0.66832	0.39442	57.7788	31.9915

SOLIDS - MT/HR

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	12.0516	0.32868	0.71214	0.28486	0.32868
4	Iron Ore from Lockhopper	12.0516	0.32868	0.71214	0.28486	0.32868
5	Dried Iron Ore	12.0516	0.32868	0.71214	0.28486	0.32868
7	Iron Ore	12.0516	0.32868	0.71214	0.28486	0.32868
12	Iron Ore Feed to Gasifier	12.1733	0.33200	0.71933	0.28773	0.33200
15	Iron Ore from Cyclone 2	12.0517	0.32868	0.71214	0.28486	0.32868
16	Feed to CFB	9.8946	0.26985	0.58468	0.23387	0.26985
17	Iron Ore Recycle	3.2982	0.08995	0.19489	0.07796	0.08995
18	Iron Ore to Cyclone 2	12.1733	0.33200	0.71933	0.28773	0.33200
29	Partially Reduced Ore	12.0516	0.32868	0.71214	0.28486	0.32868
31	Recycle solids	0.1217	0.00332	0.00719	0.00288	0.00332
38	Partially Reduced Fines	0.1217	0.00332	0.00719	0.00288	0.00332
48	Char and Ash	12.0516	0.32868	0.71214	0.28486	0.32868
50	Reduced Iron	12.0516	0.32868	0.71214	0.28486	0.32868

CIRCOFER MODEL

STREAM DATA

SOLIDS - MT/HR

NO.	STREAM	Zn1	Pb1	Ca1C1O3	C	C5H8
1	Iron Ore to Lockhopper	0.44920	0.66832	0.00000	0.000	0.0000
2	Char	0.00000	0.00000	0.00000	173.600	7.4000
4	Iron Ore from Lockhopper	0.44920	0.66832	0.00000	173.600	7.4000
5	Dried Iron Ore	0.44920	0.66832	0.00000	173.600	7.4000
7	Iron Ore	0.44920	0.66832	0.00000	173.600	7.4000
9	Coal	0.00000	0.00000	0.00000	114.000	73.6000
12	Iron Ore Feed to Gasifier	0.45373	0.67507	0.00000	175.064	8.2182
15	Iron Ore from Cyclone 2	0.44920	0.66832	0.00000	0.000	0.0000
16	Feed to CFB	0.36880	0.54870	0.00000	0.000	0.0000
17	Iron Ore Recycle	0.12293	0.18290	0.00000	0.000	0.0000
18	Iron Ore to Cyclone 2	0.45373	0.67507	0.00000	146.427	81.8182
29	Partially Reduced Ore	0.44920	0.66832	0.00000	144.962	81.0000
31	Recycle solids	0.00454	0.00675	0.00000	1.464	0.8182
38	Partially Reduced Fines	0.00454	0.00675	0.00000	1.464	0.8182
48	Char and Ash	0.44920	0.66832	0.00000	144.962	81.0000
50	Reduced Iron	0.44920	0.66832	0.00000	144.962	81.0000

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	9.23000	83.8100	0.0000	0.0000	1.0700
2	Char	0.00000	0.0000	0.0000	0.0000	9.5000
3	Additive	0.00000	0.0000	0.0000	0.0000	0.0000
4	Iron Ore from Lockhopper	7.51515	68.2389	0.0000	0.0000	2.2832
5	Dried Iron Ore	7.51515	68.2389	0.0000	0.0000	2.2832
7	Iron Ore	7.51515	68.2389	0.0000	0.0000	2.2832
9	Coal	0.00000	0.0000	0.0000	0.0000	6.2000
12	Iron Ore Feed to Gasifier	7.43858	67.9947	0.2828	0.0000	2.2920
15	Iron Ore from Cyclone 2	9.23000	83.8100	0.0000	0.0000	1.0700
16	Feed to CFB	9.23000	83.8100	0.0000	0.0000	1.0700
17	Iron Ore Recycle	9.23000	83.8100	0.0000	0.0000	1.0700
18	Iron Ore to Cyclone 2	7.13741	65.2418	0.2713	0.0000	3.0744
29	Partially Reduced Ore	0.00000	44.2728	27.7532	0.0000	3.1446
31	Recycle solids	0.00000	44.2728	27.7532	0.0000	3.1446
38	Partially Reduced Fines	0.00000	44.2728	27.7532	0.0000	3.1446
47	DRI	0.00000	0.0000	6.3416	93.6584	0.0000
48	Char and Ash	0.00000	0.0000	0.1209	1.7858	11.0268
50	Reduced Iron	0.00000	0.0000	4.1874	61.8433	3.8186

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	0.81000	0.06100	0.03600	0.710	2.92000
3	Additive	0.00000	0.00000	0.00000	100.000	0.00000
4	Iron Ore from Lockhopper	0.65951	0.04967	0.02931	4.294	2.37749
5	Dried Iron Ore	0.65951	0.04967	0.02931	4.294	2.37749
7	Iron Ore	0.65951	0.04967	0.02931	4.294	2.37749
12	Iron Ore Feed to Gasifier	0.65938	0.04966	0.02931	4.293	2.37704
15	Iron Ore from Cyclone 2	0.81000	0.06100	0.03600	0.710	2.92000
16	Feed to CFB	0.81000	0.06100	0.03600	0.710	2.92000
17	Iron Ore Recycle	0.81000	0.06100	0.03600	0.710	2.92000
18	Iron Ore to Cyclone 2	0.63269	0.04765	0.02812	4.119	2.28080
29	Partially Reduced Ore	0.64713	0.04873	0.02876	4.213	2.33288
31	Recycle solids	0.64713	0.04873	0.02876	4.213	2.33288
38	Partially Reduced Fines	0.64713	0.04873	0.02876	4.213	2.33288
48	Char and Ash	2.26923	0.17089	0.10085	14.774	8.18045
50	Reduced Iron	0.78583	0.05918	0.03493	5.116	2.83286

CIRCOFER MODEL

STREAM DATA

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	1.10000	0.03000	0.06500	0.02600	0.03000
4	Iron Ore from Lockhopper	0.89563	0.02443	0.05292	0.02117	0.02443
5	Dried Iron Ore	0.89563	0.02443	0.05292	0.02117	0.02443
7	Iron Ore	0.89563	0.02443	0.05292	0.02117	0.02443
12	Iron Ore Feed to Gasifier	0.89546	0.02442	0.05291	0.02117	0.02442
15	Iron Ore from Cyclone 2	1.10000	0.03000	0.06500	0.02600	0.03000
16	Feed to CFB	1.10000	0.03000	0.06500	0.02600	0.03000
17	Iron Ore Recycle	1.10000	0.03000	0.06500	0.02600	0.03000
18	Iron Ore to Cyclone 2	0.85920	0.02343	0.05077	0.02031	0.02343
29	Partially Reduced Ore	0.87882	0.02397	0.05193	0.02077	0.02397
31	Recycle solids	0.87882	0.02397	0.05193	0.02077	0.02397
38	Partially Reduced Fines	0.87882	0.02397	0.05193	0.02077	0.02397
48	Char and Ash	3.08168	0.08405	0.18210	0.07284	0.08405
50	Reduced Iron	1.06717	0.02910	0.06306	0.02522	0.02910

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Zn1	Pb1	Ca1C1O3	C	C5H8
1	Iron Ore to Lockhopper	0.04100	0.06100	0.00000	0.0000	0.0000
2	Char	0.00000	0.00000	0.00000	86.8000	3.7000
4	Iron Ore from Lockhopper	0.03338	0.04967	0.00000	12.9013	0.5499
5	Dried Iron Ore	0.03338	0.04967	0.00000	12.9013	0.5499
7	Iron Ore	0.03338	0.04967	0.00000	12.9013	0.5499
9	Coal	0.00000	0.00000	0.00000	57.0000	36.8000
12	Iron Ore Feed to Gasifier	0.03338	0.04966	0.00000	12.8776	0.6045
15	Iron Ore from Cyclone 2	0.04100	0.06100	0.00000	0.0000	0.0000
16	Feed to CFB	0.04100	0.06100	0.00000	0.0000	0.0000
17	Iron Ore Recycle	0.04100	0.06100	0.00000	0.0000	0.0000
18	Iron Ore to Cyclone 2	0.03202	0.04765	0.00000	10.3349	5.7748
29	Partially Reduced Ore	0.03276	0.04873	0.00000	10.5709	5.9067
31	Recycle solids	0.03276	0.04873	0.00000	10.5709	5.9067
38	Partially Reduced Fines	0.03276	0.04873	0.00000	10.5709	5.9067
48	Char and Ash	0.11486	0.17089	0.00000	37.0678	20.7123
50	Reduced Iron	0.03978	0.05918	0.00000	12.8365	7.1726

AQUEOUS - MT/HR

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	95.30
4	Iron Ore from Lockhopper	95.30
45	Water	1379.75
46	Steam	1379.75
49	Water	95.30

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	100.000
4	Iron Ore from Lockhopper	100.000
45	Water	100.000
46	Steam	100.000
49	Water	100.000

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
1	Iron Ore to Lockhopper	995.067
4	Iron Ore from Lockhopper	995.139
45	Water	997.116
46	Steam	840.126
49	Water	823.392

CIRCOFER MODEL

STREAM DATA

GASEOUS - MT/HR

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
6	top gas from Venturi 1	190.600	0.00	0.00	67.000	760.372
8	Top Gas to Steam boiler	190.600	0.00	0.00	67.000	760.372
10	Oxygen	0.000	0.00	190.00	0.000	0.000
11	Top gas recycled	95.300	0.00	0.00	67.000	760.372
13	Air for Classifier	0.000	0.77	0.23	0.000	0.000
14	Compressed Air	0.000	0.77	0.23	0.000	0.000
18	Iron Ore to Cyclone 2	32.402	0.00	0.00	22.780	2.585
19	Air to Cyclone 2	0.000	2.19	0.66	0.000	0.000
20	Air to Calciner	0.000	0.77	0.23	0.000	0.000
21	Combustion Air to Heater 2	0.000	3215.82	971.45	0.000	0.000
22	Natural gas to Heater 2	0.000	0.00	0.00	205.467	0.000
23	Exhaust from Heater 2	461.454	3215.82	151.81	0.000	563.647
25	Reducing gas for CFB	95.300	0.00	0.00	67.000	7.604
26	Natural gas for Heater 1	0.000	0.00	0.00	232.321	0.000
27	Combustion Air for Heater 1	0.000	3635.35	1098.18	0.000	0.000
28	Exhaust for Heater 1	521.764	3635.35	171.42	0.000	637.313
30	Top gas	95.300	0.00	0.00	67.000	760.372
33	Clean cool top gas	190.600	0.00	0.00	67.000	760.372
34	Dry top gas	95.300	0.00	0.00	67.000	760.372
36	Cold top gas	190.600	0.00	0.00	67.000	760.372
37	Reducing gas from BB	31.449	0.00	0.00	22.110	668.277
39	Top Gas with Fines	95.300	0.00	0.00	67.000	760.372
40	CO2	0.000	0.00	0.00	0.000	752.769
41	Cold Recycle gas	95.300	0.00	0.00	67.000	7.604
42	Recycle gas for BB	31.449	0.00	0.00	22.110	2.509
43	Recycle gas for CFB	31.449	0.00	0.00	22.110	2.509
44	Recycle gas for Gasifier	32.402	0.00	0.00	22.780	2.585

GASEOUS - MT/HR

NO.	STREAM	H2	CO
6	top gas from Venturi 1	0.00	12185.9
8	Top Gas to Steam boiler	0.00	12185.9
11	Top gas recycled	0.00	12185.9
18	Iron Ore to Cyclone 2	0.00	4475.8
24	Preheated Reformed gas for CFB	694.98	77.2
25	Reducing gas for CFB	0.00	12185.9
30	Top gas	0.00	12039.4
33	Clean cool top gas	0.00	12185.9
34	Dry top gas	0.00	12185.9
35	35	1411.02	156.8
36	Cold top gas	0.00	12185.9
37	Reducing gas from BB	0.00	3597.6
39	Top Gas with Fines	0.00	12039.4
41	Cold Recycle gas	0.00	12185.9
42	Recycle gas for BB	0.00	4021.3
43	Recycle gas for CFB	0.00	4021.3
44	Recycle gas for Gasifier	0.00	4143.2

CIRCOFER MODEL

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
6	top gas from Venturi 1	1.4435	0.0000	0.000	0.507	5.759
8	Top Gas to Steam boiler	1.4435	0.0000	0.000	0.507	5.759
10	Oxygen	0.0000	0.0000	100.000	0.000	0.000
11	Top gas recycled	0.7270	0.0000	0.000	0.511	5.801
13	Air for Classifier	0.0000	76.8000	23.200	0.000	0.000
14	Compressed Air	0.0000	76.8000	23.200	0.000	0.000
18	Iron Ore to Cyclone 2	0.7147	0.0000	0.000	0.502	0.057
19	Air to Cyclone 2	0.0000	76.8000	23.200	0.000	0.000
20	Air to Calciner	0.0000	76.8000	23.200	0.000	0.000
21	Combustion Air to Heater 2	0.0000	76.8000	23.200	0.000	0.000
22	Natural gas to Heater 2	0.0000	0.0000	0.000	100.000	0.000
23	Exhaust from Heater 2	10.5049	73.2077	3.456	0.000	12.831
25	Reducing gas for CFB	0.7713	0.0000	0.000	0.542	0.062
26	Natural gas for Heater 1	0.0000	0.0000	0.000	100.000	0.000
27	Combustion Air for Heater 1	0.0000	76.8000	23.200	0.000	0.000
28	Exhaust for Heater 1	10.5070	73.2070	3.452	0.000	12.834
30	Top gas	0.7352	0.0000	0.000	0.517	5.866
33	Clean cool top gas	1.4435	0.0000	0.000	0.507	5.759
34	Dry top gas	0.7270	0.0000	0.000	0.511	5.801
36	Cold top gas	1.4435	0.0000	0.000	0.507	5.759
37	Reducing gas from BB	0.7281	0.0000	0.000	0.512	15.471
39	Top Gas with Fines	0.7352	0.0000	0.000	0.517	5.866
40	CO2	0.0000	0.0000	0.000	0.000	100.000
41	Cold Recycle gas	0.7713	0.0000	0.000	0.542	0.062
42	Recycle gas for BB	0.7713	0.0000	0.000	0.542	0.062
43	Recycle gas for CFB	0.7713	0.0000	0.000	0.542	0.062
44	Recycle gas for Gasifier	0.7713	0.0000	0.000	0.542	0.062

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2	CO
6	top gas from Venturi 1	0.0000	92.2903
8	Top Gas to Steam boiler	0.0000	92.2903
11	Top gas recycled	0.0000	92.9613
18	Iron Ore to Cyclone 2	0.0000	98.7258
24	Preheated Reformed gas for CFB	90.0000	10.0000
25	Reducing gas for CFB	0.0000	98.6249
30	Top gas	0.0000	92.8818
33	Clean cool top gas	0.0000	92.2903
34	Dry top gas	0.0000	92.9613
35	35	90.0000	10.0000
36	Cold top gas	0.0000	92.2903
37	Reducing gas from BB	0.0000	83.2887
39	Top Gas with Fines	0.0000	92.8818
41	Cold Recycle gas	0.0000	98.6249
42	Recycle gas for BB	0.0000	98.6249
43	Recycle gas for CFB	0.0000	98.6249
44	Recycle gas for Gasifier	0.0000	98.6249

CIRCOFER MODEL

STREAM DATA

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
6	top gas from Venturi 1	2.2651	0.0000	0.000	0.894	3.699
8	Top Gas to Steam boiler	2.2651	0.0000	0.000	0.894	3.699
10	Oxygen	0.0000	0.0000	100.000	0.000	0.000
11	Top gas recycled	1.1455	0.0000	0.000	0.904	3.741
13	Air for Classifier	0.0000	79.0852	20.915	0.000	0.000
14	Compressed Air	0.0000	79.0852	20.915	0.000	0.000
18	Iron Ore to Cyclone 2	1.1030	0.0000	0.000	0.871	0.036
19	Air to Cyclone 2	0.0000	79.0852	20.915	0.000	0.000
20	Air to Calciner	0.0000	79.0852	20.915	0.000	0.000
21	Combustion Air to Heater 2	0.0000	79.0852	20.915	0.000	0.000
22	Natural gas to Heater 2	0.0000	0.0000	0.000	100.000	0.000
23	Exhaust from Heater 2	16.2156	72.6731	3.003	0.000	8.108
25	Reducing gas for CFB	1.1896	0.0000	0.000	0.939	0.039
26	Natural gas for Heater 1	0.0000	0.0000	0.000	100.000	0.000
27	Combustion Air for Heater 1	0.0000	79.0852	20.915	0.000	0.000
28	Exhaust for Heater 1	16.2188	72.6719	3.000	0.000	8.109
30	Top gas	1.1587	0.0000	0.000	0.915	3.784
33	Clean cool top gas	2.2651	0.0000	0.000	0.894	3.699
34	Dry top gas	1.1455	0.0000	0.000	0.904	3.741
36	Cold top gas	2.2651	0.0000	0.000	0.894	3.699
37	Reducing gas from BB	1.1896	0.0000	0.000	0.939	10.348
39	Top Gas with Fines	1.1587	0.0000	0.000	0.915	3.784
40	CO2	0.0000	0.0000	0.000	0.000	100.000
41	Cold Recycle gas	1.1896	0.0000	0.000	0.939	0.039
42	Recycle gas for BB	1.1896	0.0000	0.000	0.939	0.039
43	Recycle gas for CFB	1.1896	0.0000	0.000	0.939	0.039
44	Recycle gas for Gasifier	1.1896	0.0000	0.000	0.939	0.039

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2	CO
6	top gas from Venturi 1	0.0000	93.1418
8	Top Gas to Steam boiler	0.0000	93.1418
11	Top gas recycled	0.0000	94.2087
18	Iron Ore to Cyclone 2	0.0000	97.9903
24	Preheated Reformed gas for CFB	99.2067	0.7933
25	Reducing gas for CFB	0.0000	97.8324
30	Top gas	0.0000	94.1424
33	Clean cool top gas	0.0000	93.1418
34	Dry top gas	0.0000	94.2087
35	35	99.2067	0.7933
36	Cold top gas	0.0000	93.1418
37	Reducing gas from BB	0.0000	87.5237
39	Top Gas with Fines	0.0000	94.1424
41	Cold Recycle gas	0.0000	97.8324
42	Recycle gas for BB	0.0000	97.8324
43	Recycle gas for CFB	0.0000	97.8324
44	Recycle gas for Gasifier	0.0000	97.8324

CIRCOFER MODEL

STREAM DATA IN MOLES

SOLIDS - MT MOLES/HR

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	0.63324	3.96574	0.00000	0.0000	0.19511
2	Char	0.00000	0.00000	0.00000	0.0000	0.31622
3	Additive	0.00000	0.00000	0.00000	0.0000	0.00000
4	Iron Ore from Lockhopper	0.63324	3.96574	0.00000	0.0000	0.51133
5	Dried Iron Ore	0.63324	3.96574	0.00000	0.0000	0.51133
7	Iron Ore	0.63324	3.96574	0.00000	0.0000	0.51133
9	Coal	0.00000	0.00000	0.00000	0.0000	0.20637
12	Iron Ore Feed to Gasifier	0.63324	3.99223	0.05351	0.0000	0.51858
15	Iron Ore from Cyclone 2	0.63325	3.96576	0.00000	0.0000	0.19511
16	Feed to CFB	0.51991	3.25596	0.00000	0.0000	0.16019
17	Iron Ore Recycle	0.17330	1.08532	0.00000	0.0000	0.05340
18	Iron Ore to Cyclone 2	0.63324	3.99223	0.05351	0.0000	0.72495
29	Partially Reduced Ore	0.00000	2.62215	5.29727	0.0000	0.71770
31	Recycle solids	0.00000	0.02649	0.05351	0.0000	0.00725
38	Partially Reduced Fines	0.00000	0.02649	0.05351	0.0000	0.00725
47	DRI	0.00000	0.00000	0.65160	12.3805	0.00000
48	Char and Ash	0.00000	0.00000	0.00658	0.1251	0.71770
50	Reduced Iron	0.00000	0.00000	0.65819	12.5055	0.71770

SOLIDS - MT MOLES/HR

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	0.08704	0.02158	0.00621	0.13871	0.79361
3	Additive	0.00000	0.00000	0.00000	0.89159	0.00000
4	Iron Ore from Lockhopper	0.08704	0.02158	0.00621	1.03030	0.79361
5	Dried Iron Ore	0.08704	0.02158	0.00621	1.03030	0.79361
7	Iron Ore	0.08704	0.02158	0.00621	1.03030	0.79361
12	Iron Ore Feed to Gasifier	0.08792	0.02179	0.00627	1.04071	0.80163
15	Iron Ore from Cyclone 2	0.08704	0.02158	0.00621	0.13871	0.79361
16	Feed to CFB	0.07146	0.01772	0.00510	0.11388	0.65157
17	Iron Ore Recycle	0.02382	0.00591	0.00170	0.03796	0.21719
18	Iron Ore to Cyclone 2	0.08792	0.02179	0.00627	1.04071	0.80163
29	Partially Reduced Ore	0.08704	0.02158	0.00621	1.03030	0.79361
31	Recycle solids	0.00088	0.00022	0.00006	0.01041	0.00802
38	Partially Reduced Fines	0.00088	0.00022	0.00006	0.01041	0.00802
48	Char and Ash	0.08704	0.02158	0.00621	1.03030	0.79361
50	Reduced Iron	0.08704	0.02158	0.00621	1.03030	0.79361

SOLIDS - MT MOLES/HR

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	0.15084	0.01025	0.01398	0.00483	0.00560
4	Iron Ore from Lockhopper	0.15084	0.01025	0.01398	0.00483	0.00560
5	Dried Iron Ore	0.15084	0.01025	0.01398	0.00483	0.00560
7	Iron Ore	0.15084	0.01025	0.01398	0.00483	0.00560
12	Iron Ore Feed to Gasifier	0.15236	0.01035	0.01412	0.00488	0.00565
15	Iron Ore from Cyclone 2	0.15084	0.01025	0.01398	0.00483	0.00560
16	Feed to CFB	0.12384	0.00842	0.01148	0.00397	0.00460
17	Iron Ore Recycle	0.04128	0.00281	0.00383	0.00132	0.00153
18	Iron Ore to Cyclone 2	0.15236	0.01035	0.01412	0.00488	0.00565
29	Partially Reduced Ore	0.15084	0.01025	0.01398	0.00483	0.00560
31	Recycle solids	0.00152	0.00010	0.00014	0.00005	0.00006
38	Partially Reduced Fines	0.00152	0.00010	0.00014	0.00005	0.00006
48	Char and Ash	0.15084	0.01025	0.01398	0.00483	0.00560
50	Reduced Iron	0.15084	0.01025	0.01398	0.00483	0.00560

CIRCOFER MODEL

STREAM DATA IN MOLES

SOLIDS - MT MOLES/HR

NO.	STREAM	Zn1	Pb1	Ca1C1O3	C	C5H8
1	Iron Ore to Lockhopper	0.00687	0.00323	0.00000	0.0000	0.00000
2	Char	0.00000	0.00000	0.00000	14.4532	0.10863
4	Iron Ore from Lockhopper	0.00687	0.00323	0.00000	14.4532	0.10863
5	Dried Iron Ore	0.00687	0.00323	0.00000	14.4532	0.10863
7	Iron Ore	0.00687	0.00323	0.00000	14.4532	0.10863
9	Coal	0.00000	0.00000	0.00000	9.4912	1.08045
12	Iron Ore Feed to Gasifier	0.00694	0.00326	0.00000	14.5751	0.12064
15	Iron Ore from Cyclone 2	0.00687	0.00323	0.00000	0.0000	0.00000
16	Feed to CFB	0.00564	0.00265	0.00000	0.0000	0.00000
17	Iron Ore Recycle	0.00188	0.00088	0.00000	0.0000	0.00000
18	Iron Ore to Cyclone 2	0.00694	0.00326	0.00000	12.1909	1.20110
29	Partially Reduced Ore	0.00687	0.00323	0.00000	12.0690	1.18909
31	Recycle solids	0.00007	0.00003	0.00000	0.1219	0.01201
38	Partially Reduced Fines	0.00007	0.00003	0.00000	0.1219	0.01201
48	Char and Ash	0.00687	0.00323	0.00000	12.0690	1.18909
50	Reduced Iron	0.00687	0.00323	0.00000	12.0690	1.18909

SOLIDS - MOLE PERCENT

NO.	STREAM	Fe2O3	Fe3O4	FeO	Fe1	Si1O2
1	Iron Ore to Lockhopper	10.4897	65.6925	0.0000	0.0000	3.23193
2	Char	0.0000	0.0000	0.0000	0.0000	2.12541
3	Additive	0.0000	0.0000	0.0000	0.0000	0.00000
4	Iron Ore from Lockhopper	2.9039	18.1860	0.0000	0.0000	2.34483
5	Dried Iron Ore	2.9039	18.1860	0.0000	0.0000	2.34483
7	Iron Ore	2.9039	18.1860	0.0000	0.0000	2.34483
9	Coal	0.0000	0.0000	0.0000	0.0000	1.91478
12	Iron Ore Feed to Gasifier	2.8719	18.1060	0.2427	0.0000	2.35190
15	Iron Ore from Cyclone 2	10.4897	65.6925	0.0000	0.0000	3.23193
16	Feed to CFB	10.4897	65.6925	0.0000	0.0000	3.23193
17	Iron Ore Recycle	10.4897	65.6925	0.0000	0.0000	3.23193
18	Iron Ore to Cyclone 2	3.0224	19.0544	0.2554	0.0000	3.46009
29	Partially Reduced Ore	0.0000	10.9122	22.0448	0.0000	2.98675
31	Recycle solids	0.0000	10.9122	22.0448	0.0000	2.98675
38	Partially Reduced Fines	0.0000	10.9122	22.0448	0.0000	2.98675
47	DRI	0.0000	0.0000	5.0000	95.0000	0.00000
48	Char and Ash	0.0000	0.0000	0.0405	0.7700	4.41887
50	Reduced Iron	0.0000	0.0000	2.2484	42.7192	2.45168

SOLIDS - MOLE PERCENT

NO.	STREAM	Al2O3	P1	Cu1	Ca1O1	Mg1O1
1	Iron Ore to Lockhopper	1.44176	0.35742	0.10282	2.298	13.1461
3	Additive	0.00000	0.00000	0.00000	100.000	0.0000
4	Iron Ore from Lockhopper	0.39913	0.09895	0.02847	4.725	3.6393
5	Dried Iron Ore	0.39913	0.09895	0.02847	4.725	3.6393
7	Iron Ore	0.39913	0.09895	0.02847	4.725	3.6393
12	Iron Ore Feed to Gasifier	0.39873	0.09885	0.02844	4.720	3.6356
15	Iron Ore from Cyclone 2	1.44176	0.35742	0.10282	2.298	13.1461
16	Feed to CFB	1.44176	0.35742	0.10282	2.298	13.1461
17	Iron Ore Recycle	1.44176	0.35742	0.10282	2.298	13.1461
18	Iron Ore to Cyclone 2	0.41961	0.10402	0.02993	4.967	3.8260
29	Partially Reduced Ore	0.36221	0.08979	0.02583	4.288	3.3026
31	Recycle solids	0.36221	0.08979	0.02583	4.288	3.3026
38	Partially Reduced Fines	0.36221	0.08979	0.02583	4.288	3.3026
48	Char and Ash	0.53588	0.13285	0.03822	6.344	4.8862
50	Reduced Iron	0.29732	0.07371	0.02120	3.520	2.7110

CIRCOFER MODEL

STREAM DATA IN MOLES

SOLIDS - MOLE PERCENT

NO.	STREAM	Ti1O2	S1	V1	Co1	Ni1
1	Iron Ore to Lockhopper	2.49859	0.16980	0.23157	0.08007	0.09274
4	Iron Ore from Lockhopper	0.69170	0.04701	0.06411	0.02217	0.02567
5	Dried Iron Ore	0.69170	0.04701	0.06411	0.02217	0.02567
7	Iron Ore	0.69170	0.04701	0.06411	0.02217	0.02567
12	Iron Ore Feed to Gasifier	0.69100	0.04696	0.06404	0.02214	0.02565
15	Iron Ore from Cyclone 2	2.49859	0.16980	0.23157	0.08007	0.09274
16	Feed to CFB	2.49859	0.16980	0.23157	0.08007	0.09274
17	Iron Ore Recycle	2.49859	0.16980	0.23157	0.08007	0.09274
18	Iron Ore to Cyclone 2	0.72719	0.04942	0.06740	0.02330	0.02699
29	Partially Reduced Ore	0.62771	0.04266	0.05818	0.02012	0.02330
31	Recycle solids	0.62771	0.04266	0.05818	0.02012	0.02330
38	Partially Reduced Fines	0.62771	0.04266	0.05818	0.02012	0.02330
48	Char and Ash	0.92869	0.06311	0.08607	0.02976	0.03447
50	Reduced Iron	0.51526	0.03502	0.04775	0.01651	0.01912

SOLIDS - MOLE PERCENT

NO.	STREAM	Zn1	Pb1	Ca1C1O3	C	C5H8
1	Iron Ore to Lockhopper	0.11381	0.05343	0.00000	0.0000	0.0000
2	Char	0.00000	0.00000	0.00000	97.1444	0.7302
4	Iron Ore from Lockhopper	0.03151	0.01479	0.00000	66.2795	0.4982
5	Dried Iron Ore	0.03151	0.01479	0.00000	66.2795	0.4982
7	Iron Ore	0.03151	0.01479	0.00000	66.2795	0.4982
9	Coal	0.00000	0.00000	0.00000	88.0606	10.0246
12	Iron Ore Feed to Gasifier	0.03147	0.01478	0.00000	66.1027	0.5472
15	Iron Ore from Cyclone 2	0.11381	0.05343	0.00000	0.0000	0.0000
16	Feed to CFB	0.11381	0.05343	0.00000	0.0000	0.0000
17	Iron Ore Recycle	0.11381	0.05343	0.00000	0.0000	0.0000
18	Iron Ore to Cyclone 2	0.03312	0.01555	0.00000	58.1854	5.7327
29	Partially Reduced Ore	0.02859	0.01342	0.00000	50.2256	4.9484
31	Recycle solids	0.02859	0.01342	0.00000	50.2256	4.9484
38	Partially Reduced Fines	0.02859	0.01342	0.00000	50.2256	4.9484
48	Char and Ash	0.04230	0.01986	0.00000	74.3084	7.3212
50	Reduced Iron	0.02347	0.01102	0.00000	41.2279	4.0619

CIRCOFER MODEL

STREAM DATA IN MOLES

GASEOUS - MT MOLES/HR

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
6	top gas from Venturi 1	10.5799	0.000	0.0000	4.1763	17.2773
8	Top Gas to Steam boiler	10.5799	0.000	0.0000	4.1763	17.2773
10	Oxygen	0.0000	0.000	5.9377	0.0000	0.0000
11	Top gas recycled	5.2899	0.000	0.0000	4.1763	17.2773
13	Air for Classifier	0.0000	0.027	0.0073	0.0000	0.0000
14	Compressed Air	0.0000	0.027	0.0073	0.0000	0.0000
18	Iron Ore to Cyclone 2	1.7986	0.000	0.0000	1.4199	0.0587
19	Air to Cyclone 2	0.0000	0.078	0.0207	0.0000	0.0000
20	Air to Calciner	0.0000	0.027	0.0073	0.0000	0.0000
21	Combustion Air to Heater 2	0.0000	114.796	30.3588	0.0000	0.0000
22	Natural gas to Heater 2	0.0000	0.000	0.0000	12.8073	0.0000
23	Exhaust from Heater 2	25.6145	114.796	4.7443	0.0000	12.8073
25	Reducing gas for CFB	5.2899	0.000	0.0000	4.1763	0.1728
26	Natural gas for Heater 1	0.0000	0.000	0.0000	14.4811	0.0000
27	Combustion Air for Heater 1	0.0000	129.772	34.3194	0.0000	0.0000
28	Exhaust for Heater 1	28.9622	129.772	5.3572	0.0000	14.4811
30	Top gas	5.2899	0.000	0.0000	4.1763	17.2773
33	Clean cool top gas	10.5799	0.000	0.0000	4.1763	17.2773
34	Dry top gas	5.2899	0.000	0.0000	4.1763	17.2773
36	Cold top gas	10.5799	0.000	0.0000	4.1763	17.2773
37	Reducing gas from BB	1.7457	0.000	0.0000	1.3782	15.1847
39	Top Gas with Fines	5.2899	0.000	0.0000	4.1763	17.2773
40	CO2	0.0000	0.000	0.0000	0.0000	17.1045
41	Cold Recycle gas	5.2899	0.000	0.0000	4.1763	0.1728
42	Recycle gas for BB	1.7457	0.000	0.0000	1.3782	0.0570
43	Recycle gas for CFB	1.7457	0.000	0.0000	1.3782	0.0570
44	Recycle gas for Gasifier	1.7986	0.000	0.0000	1.4199	0.0587

GASEOUS - MT MOLES/HR

NO.	STREAM	H2	CO
6	top gas from Venturi 1	0.000	435.046
8	Top Gas to Steam boiler	0.000	435.046
11	Top gas recycled	0.000	435.046
18	Iron Ore to Cyclone 2	0.000	159.791
24	Preheated Reformed gas for CFB	344.742	2.757
25	Reducing gas for CFB	0.000	435.046
30	Top gas	0.000	429.817
33	Clean cool top gas	0.000	435.046
34	Dry top gas	0.000	435.046
35	35	699.932	5.597
36	Cold top gas	0.000	435.046
37	Reducing gas from BB	0.000	128.437
39	Top Gas with Fines	0.000	429.817
41	Cold Recycle gas	0.000	435.046
42	Recycle gas for BB	0.000	143.565
43	Recycle gas for CFB	0.000	143.565
44	Recycle gas for Gasifier	0.000	147.916

CIRCOFER MODEL

STREAM DATA IN MOLES

GASEOUS - MOLE PERCENT

NO.	STREAM	H2O	N2	O2	C1H4	C1O2
6	top gas from Venturi 1	2.2651	0.0000	0.000	0.894	3.699
8	Top Gas to Steam boiler	2.2651	0.0000	0.000	0.894	3.699
10	Oxygen	0.0000	0.0000	100.000	0.000	0.000
11	Top gas recycled	1.1455	0.0000	0.000	0.904	3.741
13	Air for Classifier	0.0000	79.0852	20.915	0.000	0.000
14	Compressed Air	0.0000	79.0852	20.915	0.000	0.000
18	Iron Ore to Cyclone 2	1.1030	0.0000	0.000	0.871	0.036
19	Air to Cyclone 2	0.0000	79.0852	20.915	0.000	0.000
20	Air to Calciner	0.0000	79.0852	20.915	0.000	0.000
21	Combustion Air to Heater 2	0.0000	79.0852	20.915	0.000	0.000
22	Natural gas to Heater 2	0.0000	0.0000	0.000	100.000	0.000
23	Exhaust from Heater 2	16.2156	72.6731	3.003	0.000	8.108
25	Reducing gas for CFB	1.1896	0.0000	0.000	0.939	0.039
26	Natural gas for Heater 1	0.0000	0.0000	0.000	100.000	0.000
27	Combustion Air for Heater 1	0.0000	79.0852	20.915	0.000	0.000
28	Exhaust for Heater 1	16.2188	72.6719	3.000	0.000	8.109
30	Top gas	1.1587	0.0000	0.000	0.915	3.784
33	Clean cool top gas	2.2651	0.0000	0.000	0.894	3.699
34	Dry top gas	1.1455	0.0000	0.000	0.904	3.741
36	Cold top gas	2.2651	0.0000	0.000	0.894	3.699
37	Reducing gas from BB	1.1896	0.0000	0.000	0.939	10.348
39	Top Gas with Fines	1.1587	0.0000	0.000	0.915	3.784
40	CO2	0.0000	0.0000	0.000	0.000	100.000
41	Cold Recycle gas	1.1896	0.0000	0.000	0.939	0.039
42	Recycle gas for BB	1.1896	0.0000	0.000	0.939	0.039
43	Recycle gas for CFB	1.1896	0.0000	0.000	0.939	0.039
44	Recycle gas for Gasifier	1.1896	0.0000	0.000	0.939	0.039

GASEOUS - MOLE PERCENT

NO.	STREAM	H2	CO
6	top gas from Venturi 1	0.0000	93.1418
8	Top Gas to Steam boiler	0.0000	93.1418
11	Top gas recycled	0.0000	94.2087
18	Iron Ore to Cyclone 2	0.0000	97.9903
24	Preheated Reformed gas for CFB	99.2067	0.7933
25	Reducing gas for CFB	0.0000	97.8324
30	Top gas	0.0000	94.1424
33	Clean cool top gas	0.0000	93.1418
34	Dry top gas	0.0000	94.2087
35	35	99.2067	0.7933
36	Cold top gas	0.0000	93.1418
37	Reducing gas from BB	0.0000	87.5237
39	Top Gas with Fines	0.0000	94.1424
41	Cold Recycle gas	0.0000	97.8324
42	Recycle gas for BB	0.0000	97.8324
43	Recycle gas for CFB	0.0000	97.8324
44	Recycle gas for Gasifier	0.0000	97.8324

APPENDIX E-8:

GENERIC IRON CARBIDE PROCESS

IRON CARBIDE PROCESS

PROCESS BACKGROUND:
Iron carbide (Fe_3C) is a chemical compound of 94% iron and 6% carbon in pure form. It can be used as the only feed for BOFs and EAFs. In that role it eliminates the need for coke ovens and the blast furnace, and all the ancillary equipment for coal and lime. The Iron Carbide process is a two stage fluidized bed process that operates at a lower temperature than other DR processes. It operates at low pressures and uses steam reforming to produce the H_2 which is mixed with CH_4 to make the carburizing gas. It produces Fe_3C powder which contains about 6% carbon.

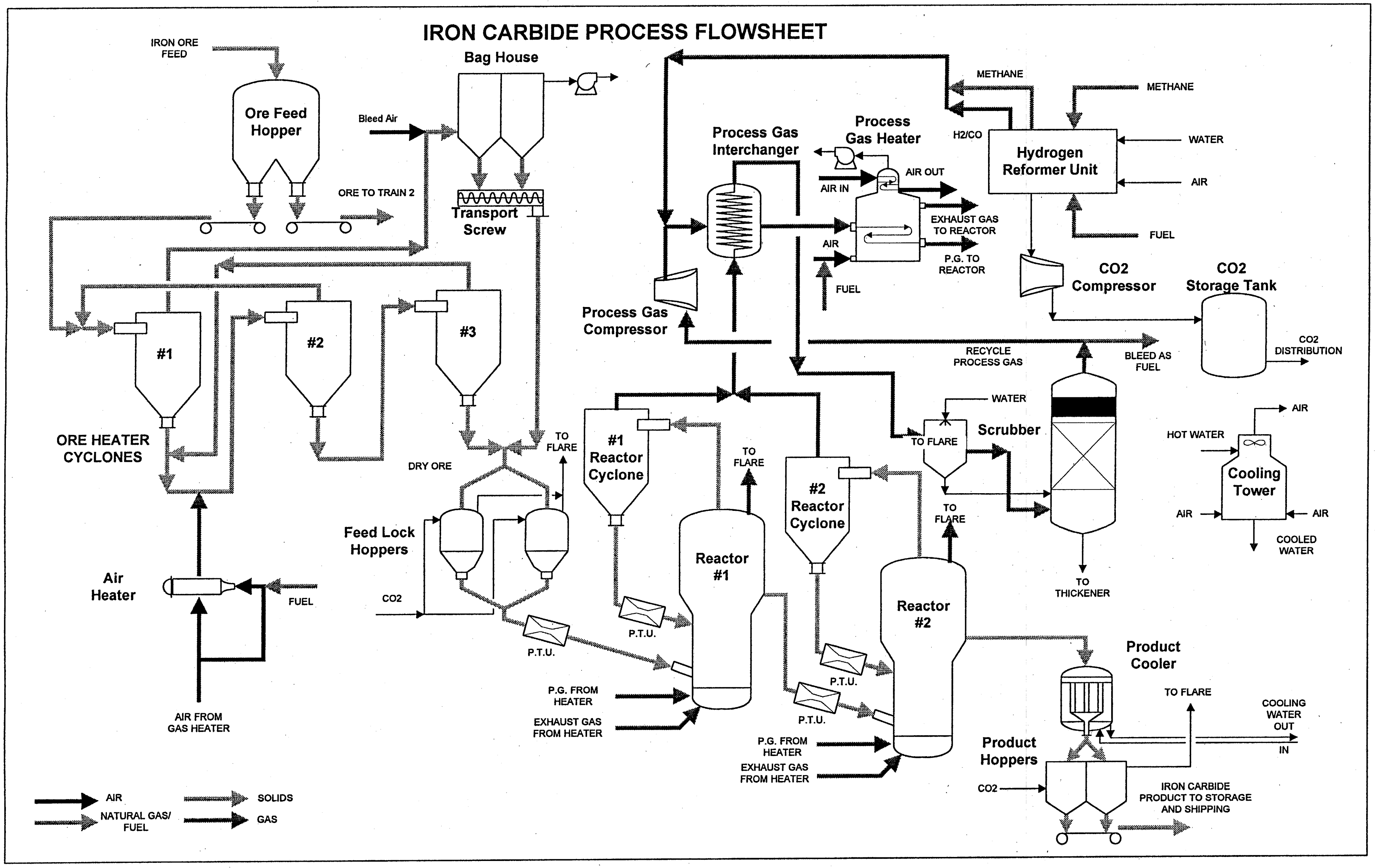
PROCESS DESCRIPTION:
The iron oxide feed to the iron carbide process is in the form of iron ore fines in the range of 1mm to 0.1 mm. Iron ore fines are preheated in a series of cyclones and then pressurized to reactor pressure in lockhoppers, and fed to the reactor by a screw feeder.

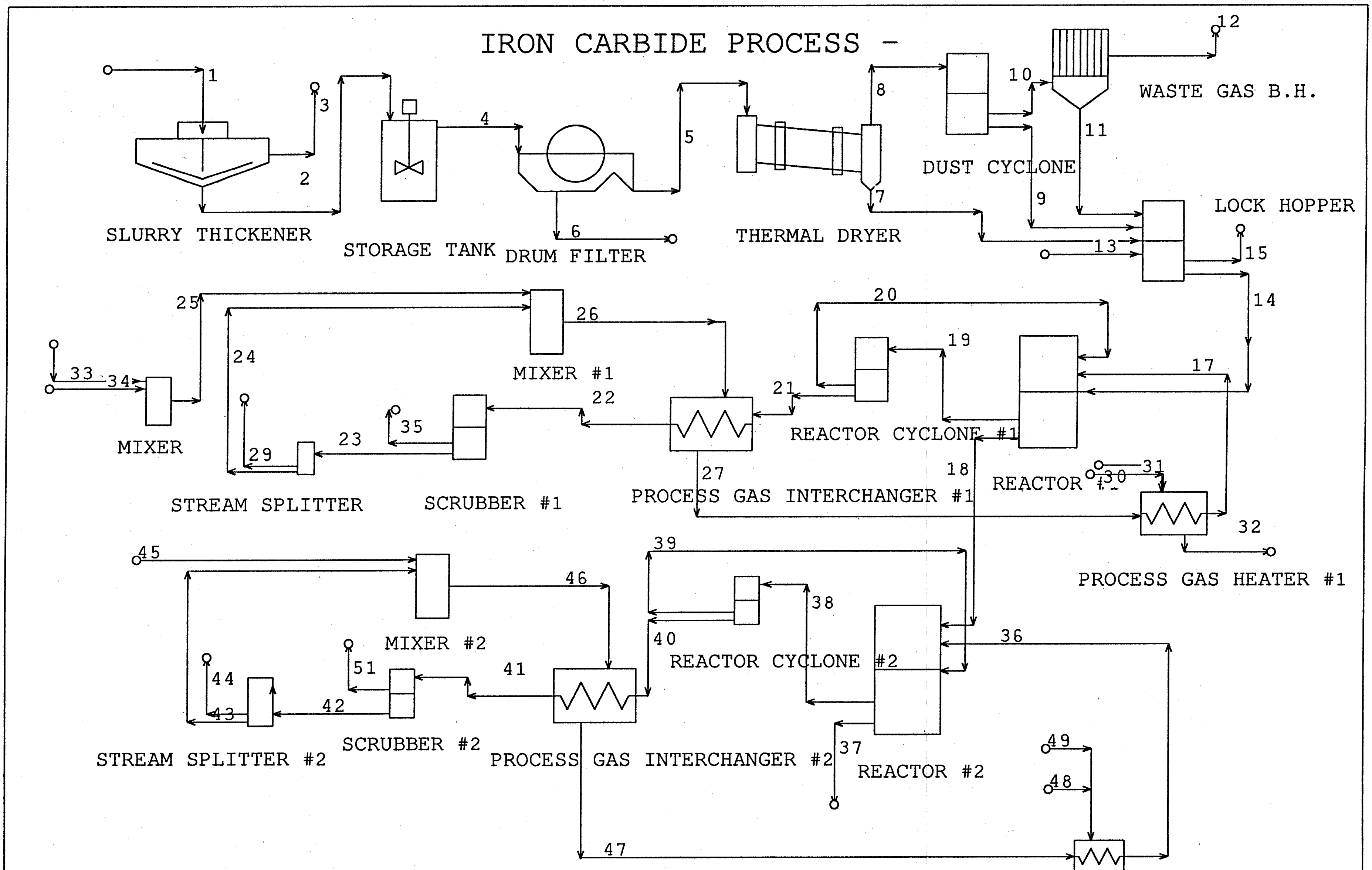
The fluidized bed reactors have the upward moving stream of 730C gas composed of CO, CO_2, H_2, CH_4 and H_2O. The hydrogen reacts with the iron ore, combing with its oxygen to form water (the only process by-product). Carbon from the carbonaceous gases combines with the elemental iron to form iron carbide. The methane provides the gas system equilibrium. After the reactions in the fluid bed reactors, the off gases are condensed to get rid of water vapor, reconstituted with H_2 and carbonaceous gases, raised to reactor working pressure to 1.8 atm, heated to 730C, and reintroduced in the windbox of the reactor.

An indication of the inherent thermal efficiency of the process is gained from the fact that the temperature of formation of iron carbide in the fluid bed reactor is only 730C as against around 1000C for reduction of iron in DRI processes and 1500C to produce hot metal in the blast furnace.

PROCESS ADVANTAGES
Lower operating temperature
Lower production costs
No storage costs as the product does not oxidize
Steelmaking cheaper with Fe_3C

IRON CARBIDE PROCESS FLOWSHEET





IRON CARBIDE PROCESS

Iron Carbide Process --- MetSim Model --- Description

The MetSim model for this process is largely based upon a basic flowsheet developed for Qualitech Steel Corporation by Iron Carbide Holdings Ltd, USA.

Flowsheet Description

Stream 1 representing the fine ore slurry is first thickened, filtered, dried to get rid of excess water, heated and pressurized. Unit operations starting from Slurry Thickener to Lock Hopper are used to carry out these functions. Then in the Reactor #1, the ore feed (Stream 14) is further heated and partially reduced to FeO by the reducing gases (Stream 17) consisting mainly Hydrogen. The gases from the Reactor #1 are then cleaned off the dust (Recycled back to the Reactor #1 as Stream 20) in a Reactor Cyclone #1. The cleaned reduced gases are used for preheating incoming reducing gases (Stream 26) in a Process Gas Interchanger #1. The water from these gases is scrubbed off in a scrubber and part of these gases are bled off to maintain N2 content of the reducing gases and are used as fuel elsewhere. Then the gases (Stream 24) are mixed with fresh Reformed gas (Stream 33) and Natural gas (Stream 34). This mixed gas (Stream 26) is preheated and then further heated to 730C in a Process Gas Heater #1 and injected in Reactor #1 as Stream 17.

The partially reduced ore (Stream 18) is carburized as Fe3C in the Reactor #2 by the help of CH4 – rich reducing gas (Stream 36). Again as for the Reactor # 1, the top gases are passed through a Reactor Cyclone #2, then used for preheating incoming reducing gases in Process Gas Interchanger #2, scrubbed off excess water, mixed with make-up CH4 and heated further in Process Gas Heater #2 to get ready for carburization in the Reactor #2.

Model Assumptions:

Reactor #1: Partial reduction of iron ore to FeO takes place in this reactor. 5% carry-over of solid particles in the Top gas is assumed.

Reactor #2: Carburization of FeO to Fe3C takes place in this reactor. 5% carry-over of solid particles in the Top gas is assumed.

Reactor Cyclones: 100% Efficiency.

Process Gas Interchangers: 100% Efficiency.

Stream Splitter: 5% gases are bled off.

Process Gas Heaters: 100% Efficiency.

Results

With the limited information available about the two-reactor system, several estimates have been made in the model. A more complete analysis can be carried out on receiving more information about the process flows and conditions.

IRON CARBIDE PROCESS --- STREAM SUMMARY

Stream Number	1	2	3	4	5	6	7	8	9
Description	Iron Ore Slur	Thickener Un	Thickener Ov	Slurry to Filte	Filtered Solid	Filterate	Dried Solids	Fines to Cycl	Dust Cyclone
MT/HR SOLIDS	1000	999.9	0.10004	999.9	997.9	1.9998	979.63	18.27	17.357
MT/HR AQUEOUS	1500	999.9	500.1	999.9	136.08	863.82	19.371	0.9943	0.9943
MT/HR GASEOUS	0	0	0	0	0	0	0	115.71	0
MT/HR TOTAL	2500	1999.8	500.2	1999.8	1134	865.82	999	134.98	18.351
Percent Solids	40	50	0.02	50	88	0.23097	98.061	13.536	94.582
Sp.Gr.SOLIDS	4.9467	4.9467	4.9467	4.9467	4.9467	4.9467	4.9704	3.9409	3.9409
Sp.Gr.AQUEOUS	0.99826	0.99826	0.99826	0.99826	0.99826	0.99826	0.31545	0.31545	0.31545
Sp.Gr.GASEOUS	0	0	0	0	0	0	0	0.00025289	0
Sp.Gr.TOTAL	1.4665	1.6613	0.99842	1.6613	3.3545	1.0001	3.8646	0.00029499	2.4286
Temperature C	20	20	20	20	20	20	595	595	595
Gas nm3/hr	0	0	0	0	0	0	0	1.44E+05	0
Sol/Liq m3/hr	1704.8	1203.8	500.99	1203.8	338.05	865.73	258.5	7.7881	7.5563
Component Mass Flow Rates									
1 Fe3O4 MT/HR	900	899.91	0.090036	899.91	898.11	1.7998	892.02	6.0901	5.7856
2 Fe2O3 MT/HR	50	49.995	0.005002	49.995	49.895	0.09999	43.805	6.0901	5.7856
3 Fe3C1 MT/HR	0	0	0	0	0	0	0	0	0
7 Si1O2 MT/HR	50	49.995	0.005002	49.995	49.895	0.09999	43.805	6.0901	5.7856
8 H2O MT/HR	1500	999.9	500.1	999.9	136.08	863.82	19.371	0.9943	0.9943
9 N2 MT/HR	0	0	0	0	0	0	0	0	0
10 O2 MT/HR	0	0	0	0	0	0	0	0	0
11 H2O MT/HR	0	0	0	0	0	0	0	115.71	0
12 CH4 MT/HR	0	0	0	0	0	0	0	0	0
14 H2 MT/HR	0	0	0	0	0	0	0	0	0
15 CO2 MT/HR	0	0	0	0	0	0	0	0	0
16 CO MT/HR	0	0	0	0	0	0	0	0	0
17 FeO MT/HR	0	0	0	0	0	0	0	0	0
Element Mass Flow Rates									
1 H 1	167.85	111.89	55.962	111.89	15.227	96.663	2.1676	13.06	0.11126
2 C 6	0	0	0	0	0	0	0	0	0
3 N 7	0	0	0	0	0	0	0	0	0
4 O 8	1622.6	1178.4	444.17	1178.4	410.66	767.74	300.25	110.4	7.3023
5 Si 14	23.372	23.37	0.0023381	23.37	23.323	0.046739	20.476	2.8468	2.7044
6 Fe 26	686.21	686.14	0.068648	686.14	684.77	1.3723	676.1	8.6664	8.2331

IRON CARBIDE PROCESS --- STREAM SUMMARY

Stream Number	10	11	12	13	14	15	17	18	19
Description	Dust Cyclone	Baghouse Di	Bag Filter Ex	CO2	Lock Hopper	Lock Hopper	H2-rich Redu	Partially Red	Top gas with
MT/HR SOLIDS	0.91352	0.8788	0.034717	0	997.87	0	0	930.81	48.99
MT/HR AQUEOUS	0	0	0	0	20.365	0	0	0	0
MT/HR GASEOUS	115.71	0	115.71	10	0	10	898.29	0	985.69
MT/HR TOTAL	116.63	0.8788	115.75	10	1018.2	10	898.29	930.81	1034.7
Percent Solids	0.78329	100	0.029994	0	98	0	0	100	4.7348
Sp.Gr.SOLIDS	3.9409	3.9409	3.9409	0	4.9467	0	0	5.3688	5.3688
Sp.Gr.AQUEOUS	0	0	0	0	0.31545	0	0	0	0
Sp.Gr.GASEOUS	0.00025289	0	0.00025289	0.0018064	0	0.00062225	2.9184E-05	0	3.2846E-05
Sp.Gr.TOTAL	0.00025489	3.9409	0.00025296	0.0018064	3.8239	0.00062225	2.9184E-05	5.3688	3.4478E-05
Temperature C	595	595	595	25	588.88	588.88	730	701.98	701.98
Gas nm3/hr	1.44E+05	0	1.44E+05	5092.9	0	5092.9	8.38E+06	0	8.41E+06
Sol/Liq m3/hr	0.2318	0.22299	0.0088094	0	266.28	0	0	173.37	9.1249
Component Mass Flow Rates									
1 Fe3O4 MT/HR	0.30451	0.29293	0.011572	0	898.1	0	0	0	0
2 Fe2O3 MT/HR	0.30451	0.29293	0.011572	0	49.883	0	0	0	0
3 Fe3C1 MT/HR	0	0	0	0	0	0	0	0	0
7 Si1O2 MT/HR	0.30451	0.29293	0.011572	0	49.883	0	0	49.883	2.6254
8 H2O MT/HR	0	0	0	0	20.365	0	0	0	0
9 N2 MT/HR	0	0	0	0	0	0	0	0	0
10 O2 MT/HR	0	0	0	0	0	0	0	0	0
11 H2O MT/HR	115.71	0	115.71	0	0	0	1.8568	0	97.728
12 CH4 MT/HR	0	0	0	0	0	0	57.261	0	57.261
14 H2 MT/HR	0	0	0	0	0	0	739.2	0	730.74
15 CO2 MT/HR	0	0	0	10	0	10	0	0	0
16 CO MT/HR	0	0	0	0	0	0	99.968	0	99.966
17 FeO MT/HR	0	0	0	0	0	0	0	880.93	46.364
Element Mass Flow Rates									
1 H 1	12.948	0	12.948	0	2.2789	0	753.8	0	756.07
2 C 6	0	0	0	2.7292	0	2.7292	85.737	0	85.736
3 N 7	0	0	0	0	0	0	0	0	0
4 O 8	103.1	0.32502	102.78	7.2708	307.88	7.2708	58.75	222.74	155.61
5 Si 14	0.14234	0.13693	0.0054094	0	23.317	0	0	23.317	1.2272
6 Fe 26	0.43332	0.41685	0.016468	0	684.75	0	0	684.75	36.04

IRON CARBIDE PROCESS --- STREAM SUMMARY

Stream Number	20	21	22	23	24	25	26	27	29
Description	Recycled Soli	Top gas from	Cooled Top g	Dry Top gas	Recycle gase	Make-up gas	Cold Reducin	Preheated R	Bleed
MT/HR SOLIDS	48.99	0	0	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	0	0	0
MT/HR GASEOUS	0	985.69	985.69	889.92	845.42	52.863	898.29	898.29	44.496
MT/HR TOTAL	48.99	985.69	985.69	889.92	845.42	52.863	898.29	898.29	44.496
Percent Solids	100	0	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	5.3688	0	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0	0	0
Sp.Gr.GASEOUS	0	3.2846E-05	4.7235E-05	7.8609E-05	7.8609E-05	9.5352E-05	7.9431E-05	4.3176E-05	7.8609E-05
Sp.Gr.TOTAL	5.3688	3.2846E-05	4.7235E-05	7.8609E-05	7.8609E-05	9.5352E-05	7.9431E-05	4.3176E-05	7.8609E-05
Temperature C	701.98	701.98	404.93	100	100	24.763	95.431	404.93	100
Gas nm3/hr	0	8.41E+06	8.41E+06	8.29E+06	7.87E+06	5.08E+05	8.38E+06	8.38E+06	4.14E+05
Sol/Liq m3/hr	9.1249	0	0	0	0	0	0	0	0
Component Mass Flow Rates									
1 Fe3O4 MT/HR	0	0	0	0	0	0	0	0	0
2 Fe2O3 MT/HR	0	0	0	0	0	0	0	0	0
3 Fe3C1 MT/HR	0	0	0	0	0	0	0	0	0
7 Si1O2 MT/HR	2.6254	0	0	0	0	0	0	0	0
8 H2O MT/HR	0	0	0	0	0	0	0	0	0
9 N2 MT/HR	0	0	0	0	0	0	0	0	0
10 O2 MT/HR	0	0	0	0	0	0	0	0	0
11 H2O MT/HR	0	97.728	97.728	1.9546	1.8568	0	1.8568	1.8568	0.097728
12 CH4 MT/HR	0	57.261	57.261	57.261	54.398	2.863	57.261	57.261	2.863
14 H2 MT/HR	0	730.74	730.74	730.74	694.2	45	739.2	739.2	36.537
15 CO2 MT/HR	0	0	0	0	0	0	0	0	0
16 CO MT/HR	0	99.966	99.966	99.966	94.968	5	99.968	99.968	4.9983
17 FeO MT/HR	46.364	0	0	0	0	0	0	0	0
Element Mass Flow Rates									
1 H 1	0	756.07	756.07	745.35	708.08	45.72	753.8	753.8	37.267
2 C 6	0	85.736	85.736	85.736	81.45	4.2875	85.737	85.737	4.2868
3 N 7	0	0	0	0	0	0	0	0	0
4 O 8	11.723	143.89	143.89	58.836	55.894	2.856	58.75	58.75	2.9418
5 Si 14	1.2272	0	0	0	0	0	0	0	0
6 Fe 26	36.04	0	0	0	0	0	0	0	0

IRON CARBIDE PROCESS --- STREAM SUMMARY

Stream Number	33	34	35	36	37	38	39	40	41
Description	SYN GAS	METHANE	Excess Wate	Hot Reducing	Final Product	Top gas with	Recycle Solid	Top gas from	Cooled Top g
MT/HR SOLIDS	0	0	0	0	787.93	41.47	41.47	0	0
MT/HR AQUEOUS	0	0	95.773	0	0	0	0	0	0
MT/HR GASEOUS	50	2.863	0	1663.8	0	1806.9	0	1806.9	1806.9
MT/HR TOTAL	50	2.863	95.773	1663.8	787.93	1848.4	41.47	1806.9	1806.9
Percent Solids	0	0	0	0	100	2.2436	100	0	0
Sp.Gr.SOLIDS	0	0	0	0	6.7988	6.7988	6.7988	0	0
Sp.Gr.AQUEOUS	0	0	0.9581	0	0	0	0	0	0
Sp.Gr.GASEOUS	9.0829E-05	0.00071758	0	0.00012038	0	0.00013731	0	0.00013731	0.0001882
Sp.Gr.TOTAL	9.0829E-05	0.00071758	0.9581	0.00012038	6.7988	0.00014047	6.7988	0.00013731	0.0001882
Temperature C	25	0	100	730	659.76	659.76	659.76	659.76	407.56
Gas nm3/hr	5.04E+05	4000	0	3.76E+06	0	3.85E+06	0	3.85E+06	3.85E+06
Sol/Liq m3/hr	0	0	99.962	0	115.89	6.0996	6.0996	0	0
Component Mass Flow Rates									
1 Fe3O4 MT/HR	0	0	0	0	0	0	0	0	0
2 Fe2O3 MT/HR	0	0	0	0	0	0	0	0	0
3 Fe3C1 MT/HR	0	0	0	0	712.9	37.521	37.521	0	0
7 Si1O2 MT/HR	0	0	0	0	49.883	2.6254	2.6254	0	0
8 H2O MT/HR	0	0	95.773	0	0	0	0	0	0
9 N2 MT/HR	0	0	0	0	0	0	0	0	0
10 O2 MT/HR	0	0	0	0	0	0	0	0	0
11 H2O MT/HR	0	0	0	22.526	0	237.11	0	237.11	237.11
12 CH4 MT/HR	0	2.863	0	1493	0	1429.4	0	1429.4	1429.4
14 H2 MT/HR	45	0	0	148.33	0	140.34	0	140.34	140.34
15 CO2 MT/HR	0	0	0	0	0	0	0	0	0
16 CO MT/HR	5	0	0	0	0	0	0	0	0
17 FeO MT/HR	0	0	0	0	25.144	1.3234	1.3234	0	0
Element Mass Flow Rates									
1 H 1	45	0.71953	10.717	526.06	0	526.12	0	526.12	526.12
2 C 6	2.144	2.1435	0	1117.8	47.689	1072.7	2.51	1070.2	1070.2
3 N 7	0	0	0	0	0	0	0	0	0
4 O 8	2.856	0	85.056	20.005	32.165	212.27	1.6929	210.58	210.58
5 Si 14	0	0	0	0	23.317	1.2272	1.2272	0	0
6 Fe 26	0	0	0	0	684.75	36.04	36.04	0	0

IRON CARBIDE PROCESS --- STREAM SUMMARY

Stream Number	42	43	44	45	46	47	51
Description	Dry Top Gas	Recycle gas	Bleed	Methane	Cold Reducin	Preheated R	Excess Water
MT/HR SOLIDS	0	0	0	0	0	0	0
MT/HR AQUEOUS	0	0	0	0	0	0	213.4
MT/HR GASEOUS	1593.5	1513.8	79.675	150	1663.8	1663.8	0
MT/HR TOTAL	1593.5	1513.8	79.675	150	1663.8	1663.8	213.4
Percent Solids	0	0	0	0	0	0	0
Sp.Gr.SOLIDS	0	0	0	0	0	0	0
Sp.Gr.AQUEOUS	0	0	0	0	0	0	0.9581
Sp.Gr.GASEOUS	0.00032537	0.00032537	0.00032537	0.00042264	0.0003319	0.00017742	0
Sp.Gr.TOTAL	0.00032537	0.00032537	0.00032537	0.00042264	0.0003319	0.00017742	0.9581
Temperature C	100	100	100	0	90.952	407.56	100
Gas nm3/hr	3.59E+06	3.41E+06	1.79E+05	3.55E+05	3.76E+06	3.76E+06	0
Sol/Liq m3/hr	0	0	0	0	0	0	222.73
Component Mass Flow Rates							
1 Fe3O4 MT/HR	0	0	0	0	0	0	0
2 Fe2O3 MT/HR	0	0	0	0	0	0	0
3 Fe3C1 MT/HR	0	0	0	0	0	0	0
7 Si1O2 MT/HR	0	0	0	0	0	0	0
8 H2O MT/HR	0	0	0	0	0	0	213.4
9 N2 MT/HR	0	0	0	0	0	0	0
10 O2 MT/HR	0	0	0	0	0	0	0
11 H2O MT/HR	23.711	22.526	1.1856	0	22.526	22.526	0
12 CH4 MT/HR	1429.4	1358	71.472	135	1493	1493	0
14 H2 MT/HR	140.34	133.33	7.0172	15	148.33	148.33	0
15 CO2 MT/HR	0	0	0	0	0	0	0
16 CO MT/HR	0	0	0	0	0	0	0
17 FeO MT/HR	0	0	0	0	0	0	0
Element Mass Flow Rates							
1 H 1	502.24	477.13	25.112	48.928	526.06	526.06	23.88
2 C 6	1070.2	1016.7	53.51	101.07	1117.8	1117.8	0
3 N 7	0	0	0	0	0	0	0
4 O 8	21.058	20.005	1.0529	0	20.005	20.005	189.52
5 Si 14	0	0	0	0	0	0	0
6 Fe 26	0	0	0	0	0	0	0

IRON CARBIDE PROCESS

CASE DEFINITION

Title : IRON CARBIDE PROCESS	
Case :	
Data Storage File Name	: ironcarb3.sfw
Mass Balance Option	: ON
Heat Balance Option	: ON
Units of Mass	: metric tonne
Units of Time	: hour
Ambient Air Pressure	: 101.325 kPa
Standard Pressure	: 101.325 kPa
Ambient Air Temperature	: 20.00 C
Standard Temperature	: 0.00 C
Plant Site Latitude	: 0.00 Degrees
Plant Site Elevation	: 0.00 Meters

IRON CARBIDE PROCESS

COMPONENT DATA

ROW	CNM	CHF			PHC	CMW	SGF
1	Fe3O4	Fe3O4	SI1	231.5386	5.1800	0.0000	0.0000
2	Fe2O3	Fe2O3	SI1	159.6922	5.2400	0.0000	0.0000
3	Fe3C1	Fe3C1	SI1	179.5521	7.6940	0.0000	0.0000
4	C1	C1	SI1	12.0112	2.2500	0.0000	0.0000
5	Fe1	Fe1	SI1	55.8470	7.8600	0.0000	0.0000
6	Si1	Si1	SI1	28.0860	2.3300	0.0000	0.0000
7	Si1O2	Si1O2	SI1	60.0848	2.6500	0.0000	0.0000
8	H2O	H2O	LI3	18.0153	1.0000	0.0000	0.0000
9	N2	N2	GC8	28.0134	0.0012	0.0000	0.0000
10	O2	O2	GC8	31.9988	0.0014	0.0000	0.0000
11	H2O	H2O	GC8	18.0153	0.0008	0.0000	0.0000
12	CH4	CH4	GC8	16.0430	0.0007	0.0000	0.0000
13	C2H6	C2H6	GC8	30.0701	0.0013	0.0000	0.0000
14	H2	H2	GC8	2.0159	0.0001	0.0000	0.0000
15	CO2	CO2	GC8	44.0100	0.0020	0.0000	0.0000
16	CO	CO	GC8	28.0106	0.0012	0.0000	0.0000
17	FeO	FeO	SI1	71.8464	5.7000	0.0000	0.0000

ROW	CNM	SOL	A	B	C	pH	Wi	COV A B C		
1	Fe3O4	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
2	Fe2O3	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
3	Fe3C1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
4	C1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
5	Fe1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
6	Si1	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
7	Si1O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
8	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
9	N2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10	O2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
11	H2O	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
12	CH4	24.40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
13	C2H6	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
14	H2	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
15	CO2	1950.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
16	CO	23.77	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
17	FeO	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	

ROW	CNM	CRIT T	CRIT P	CRIT V	ANTOINE VAPOR PRES A B C			HENRY
1	Fe3O4	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
2	Fe2O3	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
3	Fe3C1	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
4	C1	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
5	Fe1	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
6	Si1	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
7	Si1O2	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
8	H2O	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
9	N2	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
10	O2	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
11	H2O	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
12	CH4	190.700	46.9135	98.9000	6.69561	405.42	267.777	35389.5
13	C2H6	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
14	H2	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0
15	CO2	304.200	74.8792	94.8000	9.81060	1347.79	273.000	1215.7
16	CO	133.400	35.4638	93.1000	6.24020	230.27	260.010	63426.0
17	FeO	0.000	0.0000	0.0000	0.00000	0.00	0.000	0.0

IRON CARBIDE PROCESS

COMPONENT DATA

ROW	CNM	REFERENCE	H25	HTE-A	HTE-B	HTE-C	HTE-D
1	Fe3O4	B672160	-267300	-31312	71.0525	-7.8736	32.0732
2	Fe2O3	B672158	-197000	-20749	46.1517	-3.8751	21.9462
3	Fe3C1	B6771332	5985	-5013	21.1456	4.1225	-5.0322
4	C1	B672086	0	-2999	5.1802	0.2246	4.3597
5	Fe1	B672151	0	-7903	14.0914	-1.3293	11.6233
6	Si1	B672382	0	-2201	5.8656	0.2868	1.2792
7	Si1O2	B672387	-217720	-8654	19.1651	-0.5456	8.8977
8	H2O	B672180	-68315	-5071	16.1848	2.7637	0.0000
9	N2	B672244	0	-2846	7.5728	0.2525	1.7794
10	O2	B672277	0	-2979	7.9696	0.2720	1.7697
11	H2O	B672182	-57795	-2403	7.2906	1.3003	0.3596
12	CH4	YAWS	-17890	-1649	3.8363	7.1302	-0.3830
13	C2H6	B6772223	-20240	-5819	11.3274	9.4527	4.7951
14	H2	B672174	0	-1837	6.3659	0.4428	-0.2847
15	CO2	YAWS	-94050	-3105	8.4720	2.5871	1.0415
16	CO	YAWS	-26420	-1787	6.0661	0.9368	-0.3112
17	FeO	BAK2248	-62382	8754	-8.5950	9.1416	-21.4692

ROW	CNM	TEMP RANGE oK		HTG-A	HTG-B	HTG-C	HTG-D
1	Fe3O4	298.2	1800.0	-243067	-58.6967	-18.9430	-46.8195
2	Fe2O3	298.2	1800.0	-182323	-34.6418	-13.7715	-28.2755
3	Fe3C1	298.2	1400.0	15085	-32.7885	-13.6625	-16.6593
4	C1	298.2	3000.0	2405	-3.3866	-1.5836	-5.1587
5	Fe1	298.2	1811.0	2679	-8.2139	-4.0925	-5.4957
6	Si1	298.2	1687.0	2177	-6.4390	-2.6130	-4.1096
7	Si1O2	298.2	2000.0	-210342	-16.8483	-6.1496	-14.5464
8	H2O	298.2	373.2	-70630	-1.0739	-26.4253	0.0000
9	N2	298.2	3000.0	5078	-51.3044	-2.2358	-9.9139
10	O2	298.2	3000.0	5395	-54.8302	-2.3535	-10.5960
11	H2O	298.2	2000.0	-54212	-48.4557	-3.8711	-6.7579
12	CH4	298.0	700.0	-17759	-40.3353	-9.8039	-1.5255
13	C2H6	298.2	1000.0	-19821	-48.2326	-15.8609	-2.9266
14	H2	298.2	3000.0	4863	-36.6465	-2.1036	-9.3536
15	CO2	298.0	700.0	-93224	-48.5944	-8.4916	-2.4252
16	CO	298.0	700.0	-25393	-46.6664	-5.1645	-2.2650
17	FeO	298.2	1650.0	-58450	-19.5576	-4.9564	-7.3814

IRON CARBIDE PROCESS

FLOWSHEET DATA

NO	OPR	UNIT PROCESS	IS1	IS2	IS3	IS4	IS5	IS6	INV	OS1	OS2	OS3	OS4	OS5	OS6
1	SEC	IRON CARBIDE PROCESS	0	0	0	0	0	0	0	0	0	0	0	0	0
2	THK	SLURRY THICKENER	1	0	0	0	0	0	0	3	2	0	0	0	0
3	TAK	STORAGE TANK	2	0	0	0	0	0	0	4	0	0	0	0	0
4	FIL	DRUM FILTER	4	0	0	0	0	0	0	5	6	0	0	0	0
5	DRY	THERMAL DRYER	5	0	0	0	0	0	0	7	8	0	0	0	0
6	SPP	DUST CYCLONE	8	0	0	0	0	0	0	9	10	0	0	0	0
7	DCB	WASTE GAS B.H.	10	0	0	0	0	0	0	11	12	0	0	0	0
8	SPP	LOCK HOPPER	11	9	7	13	0	0	0	14	15	0	0	0	0
9	SPP	REACTOR #1	20	17	14	0	0	0	0	18	19	0	0	0	0
10	SPP	REACTOR CYCLONE #1	19	0	0	0	0	0	0	21	20	0	0	0	0
11	HTX	PROCESS GAS INTERCHANGER #1	21	0	0	26	0	0	0	22	27	0	0	0	0
12	SPP	SCRUBBER #1	22	0	0	0	0	0	0	23	35	0	0	0	0
13	SPS	STREAM SPLITTER	23	0	0	0	0	0	0	24	29	0	0	0	0
14	MIX	MIXER #1	25	24	0	0	0	0	0	26	0	0	0	0	0
15	HTX	PROCESS GAS HEATER #1	27	0	0	30	31	0	0	17	32	0	0	0	0
16	MIX	MIXER	33	34	0	0	0	0	0	25	0	0	0	0	0
17	SPP	REACTOR #2	18	36	39	0	0	0	0	37	38	0	0	0	0
18	SPP	REACTOR CYCLONE #2	38	0	0	0	0	0	0	40	39	0	0	0	0
19	HTX	PROCESS GAS INTERCHANGER #2	40	0	0	46	0	0	0	41	47	0	0	0	0
20	SPP	SCRUBBER #2	41	0	0	0	0	0	0	42	0	0	51	0	0
21	SPS	STREAM SPLITTER #2	42	0	0	0	0	0	0	43	44	0	0	0	0
22	MIX	MIXER #2	45	43	0	0	0	0	0	46	0	0	0	0	0
23	HTX	PROCESS GAS HEATER #2	47	0	0	48	49	0	0	36	50	0	0	0	0

IRON CARBIDE PROCESS

HEAT BALANCE SUMMARY - 1000000 KCAL/HOUR

OP	PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQRD	OUTPUT STREAM	TOTAL
1	IRON CARBIDE PRO	0	0	0	0	0	0	0	0
2	SLURRY THICKENER	-8	0	0	0	0	0	8	0
3	STORAGE TANK	-6	0	0	0	0	0	6	0
4	DRUM FILTER	-6	0	0	0	0	0	6	0
5	THERMAL DRYER	-2	-68	0	0	0	233	-164	0
6	DUST CYCLONE	35	0	0	0	0	0	-35	0
7	WASTE GAS B.H.	32	0	0	0	0	0	-32	0
8	LOCK HOPPER	132	0	0	0	0	0	-132	0
9	REACTOR #1	2009	-103	0	0	0	0	-1906	0
10	REACTOR CYCLONE	1813	0	0	0	0	0	-1813	0
11	PROCESS GAS INTE	1992	0	0	0	0	0	-1992	0
12	SCRUBBER #1	999	56	0	0	0	-854	-201	0
13	STREAM SPLITTER	194	0	0	0	0	0	-194	0
14	MIXER #1	184	0	0	0	0	0	-184	0
15	PROCESS GAS HEAT	993	12	0	0	0	873	-1878	0
16	MIXER	0	0	0	0	0	0	0	0
17	REACTOR #2	1339	-149	0	0	0	0	-1190	0
18	REACTOR CYCLONE	1109	0	0	0	0	0	-1109	0
19	PROCESS GAS INTE	1194	0	0	0	0	0	-1194	0
20	SCRUBBER #2	603	125	0	0	0	-614	-113	0
21	STREAM SPLITTER	97	0	0	0	0	0	-97	0
22	MIXER #2	89	0	0	0	0	0	-89	0
23	PROCESS GAS HEAT	591	0	0	0	0	0	-591	0

IRON CARBIDE PROCESS

STREAM TEMPERATURES AND ENTHALPIES

NO.	STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/H
1	Iron Ore Slurry	20.000	68.00	-8399856.0	-33333324.0	-35145000.
2	Thickener Underflow	20.000	68.00	-5902967.0	-23424865.0	-24698013.
3	Thickener Overflow	20.000	68.00	-2496890.0	-9908459.0	-10446986.
4	Slurry to Filter	20.000	68.00	-5902967.0	-23424865.0	-24698013.
5	Filtered Solids	20.000	68.00	-1588426.0	-6303382.0	-6645973.
6	Filterate	20.000	68.00	-4314541.0	-17121483.0	-18052040.
7	Dried Solids	595.000	1103.00	129106767.0	512337056.0	540182714.
8	Fines to Cyclone	595.000	1103.00	34590193.0	137264979.0	144725368.
9	Dust Cyclone Unders	595.000	1103.00	2692071.0	10683002.0	11263626.
10	Dust Cyclone Overs	595.000	1103.00	31898122.0	126581977.0	133461742.
11	Baghouse Discharge	595.000	1103.00	112224.0	445340.0	469544.
12	Bag Filter Exhaust	595.000	1103.00	31785898.0	126136637.0	132992197.
13	CO2	25.000	77.00	0.0	0.0	0.
14	Lock Hopper Discharge	588.879	1091.98	130492942.0	517837843.0	545982469.
15	Lock Hopper Flare	588.879	1091.98	1418120.0	5627556.0	5933415.
16	CAKE TO DRYER	20.000	68.00	-1588426.0	-6303382.0	-6645973.
17	H2-rich Reducing gas	730.000	1346.00	1873432343.0	7434380347.0	7838440924.
18	Partially Reduced Ore	701.984	1295.57	92812189.0	368308532.0	388326200.
19	Top gas with Fines	701.984	1295.57	1812833656.0	7193905321.0	7584896015.
20	Recycled Solids from Reactor #1	701.984	1295.57	4884852.0	19384660.0	20438221.
21	Top gas from Reactor #1	701.984	1295.57	1807948803.0	7174520661.0	7564457794.
22	Cooled Top gas	404.927	760.87	999141467.0	3964913767.0	4180407899.
23	Dry Top gas	100.000	212.00	194075162.0	770152484.0	812010479.
24	Recycle gases	100.000	212.00	184371404.0	731644860.0	771409955.
25	Make-up gases	24.763	76.57	63735.0	252921.0	266667.
26	Cold Reducing gas	95.431	203.78	184435139.0	731897781.0	771676622.
27	Preheated Reducing gas	404.927	760.87	993242475.0	3941504675.0	4155726517.
28	28	730.000	1346.00	712672346.0	2828112422.0	2981821095.
29	Bleed	100.000	212.00	9703758.0	38507624.0	40600524.
30	Natural Gas	25.000	77.00	0.0	0.0	0.
31	Air	25.000	77.00	19525.0	77483.0	81694.
32	32	730.000	1346.00	4343561.0	17236642.0	18173458.
33	SYN GAS	25.000	77.00	101123.0	401288.0	423098.
34	METHANE	0.000	32.00	-37388.0	-148368.0	-156431.
35	Excess Water	100.000	212.00	7189427.0	28529954.0	30080565.
36	Hot Reducing gas	730.000	1346.00	1242031439.0	4928779071.0	5196659542.
37	Final Product	659.762	1219.57	80817228.0	320708678.0	338139281.
38	Top gas with Fines	659.762	1219.57	1109000676.0	4400870338.0	4640058827.
39	Recycle Solids from Reactor #2	659.762	1219.57	4253538.0	16879404.0	17796804.
40	Top gas from Reactor #2	659.762	1219.57	1104747137.0	4383990934.0	4622262023.
41	Cooled Top gas	407.557	765.60	602555707.0	2391134285.0	2521093078.
42	Dry Top Gas	100.000	212.00	97148416.0	385516070.0	406468972.
43	Recycle gas	100.000	212.00	92290995.0	366240267.0	386145524.
44	Bleed	100.000	212.00	4857421.0	19275804.0	20323449.
45	Methane	0.000	32.00	-3025486.0	-12006098.0	-12658632.
46	Cold Reducing Gas	90.952	195.71	89265509.0	354234169.0	373486891.
47	Preheated Reducing Gas	407.557	765.60	591456940.0	2347090817.0	2474655836.
50	50	0.000	32.00	-650574500.0	-2581688253.0	-2722003706.
51	Excess Water	100.000	212.00	16019284.0	63569657.0	67024685.

IRON CARBIDE PROCESS

VOLUMETRIC FLOW RATE OF STREAMS WITH GASES

NO.	STREAM	TIME	ACFM	SCFM	M3/HR	NM3/HR
8	Fines to Cyclone	100.0000	269315	84738	457569	143970
10	Dust Cyclone Overs	100.0000	269310	84734	457561	143965
12	Bag Filter Exhaust	100.0000	269310	84734	457561	143964
13	CO2	100.0000	3258	2998	5536	5093
15	Lock Hopper Flare	100.0000	9459	2998	16071	5093
17	H2-rich Reducing gas	100.0000	18116257	4932897	30779716	8381045
19	Top gas with Fines	100.0000	17663233	4947724	30010023	8406237
21	Top gas from Reactor #1	100.0000	17663228	4947719	30010014	8406227
22	Cooled Top gas	100.0000	12282411	4947719	20867949	8406227
23	Dry Top gas	100.0000	6663184	4877585	11320822	8287070
24	Recycle gases	100.0000	6330025	4633706	10754781	7872716
25	Make-up gases	100.0000	326308	299191	554400	508328
26	Cold Reducing gas	100.0000	6656222	4932897	11308993	8381045
27	Preheated Reducing gas	100.0000	12245617	4932897	20805435	8381045
28	28	100.0000	6055222	1648741	10287888	2801228
29	Bleed	100.0000	333159	243879	566041	414353
30	Natural Gas	100.0000	896	822	1522	1397
31	Air	100.0000	10277	9416	17461	15997
32	32	100.0000	37599	10238	63880	17394
33	SYN GAS	100.0000	324002	296836	550483	504328
34	METHANE	100.0000	2348	2354	3990	4000
36	Hot Reducing gas	100.0000	8134866	2214845	13821225	3763046
38	Top gas with Fines	100.0000	7745051	2267508	13158925	3852520
40	Top gas from Reactor #2	100.0000	7745047	2267504	13158919	3852514
41	Cooled Top gas	100.0000	5650864	2267504	9600878	3852514
42	Dry Top Gas	100.0000	2882563	2111234	4897505	3587010
43	Recycle gas	100.0000	2738435	2005673	4652630	3407659
44	Bleed	100.0000	144128	105562	244875	179350
45	Methane	100.0000	208892	209173	354909	355387
46	Cold Reducing Gas	100.0000	2950567	2214845	5013045	3763046
47	Preheated Reducing Gas	100.0000	5519639	2214845	9377927	3763046

VOLUMETRIC FLOW RATE OF STREAMS WITH LIQUIDS AND SOLIDS ONLY

NO.	STREAM	TIME	USGPM	LPS	M3/HR	M3/DY
1	Iron Ore Slurry	100.0000	7505.837	473.5475	1704.771	40914.50
2	Thickener Underflow	100.0000	5300.047	334.3829	1203.779	28890.69
3	Thickener Overflow	100.0000	2205.790	139.1646	500.992	12023.82
4	Slurry to Filter	100.0000	5300.047	334.3829	1203.779	28890.69
5	Filtered Solids	100.0000	1488.359	93.9014	338.045	8113.08
6	Filterate	100.0000	3811.687	240.4815	865.733	20777.60
7	Dried Solids	100.0000	1138.145	71.8062	258.502	6204.06
9	Dust Cyclone Unders	100.0000	33.269	2.0990	7.556	181.35
11	Baghouse Discharge	100.0000	0.982	0.0619	0.223	5.35
14	Lock Hopper Discharge	100.0000	1172.396	73.9671	266.282	6390.76
18	Partially Reduced Ore	100.0000	763.331	48.1590	173.372	4160.93
20	Recycled Solids from Reactor #1	100.0000	40.175	2.5347	9.125	219.00
35	Excess Water	100.0000	440.117	27.7672	99.962	2399.09
37	Final Product	100.0000	510.252	32.1921	115.891	2781.40
39	Recycle Solids from Reactor #2	100.0000	26.855	1.6943	6.100	146.39
51	Excess Water	100.0000	980.656	61.8701	222.732	5345.58

IRON CARBIDE PROCESS

MASS FLOW RATES - MT/HR

NO.	STREAM	MT/HR-SI	MT/HR-LI	MT/HR-GC	MT/HR-TC
1	Iron Ore Slurry	1000.000	1500.000	0.000	2500.000
2	Thickener Underflow	999.900	999.900	0.000	1999.800
3	Thickener Overflow	0.100	500.100	0.000	500.200
4	Slurry to Filter	999.900	999.900	0.000	1999.800
5	Filtered Solids	997.900	136.077	0.000	1133.977
6	Filterate	2.000	863.823	0.000	865.822
7	Dried Solids	979.630	19.371	0.000	999.001
8	Fines to Cyclone	18.270	0.994	115.712	134.977
9	Dust Cyclone Unders	17.357	0.994	0.000	18.351
10	Dust Cyclone Overs	0.914	0.000	115.712	116.626
11	Baghouse Discharge	0.879	0.000	0.000	0.879
12	Bag Filter Exhaust	0.035	0.000	115.712	115.747
13	CO2	0.000	0.000	10.000	10.000
14	Lock Hopper Discharge	997.865	20.365	0.000	1018.231
15	Lock Hopper Flare	0.000	0.000	10.000	10.000
17	H2-rich Reducing gas	0.000	0.000	898.288	898.288
18	Partially Reduced Ore	930.809	0.000	0.000	930.809
19	Top gas with Fines	48.990	0.000	985.694	1034.684
20	Recycled Solids from Reactor #1	48.990	0.000	0.000	48.990
21	Top gas from Reactor #1	0.000	0.000	985.694	985.694
22	Cooled Top gas	0.000	0.000	985.694	985.694
23	Dry Top gas	0.000	0.000	889.921	889.921
24	Recycle gases	0.000	0.000	845.425	845.425
25	Make-up gases	0.000	0.000	52.863	52.863
26	Cold Reducing gas	0.000	0.000	898.288	898.288
27	Preheated Reducing gas	0.000	0.000	898.288	898.288
28	28	0.000	0.000	578.467	578.467
29	Bleed	0.000	0.000	44.496	44.496
30	Natural Gas	0.000	0.000	1.000	1.000
31	Air	0.000	0.000	20.583	20.583
32	32	0.000	0.000	21.583	21.583
33	SYN GAS	0.000	0.000	50.000	50.000
34	METHANE	0.000	0.000	2.863	2.863
35	Excess Water	0.000	95.773	0.000	95.773
36	Hot Reducing gas	0.000	0.000	1663.827	1663.827
37	Final Product	787.925	0.000	0.000	787.925
38	Top gas with Fines	41.470	0.000	1806.902	1848.372
39	Recycle Solids from Reactor #2	41.470	0.000	0.000	41.470
40	Top gas from Reactor #2	0.000	0.000	1806.902	1806.902
41	Cooled Top gas	0.000	0.000	1806.902	1806.902
42	Dry Top Gas	0.000	0.000	1593.502	1593.502
43	Recycle gas	0.000	0.000	1513.827	1513.827
44	Bleed	0.000	0.000	79.675	79.675
45	Methane	0.000	0.000	150.000	150.000
46	Cold Reducing Gas	0.000	0.000	1663.827	1663.827
47	Preheated Reducing Gas	0.000	0.000	1663.827	1663.827
51	Excess Water	0.000	213.400	0.000	213.400

IRON CARBIDE PROCESS

SPECIFIC GRAVITIES

NO.	STREAM	PCS	SG-SI	SG-LI	SG-GC	SG-TC
1	Iron Ore Slurry	40.0000	4.9467	0.9983	0.0000	1.4665
2	Thickener Underflow	50.0000	4.9467	0.9983	0.0000	1.6613
3	Thickener Overflow	0.0200	4.9467	0.9983	0.0000	0.9984
4	Slurry to Filter	50.0000	4.9467	0.9983	0.0000	1.6613
5	Filtered Solids	88.0000	4.9467	0.9983	0.0000	3.3545
6	Filterate	0.2310	4.9467	0.9983	0.0000	1.0001
7	Dried Solids	98.0610	4.9704	0.3154	0.0000	3.8646
8	Fines to Cyclone	13.5359	3.9409	0.3154	0.0003	0.0003
9	Dust Cyclone Unders	94.5818	3.9409	0.3154	0.0000	2.4286
10	Dust Cyclone Overs	0.7833	3.9409	0.0000	0.0003	0.0003
11	Baghouse Discharge	100.0000	3.9409	0.0000	0.0000	3.9409
12	Bag Filter Exhaust	0.0300	3.9409	0.0000	0.0003	0.0003
13	CO2	0.0000	0.0000	0.0000	0.0018	0.0018
14	Lock Hopper Discharge	97.9999	4.9467	0.3154	0.0000	3.8239
15	Lock Hopper Flare	0.0000	0.0000	0.0000	0.0006	0.0006
17	H2-rich Reducing gas	0.0000	0.0000	0.0000	0.0000	0.0000
18	Partially Reduced Ore	100.0000	5.3688	0.0000	0.0000	5.3688
19	Top gas with Fines	4.7348	5.3688	0.0000	0.0000	0.0000
20	Recycled Solids from Reactor #1	100.0000	5.3688	0.0000	0.0000	5.3688
21	Top gas from Reactor #1	0.0000	0.0000	0.0000	0.0000	0.0000
22	Cooled Top gas	0.0000	0.0000	0.0000	0.0000	0.0000
23	Dry Top gas	0.0000	0.0000	0.0000	0.0001	0.0001
24	Recycle gases	0.0000	0.0000	0.0000	0.0001	0.0001
25	Make-up gases	0.0000	0.0000	0.0000	0.0001	0.0001
26	Cold Reducing gas	0.0000	0.0000	0.0000	0.0001	0.0001
27	Preheated Reducing gas	0.0000	0.0000	0.0000	0.0000	0.0000
28	28	0.0000	0.0000	0.0000	0.0001	0.0001
29	Bleed	0.0000	0.0000	0.0000	0.0001	0.0001
30	Natural Gas	0.0000	0.0000	0.0000	0.0007	0.0007
31	Air	0.0000	0.0000	0.0000	0.0012	0.0012
32	32	0.0000	0.0000	0.0000	0.0003	0.0003
33	SYN GAS	0.0000	0.0000	0.0000	0.0001	0.0001
34	METHANE	0.0000	0.0000	0.0000	0.0007	0.0007
35	Excess Water	0.0000	0.0000	0.9581	0.0000	0.9581
36	Hot Reducing gas	0.0000	0.0000	0.0000	0.0001	0.0001
37	Final Product	100.0000	6.7988	0.0000	0.0000	6.7988
38	Top gas with Fines	2.2436	6.7988	0.0000	0.0001	0.0001
39	Recycle Solids from Reactor #2	100.0000	6.7988	0.0000	0.0000	6.7988
40	Top gas from Reactor #2	0.0000	0.0000	0.0000	0.0001	0.0001
41	Cooled Top gas	0.0000	0.0000	0.0000	0.0002	0.0002
42	Dry Top Gas	0.0000	0.0000	0.0000	0.0003	0.0003
43	Recycle gas	0.0000	0.0000	0.0000	0.0003	0.0003
44	Bleed	0.0000	0.0000	0.0000	0.0003	0.0003
45	Methane	0.0000	0.0000	0.0000	0.0004	0.0004
46	Cold Reducing Gas	0.0000	0.0000	0.0000	0.0003	0.0003
47	Preheated Reducing Gas	0.0000	0.0000	0.0000	0.0002	0.0002
51	Excess Water	0.0000	0.0000	0.9581	0.0000	0.9581

IRON CARBIDE PROCESS

STREAM DATA

SOLIDS - MT/HR

NO.	STREAM	Fe3O4	Fe2O3	Fe3C1	C1	Fe1
1	Iron Ore Slurry	900.000	50.0000	0.000	0.00000	0.00000
2	Thickener Underflow	899.910	49.9950	0.000	0.00000	0.00000
3	Thickener Overflow	0.090	0.0050	0.000	0.00000	0.00000
4	Slurry to Filter	899.910	49.9950	0.000	0.00000	0.00000
5	Filtered Solids	898.110	49.8950	0.000	0.00000	0.00000
6	Filterate	1.800	0.1000	0.000	0.00000	0.00000
7	Dried Solids	892.020	43.8049	0.000	0.00000	0.00000
8	Fines to Cyclone	6.090	6.0901	0.000	0.00000	0.00000
9	Dust Cyclone Unders	5.786	5.7856	0.000	0.00000	0.00000
10	Dust Cyclone Overs	0.305	0.3045	0.000	0.00000	0.00000
11	Baghouse Discharge	0.293	0.2929	0.000	0.00000	0.00000
12	Bag Filter Exhaust	0.012	0.0116	0.000	0.00000	0.00000
14	Lock Hopper Discharge	898.099	49.8834	0.000	0.00000	0.00000
16	CAKE TO DRYER	898.110	49.8950	0.000	0.00000	0.00000
37	Final Product	0.000	0.0000	712.898	0.00000	0.00000
38	Top gas with Fines	0.000	0.0000	37.521	0.00000	0.00000
39	Recycle Solids from Reactor #2	0.000	0.0000	37.521	0.00000	0.00000

SOLIDS - MT/HR

NO.	STREAM	Si1	Si1O2	FeO
1	Iron Ore Slurry	0.00000	50.0000	0.000
2	Thickener Underflow	0.00000	49.9950	0.000
3	Thickener Overflow	0.00000	0.0050	0.000
4	Slurry to Filter	0.00000	49.9950	0.000
5	Filtered Solids	0.00000	49.8950	0.000
6	Filterate	0.00000	0.1000	0.000
7	Dried Solids	0.00000	43.8049	0.000
8	Fines to Cyclone	0.00000	6.0901	0.000
9	Dust Cyclone Unders	0.00000	5.7856	0.000
10	Dust Cyclone Overs	0.00000	0.3045	0.000
11	Baghouse Discharge	0.00000	0.2929	0.000
12	Bag Filter Exhaust	0.00000	0.0116	0.000
14	Lock Hopper Discharge	0.00000	49.8834	0.000
16	CAKE TO DRYER	0.00000	49.8950	0.000
18	Partially Reduced Ore	0.00000	49.8834	880.925
19	Top gas with Fines	0.00000	2.6254	46.364
20	Recycled Solids from Reactor #1	0.00000	2.6254	46.364
37	Final Product	0.00000	49.8834	25.144
38	Top gas with Fines	0.00000	2.6254	1.323
39	Recycle Solids from Reactor #2	0.00000	2.6254	1.323

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Fe3O4	Fe2O3	Fe3C1	C1	Fe1
1	Iron Ore Slurry	90.0000	5.0000	0.0000	0.00000	0.00000
2	Thickener Underflow	90.0000	5.0000	0.0000	0.00000	0.00000
3	Thickener Overflow	90.0000	5.0000	0.0000	0.00000	0.00000
4	Slurry to Filter	90.0000	5.0000	0.0000	0.00000	0.00000
5	Filtered Solids	90.0000	5.0000	0.0000	0.00000	0.00000
6	Filterate	90.0000	5.0000	0.0000	0.00000	0.00000
7	Dried Solids	91.0568	4.4716	0.0000	0.00000	0.00000
8	Fines to Cyclone	33.3333	33.3333	0.0000	0.00000	0.00000
9	Dust Cyclone Unders	33.3333	33.3333	0.0000	0.00000	0.00000
10	Dust Cyclone Overs	33.3333	33.3333	0.0000	0.00000	0.00000
11	Baghouse Discharge	33.3333	33.3333	0.0000	0.00000	0.00000
12	Bag Filter Exhaust	33.3333	33.3333	0.0000	0.00000	0.00000
14	Lock Hopper Discharge	90.0020	4.9990	0.0000	0.00000	0.00000
16	CAKE TO DRYER	90.0000	5.0000	0.0000	0.00000	0.00000
37	Final Product	0.0000	0.0000	90.4778	0.00000	0.00000
38	Top gas with Fines	0.0000	0.0000	90.4778	0.00000	0.00000
39	Recycle Solids from Reactor #2	0.0000	0.0000	90.4778	0.00000	0.00000

IRON CARBIDE PROCESS

STREAM DATA

SOLIDS - WEIGHT PERCENT

NO.	STREAM	Si1	Si1O2	FeO
1	Iron Ore Slurry	0.00000	5.0000	0.0000
2	Thickener Underflow	0.00000	5.0000	0.0000
3	Thickener Overflow	0.00000	5.0000	0.0000
4	Slurry to Filter	0.00000	5.0000	0.0000
5	Filtered Solids	0.00000	5.0000	0.0000
6	Filterate	0.00000	5.0000	0.0000
7	Dried Solids	0.00000	4.4716	0.0000
8	Fines to Cyclone	0.00000	33.3333	0.0000
9	Dust Cyclone Unders	0.00000	33.3333	0.0000
10	Dust Cyclone Overs	0.00000	33.3333	0.0000
11	Baghouse Discharge	0.00000	33.3333	0.0000
12	Bag Filter Exhaust	0.00000	33.3333	0.0000
14	Lock Hopper Discharge	0.00000	4.9990	0.0000
16	CAKE TO DRYER	0.00000	5.0000	0.0000
18	Partially Reduced Ore	0.00000	5.3591	94.6409
19	Top gas with Fines	0.00000	5.3591	94.6409
20	Recycled Solids from Reactor #1	0.00000	5.3591	94.6409
37	Final Product	0.00000	6.3310	3.1912
38	Top gas with Fines	0.00000	6.3310	3.1912
39	Recycle Solids from Reactor #2	0.00000	6.3310	3.1912

AQUEOUS - MT/HR

NO.	STREAM	H2O
1	Iron Ore Slurry	1500.00
2	Thickener Underflow	999.90
3	Thickener Overflow	500.10
4	Slurry to Filter	999.90
5	Filtered Solids	136.08
6	Filterate	863.82
7	Dried Solids	19.37
8	Fines to Cyclone	0.99
9	Dust Cyclone Unders	0.99
14	Lock Hopper Discharge	20.37
16	CAKE TO DRYER	136.08
35	Excess Water	95.77
51	Excess Water	213.40

AQUEOUS - WEIGHT PERCENT

NO.	STREAM	H2O
1	Iron Ore Slurry	100.000
2	Thickener Underflow	100.000
3	Thickener Overflow	100.000
4	Slurry to Filter	100.000
5	Filtered Solids	100.000
6	Filterate	100.000
7	Dried Solids	100.000
8	Fines to Cyclone	100.000
9	Dust Cyclone Unders	100.000
14	Lock Hopper Discharge	100.000
16	CAKE TO DRYER	100.000
35	Excess Water	100.000
51	Excess Water	100.000

IRON CARBIDE PROCESS

STREAM DATA

AQUEOUS - GRAMS PER LITER

NO.	STREAM	H2O
1	Iron Ore Slurry	998.259
2	Thickener Underflow	998.259
3	Thickener Overflow	998.259
4	Slurry to Filter	998.259
5	Filtered Solids	998.259
6	Filterate	998.259
7	Dried Solids	315.448
8	Fines to Cyclone	315.448
9	Dust Cyclone Unders	315.448
14	Lock Hopper Discharge	315.448
16	CAKE TO DRYER	998.259
35	Excess Water	958.099
51	Excess Water	958.099

GASEOUS - MT/HR

NO.	STREAM	N2	O2	H2O	CH4	C2H6
8	Fines to Cyclone	0.0000	0.00000	115.712	0.00	0.00000
10	Dust Cyclone Overs	0.0000	0.00000	115.712	0.00	0.00000
12	Bag Filter Exhaust	0.0000	0.00000	115.712	0.00	0.00000
17	H2-rich Reducing gas	0.0000	0.00000	1.857	57.26	0.00000
19	Top gas with Fines	0.0000	0.00000	97.728	57.26	0.00000
21	Top gas from Reactor #1	0.0000	0.00000	97.728	57.26	0.00000
22	Cooled Top gas	0.0000	0.00000	97.728	57.26	0.00000
23	Dry Top gas	0.0000	0.00000	1.955	57.26	0.00000
24	Recycle gases	0.0000	0.00000	1.857	54.40	0.00000
25	Make-up gases	0.0000	0.00000	0.000	2.86	0.00000
26	Cold Reducing gas	0.0000	0.00000	1.857	57.26	0.00000
27	Preheated Reducing gas	0.0000	0.00000	1.857	57.26	0.00000
28	28	6.5303	0.00000	5.762	332.39	0.00000
29	Bleed	0.0000	0.00000	0.098	2.86	0.00000
30	Natural Gas	0.0000	0.00000	0.000	1.00	0.00000
31	Air	15.8489	4.73409	0.000	0.00	0.00000
32	32	15.8489	0.74497	2.246	0.00	0.00000
34	METHANE	0.0000	0.00000	0.000	2.86	0.00000
36	Hot Reducing gas	0.0000	0.00000	22.526	1492.97	0.00000
38	Top gas with Fines	0.0000	0.00000	237.111	1429.45	0.00000
40	Top gas from Reactor #2	0.0000	0.00000	237.111	1429.45	0.00000
41	Cooled Top gas	0.0000	0.00000	237.111	1429.45	0.00000
42	Dry Top Gas	0.0000	0.00000	23.711	1429.45	0.00000
43	Recycle gas	0.0000	0.00000	22.526	1357.97	0.00000
44	Bleed	0.0000	0.00000	1.186	71.47	0.00000
45	Methane	0.0000	0.00000	0.000	135.00	0.00000
46	Cold Reducing Gas	0.0000	0.00000	22.526	1492.97	0.00000
47	Preheated Reducing Gas	0.0000	0.00000	22.526	1492.97	0.00000

IRON CARBIDE PROCESS

STREAM DATA

GASEOUS - MT/HR

NO.	STREAM	H2	CO2	CO
13	CO2	0.000	10.0000	0.0000
15	Lock Hopper Flare	0.000	10.0000	0.0000
17	H2-rich Reducing gas	739.203	0.0000	99.9677
19	Top gas with Fines	730.740	0.0000	99.9660
21	Top gas from Reactor #1	730.740	0.0000	99.9660
22	Cooled Top gas	730.740	0.0000	99.9660
23	Dry Top gas	730.740	0.0000	99.9660
24	Recycle gases	694.203	0.0000	94.9677
25	Make-up gases	45.000	0.0000	5.0000
26	Cold Reducing gas	739.203	0.0000	99.9677
27	Preheated Reducing gas	739.203	0.0000	99.9677
28	28	207.514	13.0606	13.2093
29	Bleed	36.537	0.0000	4.9983
32	32	0.000	2.7432	0.0000
33	SYN GAS	45.000	0.0000	5.0000
36	Hot Reducing gas	148.327	0.0000	0.0000
38	Top gas with Fines	140.344	0.0000	0.0000
40	Top gas from Reactor #2	140.344	0.0000	0.0000
41	Cooled Top gas	140.344	0.0000	0.0000
42	Dry Top Gas	140.344	0.0000	0.0000
43	Recycle gas	133.327	0.0000	0.0000
44	Bleed	7.017	0.0000	0.0000
45	Methane	15.000	0.0000	0.0000
46	Cold Reducing Gas	148.327	0.0000	0.0000
47	Preheated Reducing Gas	148.327	0.0000	0.0000

GASEOUS - WEIGHT PERCENT

NO.	STREAM	N2	O2	H2O	CH4	C2H6
8	Fines to Cyclone	0.0000	0.0000	100.000	0.000	0.00000
10	Dust Cyclone Overs	0.0000	0.0000	100.000	0.000	0.00000
12	Bag Filter Exhaust	0.0000	0.0000	100.000	0.000	0.00000
17	H2-rich Reducing gas	0.0000	0.0000	0.207	6.374	0.00000
19	Top gas with Fines	0.0000	0.0000	9.915	5.809	0.00000
21	Top gas from Reactor #1	0.0000	0.0000	9.915	5.809	0.00000
22	Cooled Top gas	0.0000	0.0000	9.915	5.809	0.00000
23	Dry Top gas	0.0000	0.0000	0.220	6.434	0.00000
24	Recycle gases	0.0000	0.0000	0.220	6.434	0.00000
25	Make-up gases	0.0000	0.0000	0.000	5.416	0.00000
26	Cold Reducing gas	0.0000	0.0000	0.207	6.374	0.00000
27	Preheated Reducing gas	0.0000	0.0000	0.207	6.374	0.00000
28	28	1.1289	0.0000	0.996	57.461	0.00000
29	Bleed	0.0000	0.0000	0.220	6.434	0.00000
30	Natural Gas	0.0000	0.0000	0.000	100.000	0.00000
31	Air	77.0000	23.0000	0.000	0.000	0.00000
32	32	73.4324	3.4517	10.406	0.000	0.00000
34	METHANE	0.0000	0.0000	0.000	100.000	0.00000
36	Hot Reducing gas	0.0000	0.0000	1.354	89.731	0.00000
38	Top gas with Fines	0.0000	0.0000	13.123	79.110	0.00000
40	Top gas from Reactor #2	0.0000	0.0000	13.123	79.110	0.00000
41	Cooled Top gas	0.0000	0.0000	13.123	79.110	0.00000
42	Dry Top Gas	0.0000	0.0000	1.488	89.705	0.00000
43	Recycle gas	0.0000	0.0000	1.488	89.705	0.00000
44	Bleed	0.0000	0.0000	1.488	89.705	0.00000
45	Methane	0.0000	0.0000	0.000	90.000	0.00000
46	Cold Reducing Gas	0.0000	0.0000	1.354	89.731	0.00000
47	Preheated Reducing Gas	0.0000	0.0000	1.354	89.731	0.00000

IRON CARBIDE PROCESS

STREAM DATA

GASEOUS - WEIGHT PERCENT

NO.	STREAM	H2	CO2	CO
13	CO2	0.0000	100.000	0.0000
15	Lock Hopper Flare	0.0000	100.000	0.0000
17	H2-rich Reducing gas	82.2902	0.000	11.1287
19	Top gas with Fines	74.1345	0.000	10.1417
21	Top gas from Reactor #1	74.1345	0.000	10.1417
22	Cooled Top gas	74.1345	0.000	10.1417
23	Dry Top gas	82.1129	0.000	11.2331
24	Recycle gases	82.1129	0.000	11.2331
25	Make-up gases	85.1256	0.000	9.4584
26	Cold Reducing gas	82.2902	0.000	11.1287
27	Preheated Reducing gas	82.2902	0.000	11.1287
28	28	35.8732	2.258	2.2835
29	Bleed	82.1129	0.000	11.2331
32	32	0.0000	12.710	0.0000
33	SYN GAS	90.0000	0.000	10.0000
36	Hot Reducing gas	8.9148	0.000	0.0000
38	Top gas with Fines	7.7671	0.000	0.0000
40	Top gas from Reactor #2	7.7671	0.000	0.0000
41	Cooled Top gas	7.7671	0.000	0.0000
42	Dry Top Gas	8.8073	0.000	0.0000
43	Recycle gas	8.8073	0.000	0.0000
44	Bleed	8.8073	0.000	0.0000
45	Methane	10.0000	0.000	0.0000
46	Cold Reducing Gas	8.9148	0.000	0.0000
47	Preheated Reducing Gas	8.9148	0.000	0.0000

GASEOUS - VOLUME PERCENT

NO.	STREAM	N2	O2	H2O	CH4	C2H6
8	Fines to Cyclone	0.0000	0.0000	100.000	0.000	0.00000
10	Dust Cyclone Overs	0.0000	0.0000	100.000	0.000	0.00000
12	Bag Filter Exhaust	0.0000	0.0000	100.000	0.000	0.00000
17	H2-rich Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
19	Top gas with Fines	0.0000	0.0000	1.446	0.952	0.00000
21	Top gas from Reactor #1	0.0000	0.0000	1.446	0.952	0.00000
22	Cooled Top gas	0.0000	0.0000	1.446	0.952	0.00000
23	Dry Top gas	0.0000	0.0000	0.029	0.965	0.00000
24	Recycle gases	0.0000	0.0000	0.029	0.965	0.00000
25	Make-up gases	0.0000	0.0000	0.000	0.787	0.00000
26	Cold Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
27	Preheated Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
28	28	0.1865	0.0000	0.256	16.578	0.00000
29	Bleed	0.0000	0.0000	0.029	0.965	0.00000
30	Natural Gas	0.0000	0.0000	0.000	100.000	0.00000
31	Air	79.2708	20.7292	0.000	0.000	0.00000
32	32	72.9037	3.0000	16.064	0.000	0.00000
34	METHANE	0.0000	0.0000	0.000	100.000	0.00000
36	Hot Reducing gas	0.0000	0.0000	0.745	55.430	0.00000
38	Top gas with Fines	0.0000	0.0000	7.657	51.839	0.00000
40	Top gas from Reactor #2	0.0000	0.0000	7.657	51.839	0.00000
41	Cooled Top gas	0.0000	0.0000	7.657	51.839	0.00000
42	Dry Top Gas	0.0000	0.0000	0.822	55.676	0.00000
43	Recycle gas	0.0000	0.0000	0.822	55.676	0.00000
44	Bleed	0.0000	0.0000	0.822	55.676	0.00000
45	Methane	0.0000	0.0000	0.000	53.072	0.00000
46	Cold Reducing Gas	0.0000	0.0000	0.745	55.430	0.00000
47	Preheated Reducing Gas	0.0000	0.0000	0.745	55.430	0.00000

IRON CARBIDE PROCESS

STREAM DATA

GASEOUS - VOLUME PERCENT

NO.	STREAM	H2	CO2	CO
13	CO2	0.0000	100.000	0.00000
15	Lock Hopper Flare	0.0000	100.000	0.00000
17	H2-rich Reducing gas	98.0634	0.000	0.95446
19	Top gas with Fines	96.6503	0.000	0.95159
21	Top gas from Reactor #1	96.6503	0.000	0.95159
22	Cooled Top gas	96.6503	0.000	0.95159
23	Dry Top gas	98.0400	0.000	0.96527
24	Recycle gases	98.0400	0.000	0.96527
25	Make-up gases	98.4260	0.000	0.78709
26	Cold Reducing gas	98.0634	0.000	0.95446
27	Preheated Reducing gas	98.0634	0.000	0.95446
28	28	82.3647	0.237	0.37734
29	Bleed	98.0400	0.000	0.96527
32	32	0.0000	8.032	0.00000
33	SYN GAS	99.2067	0.000	0.79333
36	Hot Reducing gas	43.8251	0.000	0.00000
38	Top gas with Fines	40.5035	0.000	0.00000
40	Top gas from Reactor #2	40.5035	0.000	0.00000
41	Cooled Top gas	40.5035	0.000	0.00000
42	Dry Top Gas	43.5015	0.000	0.00000
43	Recycle gas	43.5015	0.000	0.00000
44	Bleed	43.5015	0.000	0.00000
45	Methane	46.9280	0.000	0.00000
46	Cold Reducing Gas	43.8251	0.000	0.00000
47	Preheated Reducing Gas	43.8251	0.000	0.00000

IRON CARBIDE PROCESS

STREAM DATA IN MOLES

SOLIDS - MT MOLES/HR

NO.	STREAM	Fe3O4	Fe2O3	Fe3C1	C1	Fe1
1	Iron Ore Slurry	3.88704	0.31310	0.00000	0.00000	0.00000
2	Thickener Underflow	3.88665	0.31307	0.00000	0.00000	0.00000
3	Thickener Overflow	0.00039	0.00003	0.00000	0.00000	0.00000
4	Slurry to Filter	3.88665	0.31307	0.00000	0.00000	0.00000
5	Filtered Solids	3.87888	0.31244	0.00000	0.00000	0.00000
6	Filterate	0.00777	0.00063	0.00000	0.00000	0.00000
7	Dried Solids	3.85258	0.27431	0.00000	0.00000	0.00000
8	Fines to Cyclone	0.02630	0.03814	0.00000	0.00000	0.00000
9	Dust Cyclone Unders	0.02499	0.03623	0.00000	0.00000	0.00000
10	Dust Cyclone Overs	0.00132	0.00191	0.00000	0.00000	0.00000
11	Baghouse Discharge	0.00127	0.00183	0.00000	0.00000	0.00000
12	Bag Filter Exhaust	0.00005	0.00007	0.00000	0.00000	0.00000
14	Lock Hopper Discharge	3.87883	0.31237	0.00000	0.00000	0.00000
16	CAKE TO DRYER	3.87888	0.31244	0.00000	0.00000	0.00000
37	Final Product	0.00000	0.00000	3.97042	0.00000	0.00000
38	Top gas with Fines	0.00000	0.00000	0.20897	0.00000	0.00000
39	Recycle Solids from Reactor #2	0.00000	0.00000	0.20897	0.00000	0.00000

SOLIDS - MT MOLES/HR

NO.	STREAM	Si1	Si1O2	FeO
1	Iron Ore Slurry	0.00000	0.83216	0.0000
2	Thickener Underflow	0.00000	0.83207	0.0000
3	Thickener Overflow	0.00000	0.00008	0.0000
4	Slurry to Filter	0.00000	0.83207	0.0000
5	Filtered Solids	0.00000	0.83041	0.0000
6	Filterate	0.00000	0.00166	0.0000
7	Dried Solids	0.00000	0.72905	0.0000
8	Fines to Cyclone	0.00000	0.10136	0.0000
9	Dust Cyclone Unders	0.00000	0.09629	0.0000
10	Dust Cyclone Overs	0.00000	0.00507	0.0000
11	Baghouse Discharge	0.00000	0.00488	0.0000
12	Bag Filter Exhaust	0.00000	0.00019	0.0000
14	Lock Hopper Discharge	0.00000	0.83022	0.0000
16	CAKE TO DRYER	0.00000	0.83041	0.0000
18	Partially Reduced Ore	0.00000	0.83022	12.2612
19	Top gas with Fines	0.00000	0.04370	0.6453
20	Recycled Solids from Reactor #1	0.00000	0.04370	0.6453
37	Final Product	0.00000	0.83022	0.3500
38	Top gas with Fines	0.00000	0.04370	0.0184
39	Recycle Solids from Reactor #2	0.00000	0.04370	0.0184

SOLIDS - MOLE PERCENT

NO.	STREAM	Fe3O4	Fe2O3	Fe3C1	C1	Fe1
1	Iron Ore Slurry	77.2418	6.2219	0.0000	0.00000	0.00000
2	Thickener Underflow	77.2418	6.2219	0.0000	0.00000	0.00000
3	Thickener Overflow	77.2418	6.2219	0.0000	0.00000	0.00000
4	Slurry to Filter	77.2418	6.2219	0.0000	0.00000	0.00000
5	Filtered Solids	77.2418	6.2219	0.0000	0.00000	0.00000
6	Filterate	77.2418	6.2219	0.0000	0.00000	0.00000
7	Dried Solids	79.3375	5.6489	0.0000	0.00000	0.00000
8	Fines to Cyclone	15.8644	23.0018	0.0000	0.00000	0.00000
9	Dust Cyclone Unders	15.8644	23.0018	0.0000	0.00000	0.00000
10	Dust Cyclone Overs	15.8644	23.0018	0.0000	0.00000	0.00000
11	Baghouse Discharge	15.8644	23.0018	0.0000	0.00000	0.00000
12	Bag Filter Exhaust	15.8644	23.0018	0.0000	0.00000	0.00000
14	Lock Hopper Discharge	77.2457	6.2208	0.0000	0.00000	0.00000
16	CAKE TO DRYER	77.2418	6.2219	0.0000	0.00000	0.00000
37	Final Product	0.0000	0.0000	77.0864	0.00000	0.00000
38	Top gas with Fines	0.0000	0.0000	77.0864	0.00000	0.00000
39	Recycle Solids from Reactor #2	0.0000	0.0000	77.0864	0.00000	0.00000

IRON CARBIDE PROCESS

STREAM DATA IN MOLES

SOLIDS - MOLE PERCENT

NO.	STREAM	Si1	Si1O2	FeO
1	Iron Ore Slurry	0.00000	16.5363	0.0000
2	Thickener Underflow	0.00000	16.5363	0.0000
3	Thickener Overflow	0.00000	16.5363	0.0000
4	Slurry to Filter	0.00000	16.5363	0.0000
5	Filtered Solids	0.00000	16.5363	0.0000
6	Filterate	0.00000	16.5363	0.0000
7	Dried Solids	0.00000	15.0136	0.0000
8	Fines to Cyclone	0.00000	61.1338	0.0000
9	Dust Cyclone Unders	0.00000	61.1338	0.0000
10	Dust Cyclone Overs	0.00000	61.1338	0.0000
11	Baghouse Discharge	0.00000	61.1338	0.0000
12	Bag Filter Exhaust	0.00000	61.1338	0.0000
14	Lock Hopper Discharge	0.00000	16.5335	0.0000
16	CAKE TO DRYER	0.00000	16.5363	0.0000
18	Partially Reduced Ore	0.00000	6.3417	93.6583
19	Top gas with Fines	0.00000	6.3417	93.6583
20	Recycled Solids from Reactor #1	0.00000	6.3417	93.6583
37	Final Product	0.00000	16.1188	6.7947
38	Top gas with Fines	0.00000	16.1188	6.7947
39	Recycle Solids from Reactor #2	0.00000	16.1188	6.7947

GASEOUS - MT MOLES/HR

NO.	STREAM	N2	O2	H2O	CH4	C2H6
8	Fines to Cyclone	0.00000	0.00000	6.4230	0.0000	0.00000
10	Dust Cyclone Overs	0.00000	0.00000	6.4230	0.0000	0.00000
12	Bag Filter Exhaust	0.00000	0.00000	6.4230	0.0000	0.00000
17	H2-rich Reducing gas	0.00000	0.00000	0.1031	3.5692	0.00000
19	Top gas with Fines	0.00000	0.00000	5.4247	3.5692	0.00000
21	Top gas from Reactor #1	0.00000	0.00000	5.4247	3.5692	0.00000
22	Cooled Top gas	0.00000	0.00000	5.4247	3.5692	0.00000
23	Dry Top gas	0.00000	0.00000	0.1085	3.5692	0.00000
24	Recycle gases	0.00000	0.00000	0.1031	3.3907	0.00000
25	Make-up gases	0.00000	0.00000	0.0000	0.1785	0.00000
26	Cold Reducing gas	0.00000	0.00000	0.1031	3.5692	0.00000
27	Preheated Reducing gas	0.00000	0.00000	0.1031	3.5692	0.00000
28	28	0.23311	0.00000	0.3198	20.7187	0.00000
29	Bleed	0.00000	0.00000	0.0054	0.1785	0.00000
30	Natural Gas	0.00000	0.00000	0.0000	0.0623	0.00000
31	Air	0.56576	0.14795	0.0000	0.0000	0.00000
32	32	0.56576	0.02328	0.1247	0.0000	0.00000
34	METHANE	0.00000	0.00000	0.0000	0.1785	0.00000
36	Hot Reducing gas	0.00000	0.00000	1.2504	93.0606	0.00000
38	Top gas with Fines	0.00000	0.00000	13.1616	89.1008	0.00000
40	Top gas from Reactor #2	0.00000	0.00000	13.1616	89.1008	0.00000
41	Cooled Top gas	0.00000	0.00000	13.1616	89.1008	0.00000
42	Dry Top Gas	0.00000	0.00000	1.3162	89.1008	0.00000
43	Recycle gas	0.00000	0.00000	1.2504	84.6457	0.00000
44	Bleed	0.00000	0.00000	0.0658	4.4550	0.00000
45	Methane	0.00000	0.00000	0.0000	8.4149	0.00000
46	Cold Reducing Gas	0.00000	0.00000	1.2504	93.0606	0.00000
47	Preheated Reducing Gas	0.00000	0.00000	1.2504	93.0606	0.00000

IRON CARBIDE PROCESS

STREAM DATA IN MOLES

GASEOUS - MT MOLES/HR

NO.	STREAM	H2	CO2	CO
13	CO2	0.000	0.22722	0.00000
15	Lock Hopper Flare	0.000	0.22722	0.00000
17	H2-rich Reducing gas	366.679	0.00000	3.56893
19	Top gas with Fines	362.481	0.00000	3.56887
21	Top gas from Reactor #1	362.481	0.00000	3.56887
22	Cooled Top gas	362.481	0.00000	3.56887
23	Dry Top gas	362.481	0.00000	3.56887
24	Recycle gases	344.357	0.00000	3.39042
25	Make-up gases	22.322	0.00000	0.17850
26	Cold Reducing gas	366.679	0.00000	3.56893
27	Preheated Reducing gas	366.679	0.00000	3.56893
28	28	102.937	0.29676	0.47158
29	Bleed	18.124	0.00000	0.17844
32	32	0.000	0.06233	0.00000
33	SYN GAS	22.322	0.00000	0.17850
36	Hot Reducing gas	73.577	0.00000	0.00000
38	Top gas with Fines	69.617	0.00000	0.00000
40	Top gas from Reactor #2	69.617	0.00000	0.00000
41	Cooled Top gas	69.617	0.00000	0.00000
42	Dry Top Gas	69.617	0.00000	0.00000
43	Recycle gas	66.137	0.00000	0.00000
44	Bleed	3.481	0.00000	0.00000
45	Methane	7.441	0.00000	0.00000
46	Cold Reducing Gas	73.577	0.00000	0.00000
47	Preheated Reducing Gas	73.577	0.00000	0.00000

GASEOUS - MOLE PERCENT

NO.	STREAM	N2	O2	H2O	CH4	C2H6
8	Fines to Cyclone	0.0000	0.0000	100.000	0.000	0.00000
10	Dust Cyclone Overs	0.0000	0.0000	100.000	0.000	0.00000
12	Bag Filter Exhaust	0.0000	0.0000	100.000	0.000	0.00000
17	H2-rich Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
19	Top gas with Fines	0.0000	0.0000	1.446	0.952	0.00000
21	Top gas from Reactor #1	0.0000	0.0000	1.446	0.952	0.00000
22	Cooled Top gas	0.0000	0.0000	1.446	0.952	0.00000
23	Dry Top gas	0.0000	0.0000	0.029	0.965	0.00000
24	Recycle gases	0.0000	0.0000	0.029	0.965	0.00000
25	Make-up gases	0.0000	0.0000	0.000	0.787	0.00000
26	Cold Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
27	Preheated Reducing gas	0.0000	0.0000	0.028	0.955	0.00000
28	28	0.1865	0.0000	0.256	16.578	0.00000
29	Bleed	0.0000	0.0000	0.029	0.965	0.00000
30	Natural Gas	0.0000	0.0000	0.000	100.000	0.00000
31	Air	79.2708	20.7292	0.000	0.000	0.00000
32	32	72.9037	3.0000	16.064	0.000	0.00000
34	METHANE	0.0000	0.0000	0.000	100.000	0.00000
36	Hot Reducing gas	0.0000	0.0000	0.745	55.430	0.00000
38	Top gas with Fines	0.0000	0.0000	7.657	51.839	0.00000
40	Top gas from Reactor #2	0.0000	0.0000	7.657	51.839	0.00000
41	Cooled Top gas	0.0000	0.0000	7.657	51.839	0.00000
42	Dry Top Gas	0.0000	0.0000	0.822	55.676	0.00000
43	Recycle gas	0.0000	0.0000	0.822	55.676	0.00000
44	Bleed	0.0000	0.0000	0.822	55.676	0.00000
45	Methane	0.0000	0.0000	0.000	53.072	0.00000
46	Cold Reducing Gas	0.0000	0.0000	0.745	55.430	0.00000
47	Preheated Reducing Gas	0.0000	0.0000	0.745	55.430	0.00000

IRON CARBIDE PROCESS

STREAM DATA IN MOLES

GASEOUS - MOLE PERCENT

NO.	STREAM	H2	CO2	CO
13	CO2	0.0000	100.000	0.00000
15	Lock Hopper Flare	0.0000	100.000	0.00000
17	H2-rich Reducing gas	98.0634	0.000	0.95446
19	Top gas with Fines	96.6503	0.000	0.95159
21	Top gas from Reactor #1	96.6503	0.000	0.95159
22	Cooled Top gas	96.6503	0.000	0.95159
23	Dry Top gas	98.0400	0.000	0.96527
24	Recycle gases	98.0400	0.000	0.96527
25	Make-up gases	98.4260	0.000	0.78709
26	Cold Reducing gas	98.0634	0.000	0.95446
27	Preheated Reducing gas	98.0634	0.000	0.95446
28	28	82.3647	0.237	0.37734
29	Bleed	98.0400	0.000	0.96527
32	32	0.0000	8.032	0.00000
33	SYN GAS	99.2067	0.000	0.79333
36	Hot Reducing gas	43.8251	0.000	0.00000
38	Top gas with Fines	40.5035	0.000	0.00000
40	Top gas from Reactor #2	40.5035	0.000	0.00000
41	Cooled Top gas	40.5035	0.000	0.00000
42	Dry Top Gas	43.5015	0.000	0.00000
43	Recycle gas	43.5015	0.000	0.00000
44	Bleed	43.5015	0.000	0.00000
45	Methane	46.9280	0.000	0.00000
46	Cold Reducing Gas	43.8251	0.000	0.00000
47	Preheated Reducing Gas	43.8251	0.000	0.00000

APPENDIX F

SUMMARY OF CONSUMABLES AND RELATIVE OPERATING COST ESTIMATES

F-1: CONSUMABLE COMPONENTS & COSTS

F-2: IRONMAKING PROCESS CONSUMPTIONS & RELATIVE OPERATING COSTS

F-3: IRONMAKING PROCESS SUMMARIES

F-4: IRONMAKING PROCESS RELATIVE OPERATING COSTS (OPEX)

F-5: IRONMAKING PROCESS RELATIVE CAPITAL COSTS (CAPEX)

F-6: RANKINGS OF PROCESSES

APPENDIX F-1

CONSUMABLE COMPONENTS & COSTS

Appendix F: Summary of Consumables and Relative Cost Estimates

F-1: Consumable Components & Costs

The approaches followed in developing the operating costs for the various Ironmaking Processes were to build up the operating cost (OPEX) from the individual components. These bases for these costs include:

- Consumable components as defined by the mass and fuel balances (Appendix B).
- Electrical power consumptions from experience or Process Vendor data.
- Labor estimates were factored from man-hour/mt data supplied by Process Vendors and experience with similar processes.
- Costs and/or fuel costs for transport of materials.
- Allowances for maintenance materials and supplies based on Vendor factors.
- As appropriate, allowances for G&A were added.
- Each process component cost was built up using the above factors for each unit operation involved in producing and delivering the consumable to the ironmaking process.

In the following tables, the Consumable component costs are defined and summarized for:

F1.1 Bentonite Binder
F1.2 Coal (lump delivered to use)
F1.3 Burnt Lime/Dolomite
F1.4 Lump Iron Ore
F1.5 Fine Iron Ore
F1.6 Iron Ore Concentrate
F1.7 Iron Ore Pellets
F1.8 Co-Product Coke Production
F1.9 Non-Recovery Coke/with Co-Generation
F1.10 Steel Scrap Composite Price Basis

ABIND

12-June-2000

Rev. 2

SUMMARY CONSUMABLES
BENTONITE BINDER PREPARATION

BASIS:

1.0000 MM MT/YEAR PELLETIZING BINDER (BENTONITE)

SUMMARY:

2.1053	MM MT/YEAR AS-MINED BENTONITE RESOURCE
1.0527	MM MT/YEAR MINE WASTE ROCK
1.0527	MM MT/YEAR BENTONITE ROCK TO PREP. PLANT
1.0000	MM MT/YEAR NET BENTONITE TO SHIPPING

ASSUMPTIONS: (1)

5.8464	TOTAL FUEL MINING (kg/mt ROCK)
2.4992	BENTONITE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
14.1809	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
10.0922	FUEL REQUIREMENT BENTONITE TRANS. TRUCK 30 mt - (kg/mt)
$1.30	FUEL COST - ($/gal)
3.1412	FUEL DENSITY - (kg/gal)
$413.85	FUEL COST - ($/mt)
$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$0.033	ELECTRIC POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
BINDER MINING:				
	AS-MINED CLAY/ROCK	2.1053	0.0632	2.1685
	WASTE ROCK	1.0527	0.0316	1.0842
	BENTONITE ROCK TO PREP PLANT	1.0527	0.0316	1.0842
	DIESEL FUEL (MINING ETC.)		0.0062	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	5.2615		
PREPARATION PLANT:				
	FUEL-ROCK TRANS. TO PREP PLANT		0.0005	
	NET PREPPED BENTONITE TO PELLET PLANT	1.0000	0.0300	1.0300
	REJECT TAILINGS TO DISPOSAL	0.0526	0.0016	0.0542
	PREP. P ELECTRICAL POWER REQ'D (MM kWhr/yr)	14.9275		
	NET PREPPED BENTONITE TO PELLET PLANT	1.0000	0.0300	1.0300
TRANSPORT TO PELLETIZING:				
	DIESEL FUEL - BENTONITE TRANS.		0.0050	
COSTS:		$/YEAR	$/T	
0.0117	TOTAL FUEL - MM mt/yr	$4,835,993	$4.84	
20.1891	TOTAL ELECTRIC POWER - (MM kWhr/yr)	$666,239	$0.67	
$1.201	PREP. PLANT LABOR COSTS - $/mt PRODUCT	$1,201,200	$1.20	
$0.137	LABOR OPERATING COSTS $/mt - SHOVELS (1)	$287,980	$0.29	
$0.547	LABOR OPERATING COSTS $/mt - LOADERS (2)	$1,151,920	$1.15	
$2.189	OPERATING HOURS/mt - MINE HAUL TRUCKS (4)	$4,607,680	$4.61	
$10.267	TRANSPORT HAUL TRUCK LABOR - $/mt	$10,266,667	$10.27	
$20.000	EQUIPMENT COST AMORTIZATION - $/mt	$20,000,000	$20.00	
$4.500	EQUIPMENT MAINTENANCE & PARTS - $/mt	$4,500,000	$4.50	
$42.500	RAW MATERIAL VALUE ADDED - $/mt	$42,500,000	$42.50	
	TOTAL:	$90,017,678	$90.02	

ACOAL

12-June-2000

Rev. 2

SUMMARY CONSUMABLES
COAL ONLY - DELIVERED TO USE

BASIS:

1.000 MM MT/YR COAL DELIVERED

SUMMARY:

1.5038 MM MT/YEAR AS-MINED COAL RESOURCE
0.4511 MM MT/YEAR MINE WASTE ROCK
1.0527 MM MT/YEAR COAL TO PREP. PLANT
1.0000 MM MT/YEAR NET COAL TO SHIPPING

ASSUMPTIONS:

11.459 TOTAL FUEL MINING (kg/mt ROCK)
0.29 COAL MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
1.62 PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt COAL)
6.728 FUEL REQUIREMENT COAL TRANS. - (kg/mt)
$1.30 FUEL COST - ($/gal)
3.1412 FUEL DENSITY - (kg/gal)
$413.85 FUEL COST - ($/mt)
$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$0.033 ELECTRICAL POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
COAL MINING:				
	AS-MINED COAL/ROCK	1.504	0.045	1.549
	WASTE ROCK	0.451	0.014	0.465
	RAW COAL TO PREP PLANT	1.053	0.032	1.084
	DIESEL FUEL (MINING ETC.)		0.0121	
	MINE ELECTRICAL POWER REQ'D - (MM kWhr/yr)	0.430		
PREPARATION PLANT:				
	AS-MINED RAW TRANS. TO PREP PLANT		0.00004	
	NET PREPPED COAL TO USE	1.000	0.030	1.030
	REJECT TAILINGS TO DISPOSAL	0.053	0.002	0.054
	PREP. P ELECTRICAL POWER REQ'D - (MM kWhr/yr)	1.708		
	NET PREPPED COAL TO USE	1.000	0.030	1.030
TRANSPORTATION TO USE:				
	DIESEL FUEL - COAL TRANS.		0.0050	
COSTS:		**$/YEAR**	**$/T**	
0.0171	TOTAL FUEL - MM mt/yr	$7,079,265	$7.08	
2.1379	TOTAL ELECTRIC POWER - (MM kWhr/yr)	$70,549	$0.07	
$0.480	PREP. PLANT LABOR COSTS - $/mt PRODUCT	$480,480	$0.48	
$0.192	LABOR OPERATING COSTS $/mt - SHOVELS (1)	$201,586	$0.20	
$0.766	LABOR OPERATING COSTS $/mt - LOADERS (2)	$806,344	$0.81	
$3.064	OPERATING HOURS/mt - MINE HAUL TRUCKS (4)	$3,225,376	$3.23	
$8.000	TRANSPORT HAUL TRUCK LABOR - $/mt	$8,000,000	$8.00	
$15.000	EQUIPMENT COST AMORTIZATION - $/mt	$15,000,000	$15.00	
$3.300	EQUIPMENT MAINTENANCE & PARTS - $/mt	$3,300,000	$3.30	
$20.000	RAW MATERIAL VALUE ADDED - $/mt	$20,000,000	$20.00	
	TOTAL:	$58,163,600	$58.16	

ALIME

13-June-2000

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SUMMARY CONSUMABLES
BURNT LIME/DOLOMITE

BASIS:

1.0001 MM MT/YEAR BURNT LIME/DOLOMITE

SUMMARY:

2.7800 MM MT/YEAR AS-MINED LIMESTONE/MGO ROCK
0.9267 MM MT/YEAR MINE WASTE ROCK
1.8533 MM MT/YEAR LIME ROCK TO PREP. PLANT
1.7607 MM MT/YEAR NET LIMESTONE TO CALCINATION
1.0001 MMM MT/YEAR TARGET CALCINED LIME

ASSUMPTIONS:

7.3791	TOTAL FUEL (kg/mt LIME ROCK)
3.3537	LIMESTONE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
19.0328	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
6.3076	FUEL REQUIREMENT LIME TRANS. TRUCK 30 mt - (kg/mt)
124.0519	FUEL REQUIREMENT - CALCINING (kg N.G./mt CALCINE)
26.4600	CALCINING PLANT ELEC. POWER REQ'D (kWhr/mt FEED)
$1.30	FUEL COST - ($/gal)
3.1412	FUEL DENSITY - (kg/gal)
$413.85	FUEL COST - ($/mt)
$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$2.50	N.G. COSTS - ($/GJ)
49.78	N.G. - (GJ/mt)
$124.45	N.G. COSTS - ($/mt)
1,345.53	N.G. DENSITY - (Nm3/mt)
27.03	N.G. CONVERSION - (GJ/Nm3)
$0.033	ELECTRIC POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
LIME ROCK MINING:				
	AS-MINED LIME ROCK	2.7800	0.0834	2.8634
	WASTE ROCK	0.9267	0.0278	0.9545
	LIME ROCK TO PREP PLANT	1.8533	0.0556	1.9089
	DIESEL FUEL (MINING ETC.)		0.0137	
	MINE ELECTRICAL POWER REQ'D - (MM kWhr/yr)	9.3234		
LIME ROCK PREP PLANT:				
	NET PREPPED LIME ROCK TO CALC.	1.7607	0.0528	1.8135
	REJECT TAILINGS TO DISPOSAL	0.0927	0.0028	0.0954
	PREP. P ELECTRICAL POWER REQ'D - (MM kWhr/yr)	35.2743		
LIME CALCINATION:				
	NET PREPPED LIME ROCK TO CALC.	1.7607	0.0528	1.8135
	DIESEL FUEL - LIME ROCK TRANS.		0.0002	
	BURNT LIME/DOLOMITE	1.0001	0.0000	1.0001
	N.G. FUEL (DRYING, CALCINATION, ETC.)		0.2184	
	CALC, ELECTRICAL POWER REQ'D	46.5875		
	NET LIME/MgO SHIPPED	1.0001	0.0000	1.0001
	LIME TRANSPORT FUEL		0.0063	

SUMMARY CONSUMABLES
BURNT LIME/DOLOMITE

COSTS:		$/YEAR	$/T	
0.2184	TOTAL N.G. FUEL - (MM mt/yr)	$27,181,466	$27.18	
0.0202	TOTAL FUEL DIESEL - (MM mt/yr)	$8,362,424	$8.36	
91.1852	TOTAL ELECTRICAL POWER - (MM kWhr/yr)	$3,009,111	$3.01	
$1.201	PREP. PLANT LABOR COSTS - $/mt PRODUCT	$1,201,200	$1.20	
$0.104	LABOR OPERATING COSTS $/mt - SHOVELS (1)	$258,975	$0.26	
$0.414	LABOR OPERATING COSTS $/mt - LOADERS (2)	$1,035,899	$1.04	
$1.657	OPERATING HOURS/mt - MINE HAUL TRUCKS (4)	$4,143,597	$4.14	
$5.133	TRANSPORT HAUL TRUCK LABOR - $/mt	$5,133,332	$5.13	
$12.000	EQUIPMENT COST AMORTIZATION - $/mt	$12,000,000	$12.00	
$3.000	EQUIPMENT MAINTENANCE & PARTS - $/mt	$3,000,000	$3.00	
$12.500	RAW MATERIAL VALUE ADDED - $/mt	$12,500,000	$12.50	
	TOTAL:	$77,826,004	$77.83	

AORE

13-June-2000

Rev. 2

SUMMARY CONSUMABLES
LUMP IRON ORE DELIVERED

BASIS:

1.0000 MM MT/YEAR LUMP ORE DELIVERED

SUMMARY:

3.1630 MM MT/YEAR AS-MINED ROCK
1.9127 MM MT/YEAR WASTE ROCK
1.2503 MM MT/YEAR ORE ROCK TO PREP PLANT
1.0003 MM MT/YEAR CRUSHED LUMP ORE
0.2501 MM MT/YEAR FINE ORE REJECTS

ASSUMPTIONS:

26.124	TOTAL FUEL (kg/mt ORE)
6.53	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
9.26	PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.028	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
0.00449	FUEL REQUIREMENT - SHIPPING (kg/mt/km)
13.95	FUEL REQUIREMENT SHIPPING (kg/mt LUMP ORE)
$1.30	FUEL COST - ($/gal)
3.1412	FUEL DENSITY - (kg/gal)
$413.85	FUEL COST - ($/mt)
$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$2.50	N.G. COSTS - ($/GJ)
49.78	N.G. - (GJ/mt)
$124.45	N.G. COSTS - ($/mt)
1,345.53	N.G. DENSITY - (Nm3/mt)
27.03	N.G. CONVERSION - (GJ/Nm3)
$0.033	ELECTRIC POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
LUMP ORE MINING:				
	AS-MINED ROCK	3.1630	0.0949	3.2579
	WASTE ROCK	1.9127	0.0574	1.9701
	IRON ORE TO PREP PLANT	1.2503	0.0375	2.5645
	DIESEL FUEL REQ'D		0.0026	
	MINE ELECTRICAL POWER REQ'D - (MM kWhr/yr)	20.6657		
ORE PREPARATION:				
	CRUSHED LUMP ORE TO SHIPPING	1.0003	0.0300	1.0303
	FINE ORE TO DISPOSAL	0.2501	0.0075	0.2576
	PREP. ELECTRICAL POWER REQ'D - (MM kWhr/yr)	11.5729		
	SHIPPING FUEL REQ'D		0.0140	
COSTS:		$/YEAR	$/T	
32.2386	PROCESS ELECTRIC POWER REQ'D - (MM kWhr/yr)	$1,063,874	$1.06	
0.0261	TOTAL FUEL - MM mt/yr	$10,811,414	$10.81	
$1.201	PREP. PLANT LABOR COSTS - $/mt PRODUCT	$1,201,200	$1.20	
$0.244	LABOR OPERATING COSTS $/mt - SHOVELS (1)	$767,988	$0.77	
$0.978	LABOR OPERATING COSTS $/mt - LOADERS (2)	$3,071,951	$3.07	
$1.546	OPERATING HOURS/mt - MINE HAUL TRUCKS (4)	$4,857,333	$4.86	
$5.775	ORE TRANSPORT COSTS - $/mt	$5,775,000	$5.78	
$3.500	EQUIPMENT COST AMORTIZATION - $/mt	$3,500,000	$3.50	
$0.788	EQUIPMENT MAINTENANCE & PARTS - $/mt	$787,500	$0.79	
$6.000	RAW MATERIAL VALUE ADDED - $/mt	$6,000,000	$6.00	
	TOTAL:	$37,836,259	$37.84	

AFINEORE

13-June-2000

Rev. 2

SUMMARY CONSUMABLES
FINE IRON ORE DELIVERED

BASIS:

0.2501 MM MT/YEAR FINE ORE DELIVERED

SUMMARY:

3.1630 MM MT/YEAR AS-MINED ROCK
1.9127 MM MT/YEAR WASTE ROCK
1.2503 MM MT/YEAR ORE ROCK TO PREP PLANT
1.0003 MM MT/YEAR CRUSHED LUMP ORE
0.2501 MM MT/YEAR FINE ORE TO DELIVERY

ASSUMPTIONS:

26.124 TOTAL FUEL (kg/mt ORE)
6.53 IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
9.26 PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.028 PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
13.95 FUEL REQUIREMENT SHIPPING (kg/mt LUMP ORE)
$1.30 FUEL COST - ($/gal)
3.1412 FUEL DENSITY - (kg/gal)
$413.85 FUEL COST - ($/mt)
$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$0.033 ELECTRIC POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
LUMP ORE MINING:				
	AS-MINED ROCK	3.1630	0.0949	3.2579
	WASTE ROCK	1.9127	0.0574	1.9701
	IRON ORE TO PREP PLANT	1.2503	0.0375	2.5645
	DIESEL FUEL REQ'D		0.0026	
	MINE ELECTRICAL POWER REQ'D - (MM kWhr/yr)	20.6657		
ORE PREPARATION:				
	CRUSHED LUMP ORE TO SHIPPING	1.0003	0.0300	1.0303
	FINE ORE TO SHIPPING	0.2501	0.0075	0.2576
	PREP. ELECTRICAL POWER REQ'D - (MM kWhr/yr)	11.5729		
	SHIPPING FUEL REQ'D		0.0140	
COSTS - FINE ORE PORTION ONLY:		$/YEAR	$/T	
7.91%	PERCENT FACTOR - FINE ORE/ORE MINED			
2.5488	PROCESS ELECTRIC POWER REQ'D - (MM kWhr/yr)	$21,033	$0.08	
0.0021	TOTAL FINE ORE FUEL - MM mt/yr	$213,742	$0.85	
$0.095	PREP. PLANT LABOR COSTS - $/mt PRODUCT	$23,748	$0.09	
$0.019	LABOR OPERATING COSTS $/mt - SHOVELS (1)	$15,183	$0.06	
$0.077	LABOR OPERATING COSTS $/mt - LOADERS (2)	$60,732	$0.24	
$0.122	OPERATING HOURS/mt - MINE HAUL TRUCKS (4)	$96,029	$0.38	
$5.775	FINE ORE TRANSPORT COSTS - $/mt	$1,444,125	$5.78	
$1.384	EQUIPMENT COST AMORTIZATION - $/mt (F.O.)	$345,975	$1.38	
$0.311	EQUIPMENT MAINTENANCE & PARTS - $/mt (F.O.)	$77,844	$0.31	
$12.000	RAW MATERIAL VALUE ADDED - $/mt	$3,000,779	$12.00	
	TOTAL:	$5,299,191	$21.19	

AORECONC

13-June-2000

Rev. 2

SUMMARY CONSUMABLES
IRON ORE CONCENTRATOR

BASIS:

2.5677	MM MT/YEAR ORE DELIVERED TO CONCENTRATOR
1.4670	MM MT/YEAR CONCENTRATE TO PIPELINE (DRY)

SUMMARY:

6.4963	MM MT/YEAR AS-MINED ROCK
3.9286	MM MT/YEAR WASTE ROCK
2.5677	MM MT/YEAR ORE ROCK TO CONCENTRATOR
1.4670	MM MT/YEAR CONCENTRATE (DRY)

ASSUMPTIONS:

32.700	TOTAL FUEL (kg/mt ORE)
31.50	IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
27.26	CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
54.167	PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE)
$1.30	FUEL COST - ($/gal)
3.1412	FUEL DENSITY - (kg/gal)
$413.85	FUEL COST - ($/mt)
$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$2.50	N.G. COSTS - ($/GJ)
49.78	N.G. - (GJ/mt)
$124.45	N.G. COSTS - ($/mt)
1,345.53	N.G. DENSITY - (Nm3/mt)
27.03	N.G. CONVERSION - (GJ/Nm3)
$0.033	ELECTRIC POWER COSTS - ($/kWhr)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	6.3014	0.1949	6.4963
	WASTE ROCK	3.8107	0.1179	3.9286
	IRON ORE TO CONCENTRATOR	2.4907	0.0770	2.5677
	DIESEL FUEL REQ'D		0.0327	
	MINE ELECTRICAL POWER REQ'D - (MM kWhr/yr)	31.5022		
ORE CONCENTRATION:				
	CONCENTRATE TO PIPELINE TRANSPORT	1.4670	0.7899	2.2569
	FINE ORE TO DISPOSAL	1.0237	1.9011	2.9248
	CONC. ELECTRICAL POWER REQ'D - (MM kWhr/yr)	69.9937		
	PIPELINE ELECT. POWER REQ'D - (MM kWhr/yr)	122.2500		
COSTS:		$/YEAR	$/T CONC.	
223.7459	PROCESS ELECTRIC POWER REQ'D - (MM kWhr/yr)	$7,383,615	$5.03	
0.0327	TOTAL FUEL - MM mt/yr	$13,533,037	$9.22	
$1.682	CONC. LABOR COSTS - $/mt CONC. PRODUCT	$2,467,025	$1.68	
$0.980	OTHER CONC. COSTS - $/mt CONC. PRODUCT	$1,437,660	$0.98	
$1.450	LABOR OPERATING COSTS $/mt - MINING TOTAL	$9,419,635	$6.42	
$0.520	OTHER OPERATING COSTS $/mt - MINING TOTAL	$3,378,076	$2.30	
$10.000	EQUIPMENT COST AMORTIZATION - $/mt CONC.	$14,670,000	$10.00	
$2.250	EQUIPMENT MAINTENANCE & PARTS - $/mt CONC.	$3,300,750	$2.25	
$6.000	RAW MATERIAL VALUE ADDED - $/mt CONC.	$8,802,000	$6.00	
	TOTAL:	$64,391,797	$43.89	

APELLETS

13-June-2000

SUMMARY CONSUMABLES
IRON ORE PELLETS DELIVERED

BASIS:

1.0000 MM MT/YEAR INDURATED PELLETS DELIVERED

SUMMARY:

3.5343 MM MT/YEAR AS-MINED ROCK
2.1373 MM MT/YEAR WASTE ROCK
1.3969 MM MT/YEAR ORE ROCK TO CONCENTRATOR
0.8228 MM MT/YEAR CONCENTRATE TO PIPELINE
0.1404 MM MT/YEAR FINE ORE TO DELIVERY

ASSUMPTIONS:

26.124 TOTAL FUEL (kg/mt ORE)
6.534 IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
9.256 PREP PLANT ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.028 PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
0.014 FUEL REQUIREMENT SHIPPING (kg/mt PELLETS)
$1.30 FUEL COST - ($/gal)
3.1412 FUEL DENSITY - (kg/gal)
$413.85 FUEL COST - ($/mt)
$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$0.033 ELECTRIC POWER COSTS - ($/kWhr)
$2.50 N.G. COSTS - ($/GJ)
49.78 N.G. - (GJ/mt)
$124.45 N.G. COSTS - ($/mt)
1,345.53 N.G. DENSITY - (Nm3/mt)
27.03 N.G. CONVERSION - (GJ/Nm3)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	3.5343	0.1093	3.6436
	WASTE ROCK	2.1373	0.0661	2.2034
	DIESEL FUEL (MINING ETC.)		0.0183	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	17.6774		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	1.3969	0.0432	1.4401
	CONCENTRATE TO PIPELINE FEED	0.8228	0.4430	1.2658
	DEWATERED TAILINGS TO DISPOSAL	0.5741	1.0663	1.6404
	CONC. ELECTRICAL POWER REQ'D (MM kWhr/yr)	39.2770		
	CONC. SLURRY PIPELINE POWER (MM kWhr/yr)	68.5665		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	1.1059	0.0970	1.2029
	BINDER TO PELLETIZING	0.0066	0.0000	0.0066
	DOLOMITE TO PELLETIZING	0.0226	0.0000	0.0226
	TOTAL OTHER FEED TO PELLETIZING	0.2831		
	NET PELLETS, ETC. TO SHIPMENT	1.0000		
	N.G. FUEL (DRYING, INDURATION, ETC.)		0.0288	
	PELLET ELECTRICAL POWER REQ'D (MM kWhr/yr)	71.8837		
COSTS - THROUGH PELLET DELIVERY:		**$/YEAR**	**$/T**	
197.4046	TOTAL ELECTRIC POWER REQ'D - (MM kWhr/yr)	$6,514,353	$6.51	
0.0183	TOTAL FUEL OIL THROUGH PELLET - MM mt/yr	$7,591,173	$7.59	
0.0288	TOTAL N.G. FUEL THROUGH PELLET - MM mt/yr	$3,589,842	$3.59	
$1.201	CONC. PLANT LABOR COSTS - $/mt PRODUCT	$1,201,000	$1.20	
$1.377	ORE MINING LABOR COSTS - ($/mt ORE)	$4,324,123	$4.32	
$1.100	PELLET PLANT LABOR COSTS - ($/mt PELLET)	$1,100,000	$1.10	
$3.660	PELLET PLANT CONSUM. COSTS - ($/mt PELLET)	$3,660,000	$3.66	
$3.850	FINE ORE PIPELINE TRANSPORT COSTS - $/mt	$3,850,000	$3.85	
$5.000	EQUIPMENT COST AMORTIZATION - $/mt (PEL.)	$5,000,000	$5.00	
$1.125	EQUIPMENT MAINTENANCE & PARTS - $/mt (PEL.)	$1,125,000	$1.13	
$10.000	RAW MATERIAL VALUE ADDED - $/mt	$10,000,000	$10.00	
	TOTAL:	$47,955,491	$47.96	

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18-June-2000

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SUMMARY CONSUMABLES
COPRODUCT COKE PRODUCTION

BASIS:

1.000 MM MT/YR COPRODUCT COKE DELIVERED (TARGET)
1.111 MM MT/YR COPRODUCT COKE DELIVERED (CALCULATED)

SUMMARY:

1.5873 MM MT/YEAR BITUMINOUS COAL FEED
1.1111 MM MT/YEAR TOTAL COKE PRODUCT
0.000 MM MT/YEAR FINE COKE BREEZE
1.111 MM MT/YEAR SIZED COKE PRODUCT TO USE

ASSUMPTIONS: (R

5.000	FUEL REQUIREMENT COKE TRANS. - (kg/mt)
500	TRANSPORT DISTANCE, ONE WAY - (km)
24.50	COKE PLANT ELECTRICAL POWER REQ'D (kWhr/mt COKE)
$1.30	FUEL COST - ($/gal)
$413.85	FUEL COST - ($/mt)
$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$2.50	N.G. COSTS - ($/GJ)
49.78	N.G. - (GJ/mt)
$124.45	N.G. COSTS - ($/mt)
1,345.53	N.G. DENSITY - (Nm3/mt)
0.0007432	N.G. DENSITY - (mt/Nm3)
$0.033	ELECTRIC POWER COSTS - ($/kWhr)
$72.70	COKING COAL ONLY

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
	COAL FEED	1.587	0.000	1.587
	COKE PRODUCT GROSS	1.111	0.000	1.111
	COKE BREEZE (FINES)	0.111	0.000	0.111
	COKE PRODUCED (NET TO SHIPMENT)	1.000	0.000	1.000
	TOTAL ELEC. POWER FOR COKE:	30.6157		
	TRANS. OF COKE (FUEL)		0.0056	
COSTS:		$/YEAR	$/T	
1.587	COAL FEED - MM mt/yr	$115,396,710	$115.40	
0.0056	TOTAL TRANSPORT FUEL - MM mt/yr	$2,299,164	$2.30	
30.6157	TOTAL ELECTRIC POWER - (MM kWhr/yr)	$1,010,317	$1.01	
$10.66	TRANSPORT LABOR - (MN-HR/mt)	$10,660,000	$10.66	
$3.134	COKE PLANT LABOR COSTS - $/mt PROD	$3,133,809	$3.13	
$7.500	COKE PLANT OTHER - ($/mt)	$7,500,000	$7.50	
	TOTAL:	**$140,000,000**	**$140.00**	

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SUMMARY CONSUMABLES
NON-RECOVERY COKE/CO-GENERATION

BASIS:

1.000 MM MT/YR NON-RECOVERY COKE DELIVERED (TARGET)
1.000 MM MT/YR NON-RECOVERY COKE DELIVERED (CALCULATED)

SUMMARY:

4.2045 MM MT/YEAR FINE COAL SLURRY RECLAIMED FROM WASTE POND
0.0334 MM MT/YEAR COARSE REJECT SLURRY
4.1711 NET FEED TO COAL CLEANING/CONCENTRATION
1.2551 CLEANED COAL TO DRYER
0.9413 MM MT/YEAR BITUMINOUS COAL FEED TO CHARRING (DRY BASIS)
0.8256 MM MT/YEAR NET CHAR PRODUCT
1.1541 MM MT/YEAR TOTAL COKE PRODUCT
0.1541 MM MT/YEAR FINE COKE BREEZE
1.0000 MM MT/YEAR SIZED COKE PRODUCT TO USE

ASSUMPTIONS:

5.50 ELECTRIC POWER CONSUMMED IN RECLAIM (kWhr/MT FEED)
7.50 ELECTRIC POWER CONSUMMED IN CLEANING (kWhr/MT COAL FD.)
11.00 ELECTRIC POWER CONSUMMED IN CHARRING (kWhr/MT CHAR)
12.00 ELECTRIC POWER CONSUMMED IN BRIQUET. (kWhr/MT BRIQ. FD.)
425.67 (kWhr/MT CHAR) ELECTRIC POWER GENERATED
515.50 (kWhr/MT COKE) ELECTRIC POWER GENERATED
$10.00 FINE COAL RECLAIMED - VALUE ADDED ($/mt CONC.)
$38.50 LABOR COSTS - ($/MN-HR INCLUDING BURDEN)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
CHAR PRODUCT PRODUCTION:				
	FINE COAL SLURRY RECLAIMED	1.261	2.943	4.204
	ELECTRIC POWER IN COAL RECLAIM	6.937		
	FINE COAL TO CLEANING	1.236	2.935	4.171
	ELECTRICAL POWER IN CLEANING	9.272		
	CLEANED COAL TO DRYER	0.941	0.314	1.255
	DRIED COAL TO CHARRING FURNACE	0.941	0.060	1.001
	CHAR PRODUCT TO BRIQUETTING	0.826	0.000	0.826
	ELECTRICAL POWER IN CHARRING	10.355		
	TOTAL ELEC. THROUGH CHARRING	26.564		
	CO-GENERATED ELECTRIC POWER - CHAR	(351.444)		
	NET ELECTRICAL POWER GENERATED - CHAR	(324.880)		
BRIQUETTING OPERATION:				
	CHAR FEED TO BRIQUETTING	0.826	0.000	0.826
	COAL FEED TO BRIQUETTING	0.247	0.000	0.247
	RECYCLE BREEZE FEED TO BRIQUET.	0.154	0.000	0.154
	PITCH FEED TO BRIQUETTING	0.160	0.000	0.160
	ELECTRIC POWER IN BRIQUETTING	16.641		
NON-RECOVERY COKING:				
	COKE PRODUCT GROSS	1.154	0.000	1.154
	COKE BREEZE (FINES)	0.154	0.000	0.154
	COKE PRODUCED (NET TO SHIPMENT)	1.000	0.000	1.000
	COKING ELECTRICAL POWER REQ'D	16.152		
	COKE ELECT. POWER CO-GENERATED	(515.493)		
	TOTAL ELECT. POWER REQUIRED COKE	32.793		
	NET ELECT. POWER PRODUCED COKE	(482.700)		
	TRANS. OF COKE		0.0058	

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SUMMARY CONSUMABLES
NON-RECOVERY COKE/CO-GENERATION

COSTS:		$/YEAR	$/T - PROD	$/T - COKE
	CHAR PRODUCT PRODUCTION:			
$10.00	FINE COAL SLURRY RECLAIMED - ($/mt DRY)	$12,613,402	$15.28	$12.61
0.826	CHAR PRODUCT TO BRIQUETTING			
$0.033	TOTAL ELEC. THROUGH CHARRING	$876,619	$1.06	$0.88
$0.033	CO-GENERATED ELECTRIC POWER - CHAR	($11,597,647)	($14.05)	($11.60)
$0.033	NET ELECTRICAL POWER GENERATED - CHAR	($10,721,028)		
$0.250	LABOR IN CHAR PRODUCT PROD. - (MN-HR/mt)	$9,060,230	$10.97	$9.06
$15.00	OTHER THROUGH CHARRING - ($/mt CHAR)	$12,384,511	$15.00	$12.38
	SUB-TOTAL CHAR FROM FINES:	$23,337,115	$28.27	$23.34
	BRIQUETTING OPERATION:			
0.826	CHAR FEED TO BRIQUETTING	0.826		
	COAL FEED TO BRIQUETTING	$14,357,645	$14.36	$14.36
$150.00	PITCH FEED TO BRIQUETTING	$9,315,662	$9.32	$9.32
$0.033	ELECTRIC POWER IN BRIQUETTING	$549,155	$0.55	$0.55
$0.100	LABOR IN BRIQUETTING - (MN-HR/mt)	$4,443,164	$4.44	$4.44
$7.50	OTHER THROUGH CHARRING - ($/mt CHAR)	$8,655,515	$8.66	$8.66
	SUB-TOTAL BRIQUETTING:	$37,321,141	$37.32	$37.32
	NON-RECOVERY COKING:			
	COKE PRODUCT GROSS	1.154		
	COKE PRODUCED (NET TO SHIPMENT)	1.000		
$0.033	COKING ELECTRICAL POWER REQ'D - (kWhr/mt COKE)	$533,026	$0.53	$0.53
$0.033	COKE ELECT. POWER CO-GENERATED - (kWhr/mt COK	($17,011,276)	($17.01)	($17.01)
	NET ELECT. POWER PRODUCED COKE	($16,478,250)		
$413.85	TRANS. OF COKE (FUEL $/mt)	$2,388,056	$2.39	$2.39
$10.66	TRANSPORT LABOR - (MN-HR/MT COKE)	$10,659,836	$10.66	$10.66
$0.300	LABOR IN BRIQUETTING - (MN-HR/mt)	$13,329,493	$13.33	$13.33
$7.50	OTHER THROUGH CHARRING - ($/mt CHAR)	$7,499,885	$7.50	$7.50
	SUB-TOTAL COKING:	$17,399,022	$16.87	$16.87
	TOTAL NON-RECOVERY COKE WITH CO-GENERATION:	**$78,057,278**	**$82.45**	**$77.53**

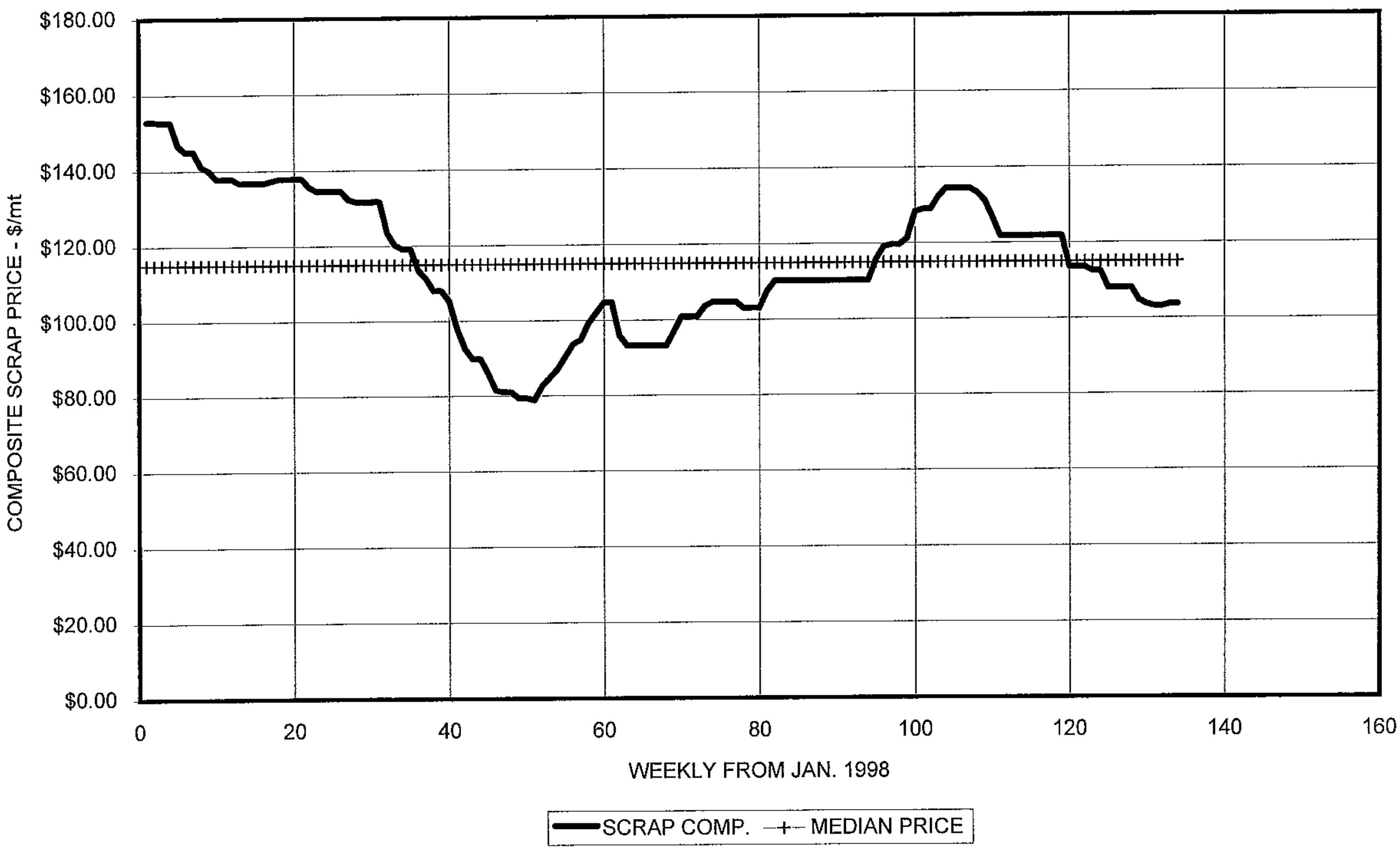
WEEKLY STEEL SCRAP PRICE COMPOSITE - $/TON AND $/mt

(From American Metal Market)

MONTH	WEEK	$/TON			$/mt		
		1998	1999	2000	1998	1999	2000
JANUARY	1	$138.70	$77.00	$122.00	$152.92	$84.89	$134.51
	2	$138.70	$79.00	$122.00	$152.92	$87.10	$134.51
	3	$138.50	$82.00	$122.00	$152.70	$90.41	$134.51
	4	$138.50	$85.00	$121.00	$152.70	$93.71	$133.40
FEBRUARY	5	$133.00	$86.00	$119.00	$146.63	$94.82	$131.20
	6	$131.50	$90.00	$115.00	$144.98	$99.23	$126.79
	7	$131.50	$92.50	$110.50	$144.98	$101.98	$121.83
	8	$128.00	$95.00	$110.50	$141.12	$104.74	$121.83
MARCH	9	$127.00	$95.00	$110.50	$140.02	$104.74	$121.83
	10	$125.00	$87.00	$110.50	$137.81	$95.92	$121.83
	11	$125.00	$84.50	$110.50	$137.81	$93.16	$121.83
	12	$125.00	$84.50	$110.50	$137.81	$93.16	$121.83
	13	$124.00	$84.50	$110.50	$136.71	$93.16	$121.83
APRIL	14	$124.00	$84.50	$110.50	$136.71	$93.16	$121.83
	15	$124.00	$84.50	$110.50	$136.71	$93.16	$121.83
	16	$124.00	$84.50	$103.00	$136.71	$93.16	$113.56
	17	$124.50	$88.00	$103.00	$137.26	$97.02	$113.56
MAY	18	$125.00	$91.50	$103.00	$137.81	$100.88	$113.56
	19	$125.00	$91.50	$102.00	$137.81	$100.88	$112.46
	20	$125.00	$91.50	$102.00	$137.81	$100.88	$112.46
	21	$125.00	$94.00	$98.00	$137.81	$103.64	$108.05
	22	$123.00	$95.00	$98.00	$135.61	$104.74	$108.05
JUNE	23	$122.00	$95.00	$98.00	$134.51	$104.74	$108.05
	24	$122.00	$95.00	$98.00	$134.51	$104.74	$108.05
	25	$122.00	$95.00	$95.00	$134.51	$104.74	$104.74
	26	$122.00	$93.50	$94.00	$134.51	$103.08	$103.64
JULY	27	$120.00	$93.50	$93.50	$132.30	$103.08	$103.08
	28	$119.50	$93.50	$93.50	$131.75	$103.08	$103.08
	29	$119.50	$97.50	$94.00	$131.75	$107.49	$103.64
	30	$119.50	$100.00	$94.00	$131.75	$110.25	$103.64
	31	$119.50	$100.00		$131.75	$110.25	
AUGUST	32	$112.00	$100.00		$123.48	$110.25	
	33	$109.00	$100.00		$120.17	$110.25	
	34	$108.00	$100.00		$119.07	$110.25	
	45	$108.00	$100.00		$119.07	$110.25	
	46	$103.00	$100.00		$113.56	$110.25	
SEPTEMBER	37	$101.00	$100.00		$111.35	$110.25	
	38	$98.00	$100.00		$108.05	$110.25	
	39	$98.00	$100.00		$108.05	$110.25	
	40	$95.50	$100.00		$105.29	$110.25	
OCTOBER	41	$89.00	$100.00		$98.12	$110.25	
	42	$84.00	$100.00		$92.61	$110.25	
	43	$81.50	$105.00		$89.85	$115.76	
	44	$81.50	$108.00		$89.85	$119.07	
NOVEMBER	45	$78.00	$108.50		$86.00	$119.62	
	46	$74.00	$108.50		$81.59	$119.62	
	47	$73.50	$110.00		$81.03	$121.28	
	48	$73.50	$116.50		$81.03	$128.44	
DECEMBER	49	$72.00	$117.00		$79.38	$128.99	
	50	$72.00	$117.00		$79.38	$128.99	
	51	$71.50	$120.00		$78.83	$132.30	
	52	$75.00	$122.00		$82.69	$134.51	

MEDIAN PRICE (1998-2000): $115.00

STEEL SCRAP PRICE COMPOSITE
($/mt WEEKLY FROM JANUARY 1998)



APPENDIX F-2

IRONMAKING PROCESS CONSUMPTIONS & RELATIVE OPERATING COSTS

SHAFT FURNACE DRI PROCESSES

HOT METAL VARIATIONS

ROTARY HEARTH DRI FURNACES

FLUID BED DRI/HBI PROCESSES

OTHER PROCESSES

F-2 Ironmaking Process Consumptions & Relative Operating Costs

The Ironmaking Process Consumptions and their Relative Operating Costs are built up from the costs of the various consumable materials in a similar manner.

- Consumable components as defined by the mass and fuel balances for the Ironmaking Processes (Appendices C & D).
- Electrical power consumptions from experience or Process Vendor data.
- Labor estimates were factored from man-hour/mt data supplied by Process Vendors and experience with similar processes.
- Costs for transport of materials included in material costs.
- Allowances for maintenance materials and supplies based on Vendor factors.
- Other consumable cost assumptions, e.g. composite steel scrap, overall labor cost per man-hour, natural gas, electrical power, and other delivered materials are based on an upper mid-West U.S.A. location. These were derived from negotiated commodity costs achieved for a recent large-scale project in that region.
- As appropriate, allowances for G&A and/or Vendor fees were added.
- Each Ironmaking Process Cost was derived from the summation of the individual costs of each unit operation involved in producing the Iron Units and subsequent production of EAF/LRF Refined Steel Product.

The Process Operating Costs, (OPEX), developed in the above fashion are believed to be relatively precise as a basis for comparing the various processes on an equalized footing. By normalizing all processes through the production of the Refined Liquid Steel product, all types of iron units produced by the Ironmaking Processes can be compared. The relative accuracy of each of the components of the OPEX based on closure of the mass balances should produce a fair overall cost for each process that can be compared accurately to each other. Thus the ranking exercise and other comparisons between processes should be relatively accurate.

It is also believed that the absolute accuracy of these OPEX costs are also relatively precise. Spot checks of the estimated costs and comparisons with recent detailed feasibility studies using Vendor data of these and similar processes have verified the accuracy of the built up operating cost calculation procedure. The Ironmaking Process Operating Costs are provided for:

SHAFT FURNACE DRI PROCESSES

F2.1 Base Process Shaft Furnace (i.e. Midrex), 100% DRI charge to EAF, 1.0 wt.% DRI Carbon (Appendix C-1)
F2.2 Base Process Shaft Furnace (i.e. Midrex), 100% DRI charge to EAF, 2.5 wt.% DRI Carbon (for reference, Appendix C-2)
F2.3 Electric Arc Furnace Steelmaking, 100% Steel Scrap Charge (for reference, Appendix C-3)
F2.4 Base Process Shaft Furnace (i.e. Midrex), 30% DRI/70% Steel Scrap charge to EAF (a common industry practice), 1.0 wt.% DRI Carbon (Appendix C-4)
F2.5 Base Process Shaft Furnace (i.e. Midrex), 30 % DRI/70% Steel Scrap charge to EAF (for reference, Appendix C-5)
F2.6 HYLSA IVM Shaft Furnace without reformer, 100% hot DRI charge to EAF, (Appendix C-6)

HOT METAL VARIATIONS

F2.7 Blast Furnace Hot Metal (30% H.M./70% Steel Scrap charge to EAF), Conventional Co-Product Coke (Appendix C-7)
F2.8 Mini Blast Furnace Comparison (30% H.M./70% Steel Scrap charge to EAF), Co-Product Coke
F2.9 Blast Furnace Hot Metal (30% H.M./70% Steel Scrap charge to EAF), Non-Recovery Coking process with Co-Generation (for comparison, Appendix C-8)
F2.10 Cold Pig Iron (30% P.I./70% Steel Scrap charge to EAF), Conventional Co-Product Coke (Appendix C-9)
F2.11 Tecnored Hot Metal (30% H.M./70% Steel Scrap charge to EAF) with integral Co-Generation of Electrical Power (Appendix C-10)
F2.12 Tecnored Hot Metal (30% H.M./70% Steel Scrap charge to EAF) without Co-Generation of Electrical Power (Appendix C-11)
F2.13 Corex (VAI)/Midrex Shaft Furnace combination process, 60% H.M./40% DRI charge to EAF (Appendix C-12)
F2.14 HiSmelt Enriched Oxygen Reactor Process, 32.7% H.M. feed to EAF (Appendix C-13)

ROTARY HEARTH DRI FURNACES

F2.15 REDSMELT (Mannessmann) process to produce RHF DRI, Hot Metal utilizing a SAF, recycle scrap only charge to EAF (Appendix C-14)

F2.16 MauMee Research & Engineering Briquette DRI charge (100% with only recycle scrap charge to EAF) (Appendix C-15)

F2.17 ITMK3 (Midrex RHF) process producing reduced shot iron pellets charge to Melter/EAF (100% with only recycle scrap charge to EAF) (Appendix C-16)

Note: Other Rotary Hearth Processes, e.g. Inmetco, Iron Dynamics, FastMet/FastMelt, etc. are so generically similar to those above, that they were not individually considered.

FLUID-BED DRI/HBI

F2.18 Circored (Lurgi) natural gas based circulating fluid bed/bubbling bed fine ore process with 100% HBI charge to EAF (Appendix C-17)

F2.19 Circofer (Lurgi) fine coal and fine ore circulating fluid bed/bubbling bed with HBI charge to SAF and low-carbon, low-Si H.M. charge to EAF (Appendix C-18)

F2.20 Finmet (VAI) multi-stage fluidized bed fine ore process, natural gas based, 100% HBI charge to EAF (Appendix C-19)

F2.21 Generic Iron Carbide Process (to represent all process variations and/or configurations) with 100% IC charge to EAF (Appendix C-20)

F2.22 Generic Iron Carbide Process with 40% IC/60% Scrap charge to EAF (considered to be a practical limit for charging iron carbide to the EAF)

OTHER PROCESSES

F2.23 SL/RN (Stelco-Lurgi) Rotary Kiln reduction process to produce 100% sponge iron charge to EAF with only recycle Scrap (Appendix C-21)

SHAFT FURNACE DRI PROCESSES

ABASE
18-June-2000
Rev. 2

SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 1.0 wt.% CARBON

BASIS:

1.0000 MM MT/YEAR LIQUID STEEL PRODUCT
0.9768 MM MT/YEAR NET SLAB PRODUCT

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	6.2935	0.1946	6.4882
	WASTE ROCK	3.8060	0.1177	3.9237
	DIESEL FUEL (MINING ETC.)		0.0327	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	31.4785		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	2.4876	0.0769	2.5645
	CONCENTRATE TO PIPELINE FEED	1.4652	0.7889	2.2541
	DEWATERED TAILINGS TO DISPOSAL	1.0224	1.8987	2.9211
	CONC. ELECTRICAL POWER REQ'D (MM kWhr/yr)	69.9415		
	CONC. SLURRY PIPELINE POWER (MM kWhr/yr)	122.0979		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	1.9693	0.1727	2.1420
	BINDER TO PELLETIZING	0.0118	0.0000	0.0118
	DOLOMITE TO PELLETIZING	0.0402	0.0000	0.0402
	TOTAL OTHER FEED TO PELLETIZING	0.5041		
	FUEL (DRYING, INDURATION, ETC.)		0.0514	
	PELLET ELECTRICAL POWER REQ'D (MM kWhr/yr)	128.0051		
SHAFT FURNACE DIRECT REDUCTION:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.7807	0.0000	1.7807
	DRI TO EAF (1.0% C)	1.0450	0.0000	1.0450
	FUEL TO DRI		0.2555	
	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	141.5137		
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		11.0000	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	736.0266		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0549	1.0549
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8973		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

ABASE
18-June-2000
Rev. 2

SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 1.0 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	1.4652	$64,306,540	$64.31	$43.89
	PELLETIZING:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.7807			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	1.7807	$5,090,195	$5.09	$2.86
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0118	$1,063,663	$1.06	$0.60
$77.83	DOLOMITE TO PELLET. - ($/mt LIME/DOL.)	0.0402	$3,127,985	$3.13	$1.76
$2.36	PELLET OTHER - ($/mt PELLETS)	1.7807	$4,202,507	$4.20	$2.36
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	128.0051	$4,224,167	$4.22	$2.37
$124.45	PELLET N.G. FUEL - ($/mt)	0.0514	$6,392,588	$6.39	$3.59
	SUB-TOTAL PELLETIZING:		$24,101,105	$24.10	$13.53
	DIRECT REDUCTION IN SHAFT FURNACE:				
	DRI TO EAF (1.0% C)	1.0450			
0.0401	DRI LABOR - (MN-HR/mt DRI)	1.0450	$1,611,721	$1.61	$1.54
11.39	DRI OTHER - ($/mt DRI)	1.0450	$11,902,822	$11.90	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	141.5137	$4,669,951	$4.67	$4.47
$124.45	N.G. FUEL TO DRI - ($/mt)	0.2555	$31,802,440	$31.80	$30.43
	SUB-TOTAL DRI PRODUCTION:		$49,986,934	$49.99	$47.83
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0549			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$647,911	$0.65	$0.61
$1,076.24	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0120	$698,201	$0.70	$0.66
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,939,447	$3.94	$3.73
$77.10	LIME CHARGED	0.0124	$952,588	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	11.0000	$462,000	$0.46	$0.44
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.95
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	736.0266	$24,288,878	$24.29	$23.02
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,656	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$60,172,682	$60.17	$57.04
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$892,991	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,303	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8973	$1,151,610	$1.15	$1.15
	SUB-TOTAL LRF:		$6,815,685	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		$205,382,946	$205.38	

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Rev. 2

SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 2.5% C

BASIS:

1.0000 MM MT/YEAR LIQUID STEEL PRODUCT
0.9774 MM MT/YEAR NET SLAB PRODUCT

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	6.3014	0.1949	6.4963
	WASTE ROCK	3.8107	0.1179	3.9286
	DIESEL FUEL (MINING ETC.)		0.0327	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	31.5022		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	2.4907	0.0770	2.5677
	CONCENTRATE TO PIPELINE FEED	1.4670	0.7899	2.2569
	DEWATERED TAILINGS TO DISPOSAL	1.0237	1.9011	2.9247
	CONC. ELECTRICAL POWER REQ'D (MM kWhr/yr)	69.9937		
	CONC. SLURRY PIPELINE POWER (MM kWhr/yr)	122.2500		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	1.9714	0.1729	2.1443
	BINDER TO PELLETIZING	0.0118	0.0000	0.0118
	DOLOMITE TO PELLETIZING	0.0402	0.0000	0.0402
	TOTAL OTHER FEED TO PELLETIZING	0.5044		
	FUEL (DRYING, INDURATION, ETC.)		0.0514	
	PELLET ELECTRICAL POWER REQ'D (MM kWhr/yr)	128.1416		
SHAFT FURNACE DIRECT REDUCTION:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.7826	0.0000	1.7826
	DRI TO EAF (2.5% C)	1.0624	0.0000	1.0624
	FUEL TO DRI		0.2598	
	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	143.8703		
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0072	0.0000	0.0072
	STEEL C (CHARGE+SLAG INJ)	0.0099	0.0000	0.0099
	EAF ELECTRODES	0.0045	0.0000	0.0045
	LIME CHARGED	0.0126	0.0000	0.0126
	O2 GAS TO EAF (MM Nm3/YR)		19.2500	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	736.4717		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0549	1.0549
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9184		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9774	0.0000	0.9774

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SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 2.5% C

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS:		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
PER UNIT	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	1.4670	$64,386,622	$64.39	$43.89
	PELLETIZING:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.7826			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	1.7826	$5,095,625	$5.10	$2.86
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0118	$1,064,798	$1.06	$0.60
$77.83	DOLOMITE TO PELLET. - ($/mt LIME/DOL.)	0.0402	$3,131,322	$3.13	$1.76
$2.36	PELLET OTHER - ($/mt PELLETS)	1.7826	$4,206,990	$4.21	$2.36
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	128.1416	$4,228,673	$4.23	$2.37
$124.45	PELLET N.G. FUEL - ($/mt)	0.0514	$6,399,407	$6.40	$3.59
	SUB-TOTAL PELLETIZING:		$24,126,816	$24.13	$13.53
	DIRECT REDUCTION IN SHAFT FURNACE:				
	DRI TO EAF (1.0% C)	1.0450			
0.0401	DRI LABOR - (MN-HR/mt DRI)	1.0450	$1,611,721	$1.61	$1.54
11.39	DRI OTHER - ($/mt DRI)	1.0450	$11,902,822	$11.90	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	141.5137	$4,669,951	$4.67	$4.47
$124.45	N.G. FUEL TO DRI - ($/mt)	0.2555	$31,802,440	$31.80	$30.43
	SUB-TOTAL DRI PRODUCTION:		$49,986,934	$49.99	$47.83
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0549			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$648,303	$0.65	$0.61
$1,058.61	MISC. ADDITIVES - (AVG. $/mt)	0.0072	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0099	$576,293	$0.58	$0.55
$1,031.03	EAF ELECTRODES - ($/mt)	0.0045	$4,605,810	$4.61	$4.37
$77.10	LIME CHARGED	0.0126	$968,452	$0.97	$0.92
$0.042	O2 GAS TO EAF (MM Nm3/YR)	19.2500	$808,500	$0.81	$0.77
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.95
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	736.4717	$24,303,567	$24.30	$23.04
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,831	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$61,094,755	$61.09	$57.91
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,531	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,459	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,191	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9184	$1,152,306	$1.15	$1.15
	SUB-TOTAL LRF:		$6,817,087	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$206,412,215**	**$206.41**	

ASC100

19-June-2000

Rev. 2

SUMMARY CONSUMABLES
ELECTRIC ARC FURNACE WITH SCRAP CHARGE ONLY
100% STEEL SCRAP CHARGE TO EAF

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.028 MM MT/YEAR PURCHASED SCRAP FEED TO EAF
0.050 MM MT/YEAR REVERT SCRAP FEED TO EAF
0.000 MM MT/YEAR NET DRI TO EAF

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	REVERT SCRAP CHARGE TO EAF	0.0496	0.0000	0.0496
	PURCHASED SCRAP CHARGE TO EAF	1.0280	0.0000	1.0280
	TOTAL STEEL SCRAP (100%)	1.0776	0.0000	1.0776
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0119	0.0000	0.0119
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0122	0.0000	0.0122
	O2 GAS TO EAF (MM Nm3/YR)		11.91	
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	AUX. N.G. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/yr)	726.931		
LADLE REFINING FURNACE:				
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D	34.8964		
	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

ASC100
19-June-2000
Rev. 2

SUMMARY CONSUMABLES
ELECTRIC ARC FURNACE WITH SCRAP CHARGE ONLY
100% STEEL SCRAP CHARGE TO EAF

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	STEEL SCRAP (REVERT)	0.0496	$495,681	$0.50	$0.47
$140.00	PURCHASED STEEL SCRAP	1.0280	$143,920,000	$143.92	$136.51
$1,087.23	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0119	$691,146	$0.69	$0.66
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,899,645	$3.90	$3.70
$77.10	LIME CHARGED	0.0122	$942,964	$0.94	$0.89
$0.042	O2 GAS TO EAF (MM Nm3/YR)	11.9131	$500,350	$0.50	$0.47
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$24.83	EAF OTHER, INCL. OSBL - ($/mt L.S.)	1.0000	$24,830,000	$24.83	$23.55
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	726.9314	$23,988,736	$23.99	$22.75
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,649	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$211,622,171	$211.13	$200.26
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0521			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$892,969	$0.89	$0.85
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,297	$0.26	$0.25
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.01
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.27
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8964	$1,151,582	$1.15	$1.09
	SUB-TOTAL LRF:		$6,815,629	$6.82	$6.48
	TOTAL THROUGH LIQUID STEEL:		**$218,437,800**	**$217.94**	

A3010

18-June-2000

Rev. 2

SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
30% DRI CHARGE - 1.0 WT.% CARBON

BASIS:

1.0000 MM MT/YEAR LIQUID STEEL PRODUCT
0.9767 MM MT/YEAR NET SLAB PRODUCT

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	2.0874	0.0646	2.1520
	WASTE ROCK	1.2623	0.0390	1.3014
	DIESEL FUEL (MINING ETC.)		0.0099	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	16.1883		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	0.8251	0.0255	0.8506
	CONCENTRATE TO PIPELINE FEED	0.4860	0.2617	0.7476
	DEWATERED TAILINGS TO DISPOSAL	0.3391	0.6298	0.9689
	CONC. ELECTRICAL POWER REQ'D (MM kWhr/yr)	36.0713		
	CONC. SLURRY PIPELINE POWER (MM kWhr/yr)	40.4968		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	0.8419	0.0738	0.9157
	BINDER TO PELLETIZING	0.0051	0.0000	0.0051
	DOLOMITE TO PELLETIZING	0.0172	0.0000	0.0172
	TOTAL OTHER FEED TO PELLETIZING	0.3559		
	FUEL (DRYING, INDURATION, ETC.)		0.0220	
	PELLET ELECTRICAL POWER REQ'D (MM kWhr/yr)	54.7208		
SHAFT FURNACE DIRECT REDUCTION:				
	NET PELLETS, ETC. TO SHAFT FCE.	0.7612	0.0000	0.7612
	DRI TO EAF (1.0% C)	0.3527	0.0000	0.3527
	FUEL TO DRI		0.0863	
	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	47.7673		
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (30% DRI)	0.7364	0.0000	0.7364
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0122	0.0000	0.0122
	EAF ELECTRODES	0.0039	0.0000	0.0039
	LIME CHARGED	0.0125	0.0000	0.0125
	O2 GAS TO EAF (MM Nm3/YR)		11.8117	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	737.2919		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0541	1.0541
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0632	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8913		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9767	0.0000	0.9767

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SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
30% DRI CHARGE - 1.0 WT.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$124.45 N.G. FUEL COSTS - $/mt
$413.85 DIESEL FUEL COSTS - $/mt
$0.033 ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	0.4860	$21,328,869	$21.33	$43.89
	PELLETIZING:				
	NET PELLETS, ETC. TO SHAFT FCE.	0.7612			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	0.7612	$2,176,003	$2.18	$2.86
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0051	$454,704	$0.45	$0.60
$77.83	DOLOMITE TO PELLET. - ($/mt LIME/DOL.)	0.0172	$1,337,180	$1.34	$1.76
$2.36	PELLET OTHER - ($/mt PELLETS)	0.7612	$1,796,526	$1.80	$2.36
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	54.7208	$1,805,785	$1.81	$2.37
$124.45	PELLET N.G. FUEL - ($/mt)	0.0220	$2,732,762	$2.73	$3.59
	SUB-TOTAL PELLETIZING:		$10,302,960	$10.30	$13.53
	DIRECT REDUCTION IN SHAFT FURNACE:				
	DRI TO EAF (1.0% C)	0.3527			
0.0401	DRI LABOR - (MN-HR/mt DRI)	0.3527	$544,029	$0.54	$1.54
11.39	DRI OTHER - ($/mt DRI)	0.3527	$4,017,744	$4.02	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	47.7673	$1,576,321	$1.58	$4.47
$124.45	N.G. FUEL TO DRI - ($/mt)	0.0863	$10,734,770	$10.73	$30.43
	SUB-TOTAL DRI PRODUCTION:		$16,872,863	$16.87	$47.83
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0541			
$140.00	TOTAL STEEL SCRAP (30% DRI, REVERT & BUNDLE)	0.7364	$103,092,630	$103.09	$97.80
$1,061.37	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0122	$707,982	$0.71	$0.67
$1,031.03	EAF ELECTRODES - ($/mt)	0.0039	$3,994,636	$3.99	$3.79
$77.10	LIME CHARGED	0.0125	$965,933	$0.97	$0.92
$0.042	O2 GAS TO EAF (MM Nm3/YR)	11.8117	$496,093	$0.50	$0.47
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.97
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	737.2919	$24,330,632	$24.33	$23.08
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,607	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$162,771,513	$162.77	$154.41
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$892,837	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,259	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0632	$15,179	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8913	$1,151,412	$1.15	$1.15
	SUB-TOTAL LRF:		$6,815,288	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		$218,091,493	$218.09	

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SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
30% DRI CHARGE - 2.5% C

BASIS:

1.0000 MM MT/YEAR LIQUID STEEL PRODUCT
0.9767 MM MT/YEAR NET SLAB PRODUCT

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	2.0888	0.0646	2.1534
	WASTE ROCK	1.2632	0.0391	1.3023
	DIESEL FUEL (MINING ETC.)		0.0099	
	MINE ELECTRICAL POWER REQ'D (MM kWhr/yr)	16.1948		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	0.8256	0.0255	0.8511
	CONCENTRATE TO PIPELINE FEED	0.4863	0.2618	0.7481
	DEWATERED TAILINGS TO DISPOSAL	0.3393	0.6302	0.9695
	CONC. ELECTRICAL POWER REQ'D (MM kWhr/yr)	36.0857		
	CONC. SLURRY PIPELINE POWER (MM kWhr/yr)	40.5237		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	0.8422	0.0739	0.9161
	BINDER TO PELLETIZING	0.0051	0.0000	0.0051
	DOLOMITE TO PELLETIZING	0.0172	0.0000	0.0172
	TOTAL OTHER FEED TO PELLETIZING	0.3559		
	FUEL (DRYING, INDURATION, ETC.)		0.0220	
	PELLET ELECTRICAL POWER REQ'D (MM kWhr/yr)	54.7449		
SHAFT FURNACE DIRECT REDUCTION:				
	NET PELLETS, ETC. TO SHAFT FCE.	0.7616	0.0000	0.7616
	DRI TO EAF (2.5% C)	0.3584	0.0000	0.3584
	FUEL TO DRI		0.0876	
	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	48.5357		
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (30% DRI)	0.7364	0.0000	0.7364
	MISC. ADDITIVES	0.0072	0.0000	0.0072
	STEEL C (CHARGE+SLAG INJ)	0.0099	0.0000	0.0099
	EAF ELECTRODES	0.0045	0.0000	0.0045
	LIME CHARGED	0.0126	0.0000	0.0126
	O2 GAS TO EAF (MM Nm3/YR)		25.0833	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	737.3320		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0542	1.0542
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8932		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9767	0.0000	0.9767

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SUMMARY CONSUMABLES
BASE PROCESS SHAFT FURNACE DRI/EAF
30% DRI CHARGE - 2.5% C

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	0.4863	$21,343,027	$21.34	$43.89
	PELLETIZING:				
	NET PELLETS, ETC. TO SHAFT FCE.	0.7616			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	0.7616	$2,176,963	$2.18	$2.86
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0051	$454,905	$0.45	$0.60
$77.83	DOLOMITE TO PELLET. - ($/mt LIME/DOL.)	0.0172	$1,337,770	$1.34	$1.76
$2.36	PELLET OTHER - ($/mt PELLETS)	0.7616	$1,797,318	$1.80	$2.36
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	54.7449	$1,806,582	$1.81	$2.37
$124.45	PELLET N.G. FUEL - ($/mt)	0.0220	$2,733,967	$2.73	$3.59
	SUB-TOTAL PELLETIZING:		$10,307,505	$10.31	$13.53
	DIRECT REDUCTION IN SHAFT FURNACE:				
	DRI TO EAF (1.0% C)	0.3584			
0.0401	DRI LABOR - (MN-HR/mt DRI)	0.3584	$552,781	$0.55	$1.54
11.39	DRI OTHER - ($/mt DRI)	0.3584	$4,082,375	$4.08	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	48.5357	$1,601,678	$1.60	$4.47
$124.45	N.G. FUEL TO DRI - ($/mt)	0.0876	$10,907,454	$10.91	$30.43
	SUB-TOTAL DRI PRODUCTION:		$17,144,288	$17.14	$47.83
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0542			
$140.00	TOTAL STEEL SCRAP (30% DRI, REVERT & BUNDLE	0.7364	$103,098,237	$103.10	$97.80
$1,055.68	MISC. ADDITIVES - (AVG. $/mt)	0.0072	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0099	$577,893	$0.58	$0.55
$1,031.03	EAF ELECTRODES - ($/mt)	0.0045	$4,618,598	$4.62	$4.38
$77.10	LIME CHARGED	0.0126	$971,141	$0.97	$0.92
$0.042	O2 GAS TO EAF (MM Nm3/YR)	25.0833	$1,053,498	$1.05	$1.00
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.97
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	737.3320	$24,331,955	$24.33	$23.08
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,623	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$163,834,945	$163.83	$155.42
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$892,886	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,273	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,180	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8932	$1,151,475	$1.15	$1.15
	SUB-TOTAL LRF:		$6,815,414	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		$219,445,179	$219.45	

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SUMMARY CONSUMABLES
HYLSA IVM PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 4.0 wt.% CARBON

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

6.294 MM MT/YEAR AS-MINED ROCK
3.806 MM MT/YEAR WASTE ROCK
2.488 MM MT/YEAR ORE ROCK TO CONCENTRATOR
1.465 MM MT/YEAR CONCENTRATE
1.940 MM MT/YEAR NET GREENBALL PELLETS
1.836 MM MT/YEAR NET INDURATED PELLETS
1.781 MM MT/YEAR PELLET FEED TO DRI
1.089 MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

5.00 IRON ORE MINE ELECTRICAL POWER REQ'D (kWhr/mt ROCK)
28.12 CONCENTRATOR ELECTRICAL POWER REQ'D (kWhr/mt ORE)
0.333 PIPELINE ELECTRICAL POWER REQ'D (kWhr/mt ORE/km)
1.30 FUEL REQUIREMENT - PELLET PLANT (GJ/mt PEL)
26.08 FUEL REQUIREMENT - PELLET PLANT (kg N.G./mt PEL)
65.0 PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE MINING:				
	AS-MINED ROCK	6.294	0.195	6.488
	WASTE ROCK	3.806	0.118	3.924
	DIESEL FUEL (MINING ETC.)		0.0327	
	MINE ELECTRICAL POWER REQ'D - (kWhr/yr)	31.479		
ORE CONCENTRATION:				
	IRON ORE TO CONCENTRATOR	2.488	0.077	2.564
	CONCENTRATE TO PIPELINE FEED	1.465	0.789	2.254
	DEWATERED TAILINGS TO DISPOSAL	1.022	1.899	2.921
	CONC. ELECTRICAL POWER REQ'D - (kWhr/yr)	69.941		
	CONC. SLURRY PIPELINE POWER - (kWhr/yr)	122.098		
PELLETIZING:				
	NET OXIDE FEED TO PELLETIZING	1.969	0.173	2.142
	BINDER TO PELLETIZING	0.012	0.000	0.012
	DOLOMITE TO PELLETIZING	0.040	0.000	0.040
	TOTAL OTHER FEED TO PELLETIZING	0.504		
	FUEL (DRYING, INDURATION, ETC.)		0.0514	
	PELLET ELECTRICAL POWER REQ'D - (kWhr/yr)	128.005		
SHAFT FURNACE DIRECT REDUCTION:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.781	0.000	1.781
	DRI TO EAF (1.0% C, >450°C)	1.045	0.000	1.045
	FUEL TO DRI		0.2062	
	DRI ELECTRICAL POWER REQ'D - (kWhr/yr)	108.857		

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SUMMARY CONSUMABLES
HYLSA IVM PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 4.0 wt.% CARBON

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0084	0.0000	0.0084
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		44.00	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/yr)	639.221		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (kWhr/yr)	34.8973		
	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

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SUMMARY CONSUMABLES
HYLSA IVM PROCESS SHAFT FURNACE DRI/EAF
100% DRI CHARGE - 4.0 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	1.4652	$64,306,540	$64.31	$43.89
	PELLETIZING:				
	NET PELLETS, ETC. TO SHAFT FCE.	1.7807			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	1.7807	$5,090,195	$5.09	$2.86
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0118	$1,063,663	$1.06	$0.60
$77.83	DOLOMITE TO PELLET. - ($/mt LIME/DOL.)	0.0402	$3,127,985	$3.13	$1.76
$2.36	PELLET OTHER - ($/mt PELLETS)	1.7807	$4,202,507	$4.20	$2.36
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	128.0051	$4,224,167	$4.22	$2.37
$124.45	PELLET N.G. FUEL - ($/mt)	0.0514	$6,392,588	$6.39	$3.59
	SUB-TOTAL PELLETIZING:		$24,101,105	$24.10	$13.53
	DIRECT REDUCTION IN SHAFT FURNACE:				
	DRI TO EAF (1.0% C)	1.0450			
0.0401	DRI LABOR - (MN-HR/mt DRI)	1.0450	$1,611,721	$1.61	$1.54
11.39	DRI OTHER - ($/mt DRI)	1.0450	$11,902,822	$11.90	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	108.8567	$3,592,270	$3.59	$3.44
$124.45	N.G. FUEL TO DRI - ($/mt)	0.2062	$25,656,170	$25.66	$24.55
	SUB-TOTAL DRI PRODUCTION:		$42,762,983	$42.76	$40.92
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$647,911	$0.65	$0.61
$1,076.24	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0084	$489,310	$0.49	$0.46
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,939,447	$3.94	$3.74
$77.10	LIME CHARGED	0.0124	$952,588	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	44.0000	$1,848,000	$1.85	$1.75
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	639.2210	$21,094,291	$21.09	$20.01
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,656	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$58,155,205	$58.16	$55.16
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$892,991	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,303	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8973	$1,151,610	$1.15	$1.15
	SUB-TOTAL LRF:		$6,815,685	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$196,141,518**	**$196.14**	

HOT METAL VARIATIONS

ABF

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Rev. 2

SUMMARY CONSUMABLES
BLAST FURNACE HOT METAL/EAF
30% BF HOT METAL CHARGE - CO-PRODUCT COKE

BASIS: **28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)**

0.6882	MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.3580	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.3584	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
BLAST FURNACE:				
	LUMP IRON ORE FEED	0.1054	0.0000	0.1054
	IRON PELLET FEED	0.2097	0.0000	0.2097
	IRON SINTER FEED	0.2097	0.0000	0.2097
	IRON SCRAP FEED	0.0337	0.0000	0.0337
	LIMESTONE FEED	0.0026	0.0000	0.0026
	GRAVEL FEED	0.0026	0.0000	0.0026
	COKE FEED	0.1753	0.0000	0.1753
	AIR TO FURNACE	0.0000	0.5873	0.5873
	MOISTURE TO FURNACE	0.0000	0.0057	0.0057
	N.G. FUEL TO FURNACE	0.0000	0.0073	0.0055
	BF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.8336		
	BF HOT METAL FROM FURNACE TO EAF	0.3584	0.0000	0.3584
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (100% DRI)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		38.9907	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	542.1070		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0000	1.0000
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

ABF

18-June-2000

Rev. 2

SUMMARY CONSUMABLES
BLAST FURNACE HOT METAL/EAF
30% BF HOT METAL CHARGE - CO-PRODUCT COKE

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	BLAST FURNACE:				
	BF HOT METAL FROM FURNACE TO EAF	0.3584			
$37.84	LUMP IRON ORE FEED	0.1054	$3,987,425	$3.99	$11.13
$47.96	IRON PELLET FEED	0.2097	$10,058,433	$10.06	$28.06
$40.00	IRON SINTER FEED	0.2097	$8,389,019	$8.39	$23.41
$10.00	IRON SCRAP FEED (INTERNAL RECYCLE)	0.0337	$336,998	$0.34	$0.94
$65.00	LIMESTONE FEED	0.0026	$166,788	$0.17	$0.47
$50.00	GRAVEL FEED	0.0026	$128,299	$0.13	$0.36
$140.00	COKE FEED	0.1753	$24,547,801	$24.55	$68.49
INCL. ELEC.	AIR TO FURNACE	0.5873	$0	$0.00	$0.00
INCL. ELEC.	MOISTURE TO FURNACE	0.0057	$0	$0.00	$0.00
$124.45	N.G. FUEL TO FURNACE	0.0073	$914,401	$0.91	$2.55
$0.033	BF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.8336	$1,017,507	$1.02	$2.84
$0.75	LABOR IN BF - ($/mt)	0.3584	$268,812	$0.27	$0.75
$15.00	OTHER IN BF - ($/mt)	0.3584	$5,376,249	$5.38	$15.00
	SUB-TOTAL BF HOT METAL:		$55,191,732	$55.19	$153.99
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0000			
$140.00	TOTAL STEEL SCRAP (REVERT & PURCHASED)	0.7366	$103,127,846	$103.13	$103.13
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.58
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.35
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.96
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.96
$0.042	O2 GAS TO EAF (MM Nm3/YR)	38.9907	$1,637,608	$1.64	$1.64
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.49
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$16.83
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	542.1070	$17,889,533	$17.89	$17.89
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.29
	SUB-TOTAL EAF STEELMAKING:		$157,109,974	$157.11	$157.11
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$219,117,786**	**$219.12**	

ABFNRC

18-June-2000

Rev. 2

SUMMARY CONSUMABLES
BLAST FURNACE HOT METAL/EAF
30% BF HOT METAL CHARGE
NON-RECOVERY PROCESS COKE

BASIS: **28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)**

0.6882	MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.3580	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.3584	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
BLAST FURNACE:				
	LUMP IRON ORE FEED	0.1076	0.0000	0.1076
	IRON PELLET FEED	0.2145	0.0000	0.2145
	IRON SINTER FEED	0.2145	0.0000	0.2145
	IRON SCRAP FEED	0.0345	0.0000	0.0345
	LIMESTONE FEED	0.0026	0.0000	0.0026
	GRAVEL FEED	0.0026	0.0000	0.0026
	N.R. COKE FEED	0.1627	0.0000	0.1627
	AIR TO FURNACE	0.0000	0.5873	0.5873
	MOISTURE TO FURNACE	0.0000	0.0057	0.0057
	N.G. FUEL TO FURNACE	0.0000	0.0073	0.0055
	BF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.8336		
	BF HOT METAL FROM FURNACE TO EAF	0.3584	0.0000	0.3584
			AS N.G.	
EAF STEELMAKING:				
	TOTAL STEEL SCRAP (100% DRI)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		38.9907	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	542.1070		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

ABFNRC
18-June-2000
Rev. 2

BLAST FURNACE HOT METAL/EAF
30% BF HOT METAL CHARGE
NON-RECOVERY PROCESS COKE

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	BLAST FURNACE:				
	BF HOT METAL FROM FURNACE TO EAF	0.3584			
$37.84	LUMP IRON ORE FEED	0.1076	$4,071,272	$4.07	$11.36
$47.96	IRON PELLET FEED	0.2145	$10,286,640	$10.29	$28.70
$40.00	IRON SINTER FEED	0.2145	$8,579,349	$8.58	$23.94
$10.00	IRON SCRAP FEED (INTERNAL RECYCLE)	0.0345	$344,644	$0.34	$0.96
$65.00	LIMESTONE FEED	0.0026	$166,788	$0.17	$0.47
$50.00	GRAVEL FEED	0.0026	$128,299	$0.13	$0.36
$77.53	N.R. COKE FEED	0.1627	$12,616,306	$12.62	$35.20
INCL. ELEC.	AIR TO FURNACE	0.5873	$0	$0.00	$0.00
INCL. ELEC.	MOISTURE TO FURNACE	0.0057	$0	$0.00	$0.00
$124.45	N.G. FUEL TO FURNACE	0.0073	$914,401	$0.91	$2.55
$0.033	BF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.8336	$1,017,507	$1.02	$2.84
$0.75	LABOR IN BF - ($/mt)	0.3584	$268,812	$0.27	$0.75
$15.00	OTHER IN BF - ($/mt)	0.3584	$5,376,249	$5.38	$15.00
	SUB-TOTAL BF HOT METAL:		$43,770,267	$43.77	$122.12
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0545			
$140.00	TOTAL STEEL SCRAP (REVERT & PURCHASED)	0.7366	$103,127,846	$103.13	$97.80
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.76
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.91
$0.042	O2 GAS TO EAF (MM Nm3/YR)	38.9907	$1,637,608	$1.64	$1.55
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	542.1070	$17,889,533	$17.89	$16.97
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$157,109,974	$157.11	$148.99
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$207,696,321**	**$207.70**	

APIG

19-June-2000

Rev. 2

SUMMARY CONSUMABLES
BLAST FURNACE PRODUCING PIG IRON AS CHARGE TO EAF
30% COLD BLAST FURNACE PIG IRON CHARGE

BASIS: **28' DIA BLAST FURNACE (REF. MST OF STEEL, 9th EDITION)**

0.688 MM MT/YEAR PURCHASED SCRAP CHARGED TO EAF
0.358 MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358 MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000 MM MT/YEAR LIQUID STEEL (TARGET)
0.977 MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
BLAST FURNACE:				
	LUMP IRON ORE FEED	0.1054	0.000	0.105
	IRON PELLET FEED	0.2097	0.000	0.210
	IRON SINTER FEED	0.2097	0.000	0.210
	IRON SCRAP FEED	0.0337	0.000	0.034
	LIMESTONE FEED	0.0026	0.000	0.003
	GRAVEL FEED	0.0026	0.000	0.003
	COKE FEED	0.1753	0.000	0.175
	AIR TO FURNACE (AS GAS)	0.0000	0.587	0.587
	MOISTURE TO FURNACE (AS GAS)	0.0000	0.006	0.006
	N.G. FUEL TO FURNACE (AS GAS)	0.0000	0.007	0.005
	BF ELECTRICAL POWER REQ'D - (kWhr/yr)	36.0066		
	BF HOT METAL FROM FURNACE	0.3584	0.000	0.358
PIGGING OPERATION:				
	BF COLD PIG IRON	0.3584	0.000	0.358
	BF SCRAP FROM FCE	0.0022	0.000	0.0022
	PIGGING ELECTRICAL POWER REQ'D - (kWhr/yr)			
EAF STEELMAKING:				
	COLD PIG IRON CHARGE TO EAF	0.3584	0.000	0.358
	TOTAL STEEL SCRAP (PURCHASED & REVERT)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0050	0.0000	0.0050
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		38.99	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/yr)	736.1518		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D - (kWhr/yr)	34.9032		
	REFINED STEEL TO CASTING	1.000	0.0000	1.000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

APIG
19-June-2000
Rev. 2

SUMMARY CONSUMABLES
BLAST FURNACE PRODUCING PIG IRON AS CHARGE TO EAF
30% COLD BLAST FURNACE PIG IRON CHARGE

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	BLAST FURNACE:				
	BF HOT METAL TO PIGGING	0.3584			
$37.84	LUMP IRON ORE FEED	0.1054	$3,987,425	$3.99	$11.13
$47.96	IRON PELLET FEED	0.2097	$10,058,433	$10.06	$28.06
$40.00	IRON SINTER FEED	0.2097	$8,389,019	$8.39	$23.41
$10.00	IRON SCRAP FEED (INTERNAL RECYCLE)	0.0337	$336,998	$0.34	$0.94
$65.00	LIMESTONE FEED	0.0026	$166,788	$0.17	$0.47
$50.00	GRAVEL FEED	0.0026	$128,299	$0.13	$0.36
$140.00	COKE FEED	0.1753	$24,547,801	$24.55	$68.49
INCL. ELEC.	AIR TO FURNACE	0.5873	$0	$0.00	$0.00
INCL. ELEC.	MOISTURE TO FURNACE	0.0057	$0	$0.00	$0.00
$124.45	N.G. FUEL TO FURNACE	0.0073	$914,401	$0.91	$2.55
$0.033	BF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.8336	$1,017,507	$1.02	$2.84
$0.75	LABOR IN BF - ($/mt)	0.3584	$268,812	$0.27	$0.75
$15.00	OTHER IN BF - ($/mt)	0.3584	$5,376,249	$5.38	$15.00
	SUB-TOTAL BF HOT METAL:		$55,191,732	$55.19	$153.99
	PIGGING OPERATION:				
	BF PIG IRON TO EAF	0.3584			
$2.25	PIGGING OPERATION (ALL-IN)	0.3584	$806,437	$0.81	$2.25
	SUB-TOTAL BF PIG IRON:		$806,437	$0.81	$2.25
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0545			
$140.00	TOTAL STEEL SCRAP (REVERT & PURCHASED)	0.7366	$103,127,846	$103.13	$97.80
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0050	$5,150,738	$5.15	$4.88
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.91
$0.042	O2 GAS TO EAF (MM Nm3/YR)	38.9907	$1,637,608	$1.64	$1.55
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	736.1518	$24,293,010	$24.29	$23.04
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$164,702,084	$164.70	$156.19
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$226,709,895**	**$226.71**	

ATECN

19-June-2000

Rev. 2

SUMMARY CONSUMABLES
TECNORED PROCESS THROUGH EAF PROD. OF LIQ. STEEL
30% HOT METAL CHARGE - WITH CO-GEN. OF ELEC. PWR.

BASIS:

0.688 MM MT/YEAR PURCHASED SCRAP CHARGED
0.358 MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358 MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000 MM MT/YEAR LIQUID STEEL (TARGET)
0.977 MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
GREEN-BALL PELLET PREPARATION:				
	IRON ORE FINES TO PELLET	0.5080	0.0000	0.5080
	EAF SLAG TO PELLET	0.0610	0.0000	0.0610
	CHARCOAL TO PELLET	0.0762	0.0000	0.0762
	BINDER C TO PELLET	0.0051	0.0000	0.0051
	BINDER TO PELLET	0.0130	0.0000	0.0130
	FINES RECYCLE TO PELLET	0.0062	0.0000	0.0062
	WATER TO PELLET	0.0000	0.0656	0.0656
	GREEN PELLET PRODUCT	0.6565	0.0000	0.6565
	NET PELLET PRODUCT TO FURNACE	0.6377	0.0000	0.6377
	HEAT FOR DRYING (N.G. EQUIV.)		0.0013	
	PELLET ELECTRICAL POWER REQ'D - (MM kWhr/yr)	21.6632		
TECNORED FURNACE OPERATION:				
	EAF SLAG TO FURNACE	0.0371	0.0000	0.0371
	CHINA COKE TO FURNACE	0.1490	0.0000	0.1490
	PELLETS TO FURNACE	0.6377	0.0000	0.6377
	BURNT LIME TO SCRUBBER	0.0022	0.0000	0.0022
	AUXILLARY N.G. FUEL REQUIREMENT		0.0638	
	ELEC. POWER - CONSUMED FCE - (MM kWhr/yr)	25.0740	GENERATED	378.1112
	HOT METAL PRODUCED	0.0000	0.3582	
EAF FURNACE:				
	TOTAL STEEL SCRAP (PURCHASED)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		36.8404	
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/mt)	486.4149		
LADLE REFINING:				
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (kWhr/mt)	34.9032		
	REFINED STEEL TO CASTING	0.0000	1.0523	1.0523
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

ATECN

19-June-2000

Rev. 2

SUMMARY CONSUMABLES

TECNORED PROCESS THROUGH EAF PROD. OF LIQ. STEEL

30% HOT METAL CHARGE - WITH CO-GEN. OF ELEC. PWR.

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	GREEN BALL PELLETIZING:				
$21.19	IRON ORE FINES TO PELLET	0.5080	$10,764,520	$10.76	$16.88
$30.00	EAF SLAG TO PELLET	0.0610	$1,828,800	$1.83	$2.87
$27.00	CHARCOAL TO PELLET	0.0762	$2,057,400	$2.06	$3.23
$58.16	BINDER C TO PELLET	0.0051	$295,453	$0.30	$0.46
$75.00	BINDER TO PELLET	0.0130	$975,000	$0.98	$1.53
$3.00	FINES RECYCLE TO PELLET	0.0062	$18,659	$0.02	$0.03
$0.75	WATER TO PELLET	0.0656	$49,234	$0.05	$0.08
	GREEN PELLET PRODUCT	0.6565			
	NET PELLET PRODUCT TO FURNACE	0.6377			
$124.45	HEAT FOR DRYING (N.G. EQUIV.)	0.0013	$160,084	$0.16	$0.25
$0.033	PELLET ELECTRICAL POWER REQ'D - (MM kWhr/yr)	21.6632	$714,885	$0.71	$1.12
0.0826	LABOR FOR PELLETIZING - (MH-HR/mt PELLET)	0.6377	$2,029,161	$2.03	$3.18
$3.75	OTHER COSTS IN PELLETIZING -($/mt)	0.6377	$2,391,385	$2.39	$3.75
	SUB-TOTAL GREEN-BALL PELLETIZING:		$21,284,581	$21.28	$33.38
	TECNORED FURNACE:				
	TENORED HOT METAL TO EAF	0.3584			
$30.00	EAF SLAG TO FURNACE	0.0371	$1,111,584	$1.11	$3.10
$90.00	CHINA COKE TO FURNACE	0.1490	$13,411,471	$13.41	$37.42
$77.83	BURNT LIME TO SCRUBBER	0.0022	$174,016	$0.17	$0.49
$47.96	IRON PELLET FEED	0.2097	$10,058,433	$10.06	$28.06
$124.45	N.G. FUEL TO FURNACE	0.0638	$7,936,208	$7.94	$22.14
$0.033	NET ELECTRICAL POWER REQ'D (MM kWhr/yr)	(378.1)	($12,477,670)	($12.48)	($34.81)
0.1860	LABOR IN TECNO - ($/mt)	0.3584	$66,651	$0.07	$0.19
$10.00	OTHER IN TECNO - ($/mt)	0.3584	$3,584,166	$3.58	$10.00
	SUB-TOTAL BF HOT METAL:		$23,864,860	$23.86	$66.58
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0523			
$140.00	TOTAL STEEL SCRAP (REVERT & PURCHASED)	0.7366	$103,127,846	$103.13	$98.00
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.20
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.77
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.91
$0.042	O2 GAS TO EAF (MM Nm3/YR)	36.8404	$1,547,299	$1.55	$1.47
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.26
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.99
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	486.4149	$16,051,693	$16.05	$15.25
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$155,181,824	$155.18	$147.47
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$185,862,764**	**$207.15**	

ATECN2

19-June-2000

Rev. 2

SUMMARY CONSUMABLES
TECNORED PROCESS THROUGH EAF PROD. OF LIQ. STEEL
30% HOT METAL CHARGE - WITHOUT CO-GEN. OF ELEC. PWR.

BASIS:

0.688	MM MT/YEAR PURCHASED SCRAP CHARGED
0.358	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.358	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
GREEN-BALL PELLET PREPARATION:				
	IRON ORE FINES TO PELLET	0.5080	0.0000	0.5080
	EAF SLAG TO PELLET	0.0610	0.0000	0.0610
	CHARCOAL TO PELLET	0.0762	0.0000	0.0762
	BINDER C TO PELLET	0.0051	0.0000	0.0051
	BINDER TO PELLET	0.0130	0.0000	0.0130
	FINES RECYCLE TO PELLET	0.0062	0.0000	0.0062
	WATER TO PELLET	0.0000	0.0656	0.0656
	GREEN PELLET PRODUCT	0.6565	0.0000	0.6565
	NET PELLET PRODUCT TO FURNACE	0.6377	0.0000	0.6377
	HEAT FOR DRYING (N.G. EQUIV.)		0.0013	
	PELLET ELECTRICAL POWER REQ'D - (MM kWhr/yr)	21.6632		
TECNORED FURNACE OPERATION:				
	EAF SLAG TO FURNACE	0.0371	0.0000	0.0371
	CHINA COKE TO FURNACE	0.1490	0.0000	0.1490
	PELLETS TO FURNACE	0.6377	0.0000	0.6377
	BURNT LIME TO SCRUBBER	0.0022	0.0000	0.0022
	AUXILLARY N.G. FUEL REQUIREMENT		0.0638	
	ELEC. POWER - CONSUMED FCE - (MM kWhr/yr)	25.0740		
	HOT METAL PRODUCED	0.0000	0.3582	
EAF FURNACE:				
	TOTAL STEEL SCRAP (PURCHASED)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		36.8404	
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/mt)	486.4149		
LADLE REFINING:				
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (kWhr/mt)	34.9032		
	REFINED STEEL TO CASTING	0.0000	1.0523	1.0523
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

ATECN2

SUMMARY CONSUMABLES

19-June-2000

TECNORED PROCESS THROUGH EAF PROD. OF LIQ. STEEL

Rev. 2

30% HOT METAL CHARGE - WITHOUT CO-GEN. OF ELEC. PWR.

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$124.45 N.G. FUEL COSTS - $/mt
$413.85 DIESEL FUEL COSTS - $/mt
$0.033 ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	GREEN BALL PELLETIZING:				
$21.19	IRON ORE FINES TO PELLET	0.5080	$10,764,520	$10.76	$16.88
$30.00	EAF SLAG TO PELLET	0.0610	$1,828,800	$1.83	$2.87
$27.00	CHARCOAL TO PELLET	0.0762	$2,057,400	$2.06	$3.23
$58.16	BINDER C TO PELLET	0.0051	$295,453	$0.30	$0.46
$75.00	BINDER TO PELLET	0.0130	$975,000	$0.98	$1.53
$3.00	FINES RECYCLE TO PELLET	0.0062	$18,659	$0.02	$0.03
$0.75	WATER TO PELLET	0.0656	$49,234	$0.05	$0.08
	GREEN PELLET PRODUCT	0.6565			
	NET PELLET PRODUCT TO FURNACE	0.6377			
$124.45	HEAT FOR DRYING (N.G. EQUIV.)	0.0013	$160,084	$0.16	$0.25
$0.033	PELLET ELECTRICAL POWER REQ'D - (MM kWhr/yr)	21.6632	$714,885	$0.71	$1.12
0.0826	LABOR FOR PELLETIZING - (MH-HR/mt PELLET)	0.6377	$2,029,161	$2.03	$3.18
$3.75	OTHER COSTS IN PELLETIZING -($/mt)	0.6377	$2,391,385	$2.39	$3.75
	SUB-TOTAL GREEN-BALL PELLETIZING:		$21,284,581	$21.28	$33.38
	TECNORED FURNACE:				
	TENORED HOT METAL TO EAF	0.3584			
$30.00	EAF SLAG TO FURNACE	0.0371	$1,111,584	$1.11	$3.10
$90.00	CHINA COKE TO FURNACE	0.1490	$13,411,471	$13.41	$37.42
$77.83	BURNT LIME TO SCRUBBER	0.0022	$174,016	$0.17	$0.49
$47.96	IRON PELLET FEED	0.2097	$10,058,433	$10.06	$28.06
$124.45	N.G. FUEL TO FURNACE	0.0638	$7,936,208	$7.94	$22.14
$0.033	NET ELECTRICAL POWER REQ'D (MM kWhr/yr)	25.1	$827,443	$0.83	$2.31
0.1860	LABOR IN TECNO - ($/mt)	0.3584	$66,651	$0.07	$0.19
$10.00	OTHER IN TECNO - ($/mt)	0.3584	$3,584,166	$3.58	$10.00
	SUB-TOTAL BF HOT METAL:		$37,169,973	$37.17	$103.71
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0523			
$140.00	TOTAL STEEL SCRAP (REVERT & PURCHASED)	0.7366	$103,127,846	$103.13	$98.00
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.20
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.77
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.91
$0.042	O2 GAS TO EAF (MM Nm3/YR)	36.8404	$1,547,299	$1.55	$1.47
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.26
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.99
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	486.4149	$16,051,693	$16.05	$15.25
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$155,181,824	$155.18	$147.47
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$199,167,877**	**$220.45**	

ACOREX

04-Aug-2000

Rev. 3

SUMMARY CONSUMABLES
COREX HOT METAL/EAF
60% COREX HOT METAL CHARGE - 40%MIDREX DRI

BASIS:

0.418	MM MT/YEAR MIDREX DRI CHARGED TO EAF
0.628	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.624	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.000	MM MT/YEAR LIQUID STEEL (TARGET)
0.977	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.431	MM MT/YEAR LUMP IRON ORE
0.431	MM MT/YEAR IRON ORE PELLETS FEED
0.118	MM MT/YEAR FLUXED IRON SINTER
0.000	MM MT/YEAR IRON SCRAP
0.138	MM MT/YEAR LIMESTONE
0.138	MM MT/YEAR SIO2/GRAVEL
0.741	MM MT/YEAR COAL
1.958	MMT MT/YEAR TOTAL SOLID COREX FEED (ASSUMPTION)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
COREX FURNACE:				
	LUMP IRON ORE FEED	0.4313	0.000	0.431
	IRON PELLET FEED	0.4313	0.000	0.431
	IRON SINTER FEED	0.1181	0.000	0.118
	IRON SCRAP FEED	0.0000	0.000	0.000
	LIMESTONE FEED	0.1382	0.000	0.138
	GRAVEL FEED	0.1382	0.000	0.138
	COAL FEED	0.7413	0.000	0.741
	OXYGEN TO FURNACE (AS GAS)		0.009	
	MOISTURE TO FURNACE (AS GAS)	0.0000	0.010	0.010
	NET SOLID FEED TO FURNACE	1.9985	0.000	1.999
	N.G. FUEL TO FURNACE - (MM mt/yr)	0.0000	0.009	0.009
	COREX ELECTRICAL POWER REQ'D -	40.1390		
	BLAST GAS FROM FURNACE (AS GAS)		1.1226	
	HOT METAL FROM COREX FURNACE	0.6237	0.000	0.624
MIDREX DRI SHAFT FURNACE:				
	NET PELLETS TO SHAFT FCE - MIDREX	0.7124	0.000	0.7124
	SUPPLIMENTAL FUEL TO DRI (AS N.G.)		0.020	
	MIDREX ELECTRIC POWER REQ'D - (MM kWhr/yr)	82.4296		

ACOREX

04-Aug-2000

Rev. 2

SUMMARY CONSUMABLES
COREX HOT METAL/EAF
60% COREX HOT METAL CHARGE - 40%MIDREX DRI

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	MIDREX DRI (40.13% DRI)	0.4180	0.0000	0.4180
	HOT METAL FROM COREX FURNACE	0.6237	0.0000	0.6237
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		38.99	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/yr)	406.2297		
LADLE REFINING FURNACE:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	LIME TO LADLE REF. FCE.	0.0053	0.000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D - (kWhr/yr)	34.9032		
	REFINED STEEL TO CASTING	1.000	0.0000	1.000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

ACOREX

04-Aug-2000

Rev. 3

SUMMARY CONSUMABLES
COREX HOT METAL/EAF
60% COREX HOT METAL CHARGE - 40%MIDREX DRI

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	COREX:				
$37.84	IRON ORE LUMP. DELIVERED - ($/mt DRY)	0.4313	$16,322,186	$16.32	$26.17
$47.96	IRON ORE PELLETS DELIVERED - ($/mt)	0.4313	$20,687,421	$20.69	$33.17
$40.00	IRON SINTER FEED	0.1181	$4,722,696	$4.72	$7.57
$10.00	IRON SCRAP FEED	0.0000	$0	$0.00	$0.00
$65.00	LIMESTONE FEED	0.1382	$8,985,262	$8.99	$14.41
$50.00	GRAVEL FEED	0.1382	$6,911,740	$6.91	$11.08
$58.16	COAL FEED	0.7413	$43,113,938	$43.11	$69.13
$0.042	OXYGEN TO FURNACE ($/Nm3 AS GAS)	11.7481	$493,420	$0.49	$0.79
$124.45	N.G. FUEL TO FURNACE - (MM mt/yr)	0.0095	$1,181,064	$1.18	$1.89
$0.033	COREX ELECTRICAL POWER REQ'D -	40.1390	$1,324,587	$1.32	$2.12
0.2925	LABOR FOR COREX & FACILITY - (MN-HR/mt HM)		$7,023,145	$7.02	$11.26
$10.00	COREX & GENERAL OTHER - ($/mt HM)		$6,236,559	$6.24	$10.00
	HOT METAL FROM COREX FURNACE	0.6237			
	SUB-TOTAL COREX H.M.:		$117,002,018	$117.00	$187.61
	MIDREX SHAFT FURNACE DRI:				
	MIDREX DRI (40.13% DRI)	0.4180			
$47.96	NET PELLETS, ETC. TO SHAFT FCE.	0.7124	$34,166,704	$34.17	$81.74
$0.04	DRI LABOR - (MN-HR/mt DRI)	0.4180	$644,674	$0.64	$1.54
$11.39	DRI OTHER - ($/mt DRI)	0.4180	$4,761,020	$4.76	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	82.4296	$2,720,177	$2.72	$6.51
$124.45	N.G. FUEL TO DRI - ($/mt)	0.0204	$2,543,758	$2.54	$6.09
	SUB-TOTAL DRI PRODUCTION:		$44,836,332	$44.84	$107.26
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0545			
	MIDREX DRI (40.13% DRI)	0.4180			
	HOT METAL FROM COREX FURNACE	0.6237			
$0.00	TOTAL STEEL SCRAP (REVERT ONLY)	0.0000	$0	$0.00	$0.00
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.19
$58.16	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,169	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.76
$77.83	LIME CHARGED	0.0124	$967,138	$0.97	$0.92
$0.042	O2 GAS TO EAF (MM Nm3/YR)	38.9907	$1,637,608	$1.64	$1.55
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	406.2297	$13,405,579	$13.41	$12.71
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$49,507,306	$49.51	$46.95
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$6,816,080	$6.82	$6.82
	TOTAL THROUGH LIQUID STEEL:		**$218,161,736**	**$218.16**	

AHISMT
21-June-2000
Rev. 2

SUMMARY CONSUMABLES
HISMELT PROCESS TO PRODUCE HOT METAL
32.7% HOT METAL CHARGE TO EAF

BASIS:

0.6882	MM MT/YEAR PURCHASED SCRAP CHARGED
0.3585	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.3585	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR HOT BAND EQUIVALENT (CALC.)

SUMMARY:

0.534	MMM MT/YEAR FINE ORE FEED
454.376	MMM Nm3/YEAR AIR
61.452	MMM Nm3/YEAR OXYGEN
16.760	MMM Nm3/YEAR NATURAL GAS
0.204	MMM MT/YEAR FINE COAL
0.061	MMM MT/YEAR LIME/DOLOMITE FLUX ADDED
0.125	MMM MT/YEAR NET SLAG PRODUCED
316.573	MMM Nm3/YEAR WASTE FLUE GASES

ASSUMPTIONS:

1.621	ORE/HM RATIO - (MT/mt HM)
0.620	COAL TO HM RATIO - (MT/mt HM)
2.200	NATURAL GAS - (GJ/mt HM)
50.847	NATURAL GAS - (Nm3/mt HM)
1,378.531	TOTAL AIR TO SRV - (Nm3/mt HM)
186.441	OXYGEN TO SRV - (Nm3/mt HM)
80.00%	PERCENT C IN COAL
174.81	SRV PLANT ELEC. POWER REQ'D, W/O O2 PLANT - (kWhr/mt HM)
0.3953	TOTAL ORE/TOTAL MINED ROCK RATIO - (MT/mt)

SUMMARY CONSUMABLES
HISMELT PROCESS TO PRODUCE HOT METAL
32.7% HOT METAL CHARGE TO EAF

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
SRV REACTOR SYSTEM:				
	IRON ORE FINES FEED	0.5345	0.0000	0.5345
	COAL FINES TO FEED	0.2045	0.0000	0.2045
	OXYGEN GAS TO SRV - (MM Nm3/yr)	61.4524	0.0000	61.4524
	FLUX CHARGED TO SRV (LIME)	0.0615	0.0000	0.0615
	NATURAL GAS TO SRV - (MM Nm3/yr)	16.7598	0.0125	16.7598
	HOT METAL LEAVING SRV TO EAF	0.3585	0.0000	0.3585
	ELECT. POWER CONSUMMED IN SRV - (MM kWhr/yr)	62.6727		
EAF STEELMAKING:				
	HOT METAL LEAVING SRV TO EAF	0.3585	0.0000	0.3585
	TOTAL STEEL SCRAP (32.7% HM TO EAF)	0.7366	0.0000	0.7366
	MISC. ADDITIVES	0.0071	0.0000	0.0071
	STEEL C (CHARGE+SLAG INJ)	0.0060	0.0000	0.0060
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		36.8404	
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	486.4149		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0545	1.0545
	LIME TO LADLE REF. FCE.	0.0053	0.0000	0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0025	0.0000	0.0025
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	34.9032		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

AHISMT

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SUMMARY CONSUMABLES
HISMELT PROCESS TO PRODUCE HOT METAL
32.7% HOT METAL CHARGE TO EAF

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$43.89	IRON ORE CONC. DELIVERED - ($/mt DRY)	0.5345	$23,457,011	$23.46	$65.43
	DIRECT REDUCTION IN SHAFT FURNACE:				
$40.71	COAL FINES TO FEED	0.2045	$8,324,343	$8.32	$23.22
$0.042	OXYGEN GAS TO SRV - (MM Nm3/yr)	61.4524	$2,581,002	$2.58	$7.20
$77.83	FLUX CHARGED TO SRV (LIME)	0.0615	$4,782,843	$4.78	$13.34
$124.45	N.G. FUEL TO SRV - ($/mt)	0.0125	$1,550,131	$1.55	$4.32
	HOT METAL LEAVING SRV TO EAF	0.3585			
$0.033	ELECT. POWER CONSUMMED IN SRV - (MM kWhr/yr)	62.6727	$2,068,198	$2.07	$5.77
0.1860	SRV LABOR - (MN-HR/mt HM)	0.3585	$2,567,418	$2.57	$7.16
11.39	SRV OTHER - ($/mt HM)	0.3585	$4,083,632	$4.08	$11.39
	SUB-TOTAL DRI PRODUCTION:		$25,957,567	$25.96	$72.40
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0545			
$140.00	TOTAL STEEL SCRAP (PURCHASED, REVERT)	0.7366	$103,127,846	$103.13	$97.80
$1,070.09	MISC. ADDITIVES - (AVG. $/mt)	0.0071	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0060	$351,108	$0.35	$0.33
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,962,106	$3.96	$3.76
$77.10	LIME CHARGED	0.0124	$958,067	$0.96	$0.91
$0.042	O2 GAS TO EAF (MM Nm3/YR)	36.8404	$1,547,299	$1.55	$1.47
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	486.4149	$16,051,693	$16.05	$15.22
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$155,181,824	$155.18	$147.16
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0025	$1,750,000	$1.75	$1.75
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.9032	$1,151,806	$1.15	$1.15
	SUB-TOTAL LRF:		$8,307,733	$8.31	$8.31
	TOTAL THROUGH LIQUID STEEL:		**$212,904,134**	**$212.90**	

ROTARY HEARTH DRI FURNACES

AREDSM
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SUMMARY CONSUMABLES
ROTARY HEARTH DIRECT REDUCTION/SAF/EAF PROCESS
(E.G. REDSMELT, IRON DYNAMICS, FASTMELT, ETC.)
MAXIMUM HOT METAL CHARGED - 85.5%

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR DRI CHARGED
0.9112	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.9112	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.454	MM MT/YEAR FINE ORE FEED
3,344.5	MM Nm3/YEAR AIR
13.9	MM Nm3/YEAR OXYGEN
54.9	MM Nm3/YEAR NATURAL GAS
0.350	MM MT/YEAR COAL (AS FINES)
0.052	MM MT/YEAR FLUX ADDED
2.014	MM MT/YEAR NET G.B. PELLETS PRODUCED
3,442.3	MM Nm3/YEAR WASTE FLUE GASES SAF
0.159	MM MT/YEAR NET SLAG PRODUCED

ASSUMPTIONS:

48.48	ELECTRIC POWER CONSUMPTION IN RHF - (kWhr/mt DRI)
2.375	NATURAL GAS - (GJ/mt HM)
54.890	NATURAL GAS TO RHF- (Nm3/mt HM)
3,344.545	TOTAL AIR TO RHF - (Nm3/mt HM)
13.500	OXYGEN TO RHF - (Nm3/mt HM)
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
0.9301	NET IRON RECOVERY IN SAF + LTF

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
GREEN BALL PELLETIZING:				
	IRON ORE FINES TO PELLETIZING	1.4535	0.0000	1.4535
	COAL FINES TO PELLETIZING	0.3496	0.0018	0.3514
	BINDER TO PELLETIZING	0.0203	0.0015	0.0218
	RECYCLE DUST TO PELLETIZING	0.2046	0.2046	0.4092
	RECYCLE PELLETS TO PELLETIZING	0.0516	0.0070	0.0587
	GROSS GREEN-BALL PELLETS	2.0653	0.2816	2.3469
	ELECTRIC POWER IN G-B PELLET. - (MM kWhr/yr)	38.4560		
ROTARY HEARTH FURNACE:				
	GREEN-BALL PELLETS FEED TO RHF	2.0137	0.2746	2.2883
	NATURAL GAS FUEL TO RHF - (MM Nm3/yr)	54.8896	0.04074	
	COMBUSTION AIR TO RHF	3,344.5452	4.32383	
	DRI LEAVING RHF TO SAF	1.0261	0.000	1.0261
	ELECT. POWER CONSUM. IN RHF - (MM kWhr/yr)	49.7464		
SUBMERGED ARC FURNACE MELTER:				
	NET DRI CHARGE TO SAF (>450 °C)	1.0261	0.0000	1.0261
	LIME FLUX TO SAF	0.0635		
	SILICA FLUX TO SAF	0.0334		
	ELECTRODES TO SAF	0.0018		
	SAF CHARGE CARBON (COAL)	0.0217		
	SLAG/WIRE DESULFURIZER TO LTF	0.0046		
	NET HOT METAL CHARGE TO EAF	0.9112		
	ELECTRIC POWER CONSUMP. SAF - (MM kWhr/yr)	265.1622		

SUMMARY CONSUMABLES
ROTARY HEARTH DIRECT REDUCTION/SAF/EAF PROCESS
(E.G. REDSMELT, IRON DYNAMICS, FASTMELT, ETC.)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	PURCHASED SCRAP TO EAF	0.1181		0.1181
	RECYCLE SCRAP (REVERT) TO EAF	0.0363		0.0363
	MISC. ADDITIVES	0.0155		0.0155
	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130
	EAF ELECTRODES	0.0028		0.0005
	LIME CHARGED	0.0243		0.0243
	O2 GAS TO EAF (MM Nm3/YR)		52.60	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D	130.0000		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
	LIME TO LADLE REF. FCE.	0.0053		0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D	30.0950		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

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SUMMARY CONSUMABLES
ROTARY HEARTH DIRECT REDUCTION/SAF/EAF PROCESS
(E.G. REDSMELT, IRON DYNAMICS, FASTMELT, ETC.)

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50 LABOR RATE - $/MAN-HOUR BURDENED
$124.45 N.G. FUEL COSTS - $/mt
$413.85 DIESEL FUEL COSTS - $/mt
$0.033 ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE FINES:				
$21.19	IRON ORE FINES TO PELLETIZING	1.4535	$30,800,714	$30.80	$15.30
	GREEN BALL PELLETIZING:				
$40.71	COAL FINES TO PELLETIZING	0.3496	$14,233,112	$14.23	$7.07
$90.02	BINDER TO PELLETIZING	0.0203	$1,828,958	$1.83	$0.91
	RECYCLE DUST TO PELLETIZING	0.2046			
	RECYCLE PELLETS TO PELLETIZING	0.0516			
	GROSS GREEN-BALL PELLETS	2.0653			
$0.033	ELEC. POWER IN G-B PELLET. - (MM kWhr/yr)	38.4560	$1,269,048	$1.27	$0.63
$124.45	HEAT FOR DRYING (N.G. EQUIV.)	0.0407	$5,070,656	$5.07	$2.52
0.0582	LABOR FOR PELLETIZING - (MH-HR/mt PELLET)	2.0653	$4,630,911	$4.63	$2.30
$2.30	OTHER COSTS IN G-B PELLETIZING -($/mt)	2.0653	$4,750,203	$4.75	$2.36
	SUB-TOTAL GREEN-BALL PELLETIZING:		$31,782,887	$31.78	$15.78
	ROTARY HEARTH FURNACE:				
	DRI LEAVING RHF TO SAF	1.0261			
	GREEN-BALL PELLETS FEED TO RHF	2.0137			
$0.042	NATURAL GAS FUEL TO RHF - (MM Nm3/yr)	54.8896	$2,305,362	$2.31	$2.25
$0.033	ELECT. POWER CONSUM. IN RHF - (MM kWhr/yr)	49.7464	$1,641,633	$1.64	$1.60
0.1098	LABOR IN RHF - ($/mt)	1.0261	$4,338,678	$4.34	$4.23
$13.69	OTHER IN RHF - ($/mt)	1.0261	$14,047,624	$14.05	$13.69
	SUB-TOTAL SAF HOT METAL:		$22,333,297	$22.33	$21.76
	IRONMAKING IN SAF FURNACE:				
	NET DRI CHARGE TO SAF (>450 °C)	1.0261			
	NET HOT METAL CHARGE TO EAF	0.9112			
$77.83	LIME FLUX TO SAF	0.0635	$4,939,235	$4.94	$5.42
$50.00	SILICA FLUX TO SAF	0.0334	$1,672,070	$1.67	$1.83
$1,031.03	ELECTRODES TO SAF	0.0021	$2,113,850	$2.11	$2.32
$58.16	SAF CHARGE CARBON	0.0217	$1,264,392	$1.26	$1.39
$4.83	SLAG/WIRE DESULFURIZER TO LTF - (AVG.$/MM mt)	0.9112	$4,400,000	$4.40	$4.83
$0.72	LADLE COSTS - ($/mt)	0.9112	$656,071	$0.66	$0.72
$0.033	ELECTRIC POWER CONSUMP. SAF/LTF - (MM kWhr/y	318.9235	$10,524,475	$10.52	$11.55
0.1019	SAF LABOR - (MN-HR/mt)	0.9112	$3,574,026	$3.57	$3.92
10.46	SAF OTHER - ($/mt)	0.9112	$9,531,256	$9.53	$10.46
	SUB-TOTAL HM PRODUCTION IN SAF:		$38,675,376	$38.68	$42.44

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SUMMARY CONSUMABLES
ROTARY HEARTH DIRECT REDUCTION/SAF/EAF PROCESS
(E.G. REDSMELT, IRON DYNAMICS, FASTMELT, ETC.)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0032			
	NET HOT METAL CHARGE TO EAF	0.9112			
$140.00	PURCHASED SCRAP TO EAF	0.1181	$16,530,376	$16.53	$16.48
$10.00	REVERT STEEL SCRAP (REVERT ONLY)	0.0363	$362,919	$0.36	$0.36
$490.53	MISC. ADDITIVES - (AVG. $/mt)	0.0155	$7,580,000	$7.58	$7.56
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0130	$753,636	$0.75	$0.75
$1,031.03	EAF ELECTRODES - ($/mt)	0.0028	$2,886,897	$2.89	$2.88
$77.10	LIME CHARGED	0.0243	$1,872,407	$1.87	$1.87
$0.042	O2 GAS TO EAF (MM Nm3/YR)	52.5985	$2,209,137	$2.21	$2.20
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.47
$21.51	EAF OTHER - ($/mt L.S.)	1.0000	$21,510,000	$21.51	$21.44
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	130.0000	$4,290,000	$4.29	$4.28
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.29
	SUB-TOTAL EAF STEELMAKING:		$62,769,076	$62.77	$62.57
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0032			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0032	$4,511,842	$4.51	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.0950	$993,135	$0.99	$0.99
	SUB-TOTAL LRF:		$6,671,651	$6.67	$6.65
	TOTAL THROUGH LIQUID STEEL:		**$193,033,000**	**$193.03**	

AMAUMEE

SUMMARY CONSUMABLES

22-June-2000

MAUMEE ROTARY HEARTH FURNACE DRI WITH BRIQUETTES/EAF

Rev. 2

100% DRI CHARGE - 4.0 wt.% CARBON

BASIS:

1.0000 MM MT/YEAR LIQUID STEEL PRODUCT
0.9768 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

0.7868 MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
0.3934 MILL SCALE TO BRIQUETTING
0.3934 RESIDUAL IRON UNITS TO BRIQUETTING
1.8983 MM MT/YEAR NET GREEN BRIQUETTE FEED TO RHF
1.1217 MM MT/YEAR NET DRI TO EAF
1.0106 MM MT/YEAR NET DRI IRON UNITS TO EAF

ASSUMPTIONS:

39.47% PERCENT IRON ORE FINES IN FEED - (IRON ORE/BRIQUETTE)
19.74% PERCENT MILL SCALE IN FEED - (SCALE/BRIQUETTE)
19.74% PERCENT RESIDUAL IRON UNITS IN FEED - (RIU/BRIQUETTE)
16.29% PERCENT COAL IN FEED - (COAL/BRIQUETTE)
4.76% PERCENT RECYCLE BRIQUETTE MATERIAL IN FEED - (% RECYCLE)
55.00 OXYGEN REQUIREMENT FOR EAF - (Nm2/mt HM)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
BRIQUETTING OF IRON UNITS:				
	ORE FINES DELIVERED TO PLANT SITE	0.7868		0.7868
	COAL TO BRIQUETTING	0.3248		0.3248
	MILL SCALE TO BRIQUETTING	0.3934		0.3934
	RESIDUAL IRON UNITS TO BRIQUETTING	0.3934		0.3934
	RECYCLE BRIQUETTES TO FEED	0.0949		0.0949
	TOTAL FEED TO BRIQUETTING	1.9932		1.9932
	TOTAL BRIQUETTES TO RHF	1.8983		1.8983
	BRIQUETTE ELEC. POWER REQ'D - (MM kWhr/yr)	39.8645		
ROTARY HEARTH DRI PRODUCTION:				
	NET REDUCED IRON BRIQUETTES TO EAF (4.0% C)	1.1217		1.1217
	AUXILARY FUEL TO DRI		0.0567	
	RHF DRI ELEC. POWER REQ'D - (MM kWhr/yr)	165.0916		
EAF STEELMAKING:				
	HBI FEED TO EAF	1.1217		1.1217
	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0000	0.0000	0.0000
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		44.0000	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D	597.4453		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	PULVERIZED LIME TO LRF	0.0101	0.0000	0.0101
	SLAG/WIRE DESULFURIZER TO LRF	0.0025	0.0000	0.0025
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	34.8703		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

AMAUMEE

22-June-2000

Rev. 2

SUMMARY CONSUMABLES
MAUMEE ROTARY HEARTH FURNACE DRI WITH BRIQUETTES/EAF
100% DRI CHARGE - 4.0 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE FINES:				
	TOTAL IRON UNIT FEED	1.5735			
$21.19	IRON ORE FINES TO BRIQUETTING	0.7868	$16,671,888	$16.67	$10.60
$25.00	MILL SCALE TO BRIQUETTING (PULVERIZED)	0.3934	$9,834,352	$9.83	$6.25
$15.00	RESIDUAL IRON UNITS TO BRIQ. (RECYCLE CHARGE)	0.3934	$5,900,611	$5.90	$3.75
	SUB-TOTAL IRON UNIT FEED:		$32,406,850	$32.41	$20.60
	GREEN BRIQUETTE PRODUCTION:				
$40.71	COAL FINES TO BRIQUETTING	0.3248	$13,223,089	$13.22	$6.97
$90.02	BINDER TO BRIQUETTING	0.0000	$0	$0.00	$0.00
	RECYCLE DUST TO BRIQUETTING (INCL. IN ABOVE)	0.0000			
	RECYCLE PELLETS TO BRIQUETTING	0.0949			
	GROSS GREEN-BALL BRIQUETTES	1.9932			
$0.033	ELEC. POWER IN G-B BRIQUETTING - (MM kWhr/yr)	39.8645	$1,315,529	$1.32	$0.69
0.0582	LABOR FOR G-B BRIQUETTING - (MH-HR/mt PELLET)	1.9932	$4,469,292	$4.47	$2.35
$11.50	OTHER COSTS IN G-B BRIQUETTING -($/mt)	1.9932	$22,922,104	$22.92	$12.07
	SUB-TOTAL GREEN-BALL PELLETIZING:		$41,930,014	$41.93	$22.09
	ROTARY HEARTH FURNACE:				
	DRI LEAVING RHF TO SAF	1.1217			
	GREEN-BALL PELLETS FEED TO RHF	1.8983			
$124.450	NATURAL GAS FUEL TO RHF - (MM mt/yr)	0.0567	$7,058,058	$7.06	$6.29
$0.033	ELECT. POWER CONSUM. IN RHF - (MM kWhr/yr)	165.0916	$5,448,023	$5.45	$4.86
0.1098	LABOR IN RHF - ($/mt)	1.1217	$4,742,672	$4.74	$4.23
$13.69	OTHER IN RHF - ($/mt)	1.1217	$15,355,662	$15.36	$13.69
	SUB-TOTAL SAF HOT METAL:		$32,604,415	$32.60	$29.07
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	REVERT STEEL SCRAP (REVERT ONLY)	0.0648	$647,901	$0.65	$0.61
$1,075.81	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0000	$0	$0.00	$0.00
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,941,017	$3.94	$3.74
$77.10	LIME CHARGED	0.0124	$952,968	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	44.0000	$1,848,000	$1.85	$1.75
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$21.51	EAF OTHER - ($/mt L.S.)	1.0000	$21,510,000	$21.51	$20.40
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	597.4453	$19,715,695	$19.72	$18.70
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,652	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$60,969,232	$60.97	$57.83
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0101	$1,710,940	$1.71	$1.71
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0025	$1,750,000	$1.75	$1.75
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8703	$1,150,721	$1.15	$1.15
	SUB-TOTAL LRF:		$9,124,443	$9.12	$9.12
	TOTAL THROUGH LIQUID STEEL:		**$177,034,955**	**$177.03**	

AITMK3
22-June-2000
Rev. 3

SUMMARY CONSUMABLES
ITmk3 PROCESS TO PRODUCE SHOT IRON FOR EAF FEED
MAXIMUM SHOT IRON CHARGED

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR SHOT IRON & SLAG PRODUCED
0.9235	MM MT/YEAR HOT SHOT IRON (TARGET)
0.9235	MM MT/YEAR HOT SHOT IRON METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.454	MMM MT/YEAR FINE ORE FEED
2,725.4	MMM Nm3/YEAR AIR TO ITF
0.0	MMM Nm3/YEAR OXYGEN TO ITF
51.83	MM Nm3/YEAR NATURAL GAS TO PELLET DRYER
87.82	MMM Nm3/YEAR NATURAL GAS TO ITF
0.404	MMM MT/YEAR COAL TO PELLET
0.000	MMM MT/YEAR FLUX ADDED TO PELLET
1.878	MMM MT/YEAR NET G.B. PELLETS PRODUCED

130	ELECTRIC POWER CONSUMPTION IN ITF - (kWhr/mt DRI)
1.454	FINE IRON ORE FEED - (MM MT/YR)
77.00%	PERCENT FINE ORE TO PELLET
64.50%	PERCENT IRON IN FINE ORE - (wt.% Fe)
1.800	NATURAL GAS TO ITF - (GJ/mt PELLET)
51.827	NATURAL GAS TO ITF- (Nm3/mt PELLET)
3.050	NATURAL GAS TO ITF - (GJ/mt DRI)
87.819	NATURAL GAS TO ITF- (Nm3/mt DRI)
2,725.405	TOTAL AIR TO ITF - (Nm3/mt DRI)
0.000	OXYGEN TO ITF - (Nm3/mt DRI)
80.00%	PERCENT C IN COAL
3,189.73	GAS VOLUME LEAVING ITF - (Nm3/mt HM)
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
0.8999	NET IRON RECOVERY IN SCREENS

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
PELLETIZING/DRYING:				
	IRON ORE FINES TO PELLETIZING	1.4535	0.000	1.4535
	COAL FINES TO PELLETIZING	0.4038	0.0018	0.4056
	BINDER TO PELLETIZING	0.0303	0.0015	0.0218
	RECYCLE DUST TO PELLETIZING	0.0000	0.0000	0.0000
	RECYCLE PELLETS TO PELLETIZING	0.0000	0.0000	0.0000
	GROSS PELLETS	1.8776	0.0033	1.8809
	FUEL TO PELLET DRYING - (MM Nm3/yr)	51.8274	0.0385	
	PELLETS FEED TO RHF	1.8776	0.0000	1.8776
	ELEC. POWER IN PELLETIZING - (MM kWhr/yr)	34.9615		
ITF DIRECT REDUCTION:				
	NATURAL GAS FUEL TO ITF (MM Nm3/yr)	87.8186	0.06519	
	COMBUSTION AIR TO ITF - (MM Nm3/yr)	2,725.4053	3.52340	
	SI LEAVING ITF TO SCREENS	1.0261	0.000	1.0261
	ELECT. POWER CONSUMMED IN ITF - (MM kWhr/yr)	133.3960		

AITMK3

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SUMMARY CONSUMABLES
ITmk3 PROCESS TO PRODUCE SHOT IRON FOR EAF FEED
MAXIMUM SHOT IRON CHARGED

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	SHOT IRON NET (W/O SLAG)	0.9235		0.9235
	PURCHASE STEEL SCRAP TO EAF	0.1181		0.1181
	REVERT STEEL SCRAP TO EAF	0.0363		0.0363
	MISC. ADDITIVES	0.0155		0.0155
	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130
	EAF ELECTRODES	0.0038		.0.0005
	LIME CHARGED	0.0243		0.0243
	O2 GAS TO EAF (MM Nm3/YR)		52.60	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/mt)	467.0000		
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
	LIME TO LADLE REF. FCE.	0.0053		0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0025		0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	34.8703		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

SUMMARY CONSUMABLES
ITmk3 PROCESS TO PRODUCE SHOT IRON FOR EAF FEED
MAXIMUM SHOT IRON CHARGED

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE FINES:				
$21.19	IRON ORE FINES TO PELLETIZING	1.4535	$30,800,714	$30.80	$21.19
	GREEN BALL PELLETIZING:				
$40.71	COAL FINES TO PELLETIZING	0.4038	$16,438,030	$16.44	$8.75
$90.02	BINDER TO PELLETIZING	0.0363	$3,266,996	$3.27	$1.74
	RECYCLE DUST TO PELLETIZING	0.0000			
	RECYCLE PELLETS TO PELLETIZING	0.0000			
	GROSS GREEN-BALL PELLETS	1.8809			
$0.033	ELEC. POWER IN G-B PELLET. - (MM kWhr/yr)	34.9615	$1,153,729	$1.15	$0.61
$124.45	HEAT FOR DRYING (N.G. EQUIV.)	0.0385	$4,787,689	$4.79	$2.55
0.0874	LABOR FOR PELLETIZING - (MH-HR/mt PELLET)	1.8809	$6,326,227	$6.33	$3.37
$3.45	OTHER COSTS IN G-B PELLETIZING -($/mt)	1.8809	$6,489,190	$6.49	$3.46
	SUB-TOTAL GREEN-BALL PELLETIZING:		$38,461,860	$38.46	$20.48
	ROTARY HEARTH FURNACE:				
	GREEN-BALL PELLETS FEED TO RHF	1.8776			
	SI LEAVING RHF TO SCREENS	1.0261			
	SHOT IRON NET (W/O SLAG)	0.9235			
$124.450	NATURAL GAS FUEL TO RHF -	0.0652	$8,112,617	$8.11	$8.78
$0.033	ELECT. POWER CONSUM. IN RHF - (MM kWhr/yr)	133.3960	$4,402,067	$4.40	$4.77
0.1098	LABOR IN RHF - ($/mt)	1.0261	$4,338,678	$4.34	$4.70
$13.69	OTHER IN RHF - ($/mt)	1.0261	$14,047,623	$14.05	$15.21
	SUB-TOTAL RHF HOT SHOT IRON:		$30,900,985	$30.90	$33.46
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0032			
	NET HOT SHOT CHARGE TO EAF	0.9112			
$140.00	PURCHASED SCRAP TO EAF	0.1181	$16,530,376	$16.53	$16.48
$10.00	REVERT STEEL SCRAP (REVERT ONLY)	0.0363	$362,919	$0.36	$0.36
$490.53	MISC. ADDITIVES - (AVG. $/mt)	0.0155	$7,580,000	$7.58	$7.56
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0130	$753,636	$0.75	$0.75
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,917,931	$3.92	$3.91
$77.10	LIME CHARGED	0.0243	$1,872,407	$1.87	$1.87
$0.042	O2 GAS TO EAF (MM Nm3/YR)	52.5985	$2,209,137	$2.21	$2.20
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0032	$4,499,202	$4.50	$4.49
$21.51	EAF OTHER - ($/mt L.S.)	1.0032	$21,578,110	$21.58	$21.51
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	467.0000	$15,411,000	$15.41	$15.36
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.29
	SUB-TOTAL EAF STEELMAKING:		$75,003,422	$75.00	$74.77
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0032			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0025	$1,750,000	$1.75	$1.74
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0032	$4,511,841	$4.51	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8703	$1,150,720	$1.15	$1.15
	SUB-TOTAL LRF:		$8,320,888	$8.32	$8.29
	TOTAL THROUGH LIQUID STEEL:		**$183,487,869**	**$183.49**	

FLUID-BED DRI PROCESSES

ACIRCS

19-June-2000

Rev. 2

SUMMARY CONSUMABLES
CIRCORED/HBI/EAF
100% DRI/HBI CHARGE - 1.0 wt.% CARBON

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.791 MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.544 MM MT/YEAR NET INDURATED MICRO PELLETS
1.089 MM MT/YEAR NET DRI TO EAF

ASSUMPTIONS:

0.0154 TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
1.30 FUEL REQUIREMENT - MICRO PELLET PLANT (GJ/mt PEL)
26.08 FUEL REQUIREMENT - MICRO-PELLET PLANT (kg N.G./mt PEL)
27.6 MICRO PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)
1.00% DRI/HBI PERCENT CARBON - (WT.% C)
15.05 FUEL TO DRI - (GJ/mt DRI)
301.95 FUEL TO DRI - (kg/mt DRI)
147.18 HBI ELEC. POWER REQ'D - (kWhr/mt HBI)
2.20 AUX. FUEL TO EAF/LRF - kg/mt LIQ. ST.
566.7 EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
33.075 LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
FINE ORE MICROPELLETIZING:				
	ORE FINES DELIVERED TO PLANT SITE	1.7908		1.7908
	NET ORE FINES FEED TO MICRO-PELL.	1.7908		1.7908
	BINDER TO MICRO-PELLET	0.0015		0.0015
	FUEL (DRYING, INDURATION, ETC.)		0.0467	
	MICRO-PELLET ELEC. POWER REQ'D - (MM kWhr/yr)	49.3584		
DIRECT REDUCTION - CFB/BB:				
	NET IND. MICRO-PELLETS, ETC. TO CFB	1.5436		1.5436
	NET DRI TO EAF (1.0% C)	1.0890		1.0890
	FUEL TO DRI		0.3288	
	DRI/HBI ELECTRICAL POWER REQ'D - (MM kWhr/yr)	160.2832		
EAF STEELMAKING:				
	HBI FEED TO EAF	1.0890		1.0890
	TOTAL STEEL SCRAP (100% DRI)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		11.0000	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	597.4453		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	34.8703		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

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SUMMARY CONSUMABLES
CIRCORED/HBI/EAF
100% DRI/HBI CHARGE - 1.0 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)
17.00	ELECTRIC POWER HOT BRIQUETTING - (kWhr/mt)
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE FINES DELIVERED - ($/mt DRY)	1.7908	$37,946,614	$37.95	$21.19
	FINE ORE MICROPELLETIZING:				
	ORE FINES DELIVERED TO PLANT SITE	1.7908			
	NET IND. MICRO-PELLETS, ETC. TO CFB	1.5436			
$90.02	BINDER TO MICRO-PELLET	0.0015	$134,778	$0.13	$0.09
INCL. CRD	LABOR MICROPELLETIZING - (MN-HR/mt)				
INCL. CRD	OTHER MICROPELLETIZING - ($/mt)				
$0.033	MICRO-PELLET ELEC. POWER REQ'D - (MM kWhr/yr)	49.3584	$1,628,826	$1.63	$1.06
$124.45	FUEL (DRYING, INDURATION, ETC.)	0.0467	$5,813,063	$5.81	$3.77
	SUB-TOTAL PELLETIZING:		$7,576,666	$7.58	$4.91
	DIRECT REDUCTION IN CFB/BB FLUID BED REACTORS:				
	DRI TO EAF (1.0% C)	1.0890			
0.1526	DRI/MICROPEL. LABOR - (MN-HR/mt DRI)	1.0890	$6,399,932	$6.40	$5.88
$16.00	DRI OTHER - ($/mt DRI)	1.0890	$17,424,006	$17.42	$16.00
$0.033	ELECTRIC POWER HOT BRIQUETTING - (kWhr/mt)	17.00	$561,000	$0.56	$0.52
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)	1.0890	$7,623,003	$7.62	$7.00
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	160.2832	$5,289,344	$5.29	$4.86
$124.45	N.G. FUEL TO DRI - ($/mt)	0.3288	$40,922,190	$40.92	$37.58
	SUB-TOTAL DRI PRODUCTION:		$78,219,475	$78.22	$71.83
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$647,901	$0.65	$0.61
$1,075.81	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0120	$698,479	$0.70	$0.66
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,941,017	$3.94	$3.74
$77.10	LIME CHARGED	0.0124	$952,968	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	11.0000	$462,000	$0.46	$0.44
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	597.4453	$19,715,695	$19.72	$18.70
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,652	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$55,601,711	$55.60	$52.74
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0000	$0	$0.00	$0.00
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,299	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8703	$1,150,721	$1.15	$1.15
	SUB-TOTAL LRF:		$5,921,802	$5.92	$5.92
	TOTAL THROUGH LIQUID STEEL:		**$185,266,268**	**$185.27**	

ACIRFR

19-June-2000

Rev. 2

Page 1

SUMMARY CONSUMABLES
CIRCOFER PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
1.0261	MM MT/YEAR DRI CHARGED
0.9112	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.9112	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.737	MMM MT/YEAR FINE ORE FEED
201.1	MMM Nm3/YEAR OXYGEN TO CFB
0.482	MMM MT/YEAR COAL IN CFB

ASSUMPTIONS:

112.24	ELECTRIC POWER CONSUMPTION IN CFB - (kWhr/mt DRI)
25.246	CUMULATIVE E. POWER IN FINE ORE - (kWhr/mt)
196.000	OXYGEN TO CFB - (Nm3/mt DRI)
0.001	BINDER TO MICROPELLETIZING - (MT/mt FEED ORE)
0.0696	FLUX CHARGED (B. LIME) TO SAF+LRF - (MT/mt HM)
0.0367	SILICA FLUX TO SAF - (MT/mt HM)
0.0050	DESULFURIZING ADDITIVES TO LRF - (MT/mt HM)
0.0239	CARBON (AS COAL) CHARGE TO SAF - (MT/mt HM)
0.00225	ELECTRODES TO SAF - (MT/mt HM)
18.6200	ELECTRIC POWER CONSUMMED IN SAF - (kWhr/mt GB)
350.00	ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.150%	STEEL SCRAP PERCENT CARBON - (wt.% C)
130.0	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)
30	LRF ELEC. POWER - (kWhr/mt LIQ. STEEL)
0.00	ELEC. POWER GENERATED - (kWhr/mt HM)
2.20	AUX. FUEL TO EAF - kg/T LIQ. ST.

PROGRAM OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
FINE ORE MICROPELLETING:				
	IRON ORE FINES TO CIRCOFER	1.7367		1.7367
	COAL FINES TO CIRCOFER	0.4823		0.4823
	BINDER TO MICROPELLETIZING	0.0017		0.0017
	RECYCLE DUST TO MICROPELLETIZING	0.0868		0.0868
	MICRO-PELLET ELEC. POWER REQ'D - (MM kWhr/yr)	49.3584		
DIRECT REDUCTION IN CFB/BB:				
	DRI LEAVING CFB TO SAF	1.0261	0.000	1.0261
	OXYGEN TO CFB - (Nm3/mt DRI)	196.00		
	ELECT. POWER CONSUMMED IN CFB - (MM kWhr/yr)	115.1720		
IRONMAKING IN SAF FURNACE:				
	NET DRI CHARGE TO SAF (>450 °C)	1.0261	0.0000	1.0261
	LIME FLUX TO SAF	0.0635		
	SILICA FLUX TO SAF	0.0334		
	ELECTRODES TO SAF	0.0021		
	SAF CHARGE CARBON	0.0217		
	SLAG/WIRE DESULFURIZER TO LTF	0.0046		
	ELECTRIC POWER CONSUMP. SAF/LTF - (MM kWhr/yr)	318.9235		

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SUMMARY CONSUMABLES
CIRCOFER PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

STEELMAKING IN EAF:				
	NET HOT METAL CHARGE TO EAF	0.9112		
	TOTAL STEEL SCRAP TO EAF	0.1544		0.1544
	MISC. ADDITIVES	0.0155		0.0155
	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130
	EAF ELECTRODES	0.0005		0.0005
	LIME CHARGED	0.0243		0.0243
	O2 GAS TO EAF (MM Nm3/YR)		52.60	
	AUX. FUEL TO EAF (AS N.G.)		0.0023	
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	130.0000		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
	LIME TO LADLE REF. FCE.	0.0053		0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D	30.0950		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

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SUMMARY CONSUMABLES
CIRCOFER PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)
17.00	ELECTRIC POWER HOT BRIQUETTING - (kWhr/mt)
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE FINES DELIVERED - ($/mt DRY)	1.7367	$36,799,736	$36.80	$21.19
	FINE ORE MICROPELLETIZING:				
	ORE FINES DELIVERED TO PLANT SITE	1.7367			
$5.00	RECYCLE DUST TO MICROPELLETIZING	0.0868	$434,164	$0.43	$0.25
$26.67	COAL FINES TO MICROPELLETIZING	0.4823	$12,862,348	$12.86	$7.41
	NET IND. MICRO-PELLETS, ETC. TO CFB	1.5436			
$90.02	BINDER TO MICRO-PELLET	0.0017	$156,334	$0.16	$0.10
INCL. CFB	LABOR MICROPELLETIZING - (MN-HR/mt)				
INCL. CFB	OTHER MICROPELLETIZING - ($/mt)				
$0.033	MICRO-PELLET ELEC. POWER REQ'D - (MM kWhr/yr)	49.3584	$1,628,826	$1.63	$1.06
	SUB-TOTAL PELLETIZING:		$15,081,672	$15.08	$8.81
	DIRECT REDUCTION IN CFB/BB FLUID BED REACTORS:				
	HBI TO SAF (1.0% C, >450°C)	1.0261			
0.1310	DRI/MICROPEL. LABOR - (MN-HR/mt DRI)	1.0261	$5,176,831	$5.18	$5.05
$0.042	OXYGEN TO CFB - (Nm3/mt DRI)	196.00	$8,232,000	$8.23	$8.02
0.1526	LABOR (DRI & MICRO PELLET.) - (MN-HR/mt DRI)	1.0261	$6,028,575	$6.03	$5.88
$19.51	DRI OTHER - ($/mt DRI)	1.0261	$20,019,659	$20.02	$19.51
$0.033	ELECTRIC POWER HOT BRIQUETTING - (kWhr/mt)	17.00	$561,000	$0.56	$0.55
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)	1.0261	$7,182,861	$7.18	$7.00
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	115.1720	$3,800,677	$3.80	$3.70
	SUB-TOTAL DRI PRODUCTION:		$51,001,603	$51.00	$49.70
	IRONMAKING IN SAF FURNACE:				
	NET DRI CHARGE TO SAF (>450 °C)	1.0261			
	NET HOT METAL CHARGE TO EAF	0.9112			
$77.83	LIME FLUX TO SAF	0.0635	$4,939,234	$4.94	$5.42
$50.00	SILICA FLUX TO SAF	0.0334	$1,672,070	$1.67	$1.84
$1,031.03	ELECTRODES TO SAF	0.0021	$2,113,850	$2.11	$2.32
$58.16	SAF CHARGE CARBON	0.0217	$1,264,392	$1.26	$1.39
$4.83	SLAG/WIRE DESULFURIZER TO LTF - (AVG.$/MM mt)	0.9112	$4,400,000	$4.40	$4.83
$0.72	LADLE COSTS - ($/mt)	0.9112	$656,071	$0.66	$0.72
$0.033	ELECTRIC POWER CONSUMP. SAF/LTF - (MM kWhr/yr)	318.9235	$10,524,475	$10.52	$11.55
0.1019	SAF LABOR - (MN-HR/mt)	0.9112	$3,574,026	$3.57	$3.48
10.46	SAF OTHER - ($/mt)	0.9112	$9,531,256	$9.53	$9.29
	SUB-TOTAL HM PRODUCTION IN SAF:		$38,675,376	$38.68	$40.83

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SUMMARY CONSUMABLES
CIRCOFER PROCESS TO PRODUCE HOT METAL
MAXIMUM HOT METAL CHARGED - CFB/SAF/EAF

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0032			
	NET HOT METAL CHARGE TO EAF	0.9112			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.1544	$1,543,660	$1.54	$1.54
$490.53	MISC. ADDITIVES - (AVG. $/mt)	0.0155	$7,580,000	$7.58	$7.56
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0130	$753,636	$0.75	$0.75
$1,031.03	EAF ELECTRODES - ($/mt)	0.0005	$472,824	$0.47	$0.47
$77.10	LIME CHARGED	0.0243	$1,872,407	$1.87	$1.87
$0.042	O2 GAS TO EAF (MM Nm3/YR)	52.5985	$2,209,137	$2.21	$2.20
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.47
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$16.78
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	130.0000	$4,290,000	$4.29	$4.28
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.29
	SUB-TOTAL EAF STEELMAKING:		$40,325,368	$40.33	$40.20
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.0950	$993,135	$0.99	$0.99
	SUB-TOTAL LRF:		$6,657,409	$6.66	$6.66
	TOTAL THROUGH LIQUID STEEL:		**$188,541,164**	**$188.54**	

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SUMMARY CONSUMABLES
FINMET FLUIDED BED DIRECT REDUCTION HBI/EAF
100% DRI CHARGE - 1.0 wt.% CARBON

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.751 MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
1.509 MM MT/YEAR NET INDURATED MICRO PELLETS TO FL. BEDS
1.089 MM MT/YEAR NET DRI/HBI TO EAF

ASSUMPTIONS:

0.0154 TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE)
1.30 FUEL REQUIREMENT - MICRO PELLET PLANT (GJ/mt PEL)
26.08 FUEL REQUIREMENT - MICRO-PELLET PLANT (kg N.G./mt PEL)
16.5 MICRO PELLET PLANT ELEC. POWER REQ'D (kWhr/mt FEED)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
FINE ORE MICROPELLETIZING:				
	ORE FINES DELIVERED TO PLANT SITE	1.7511		1.7511
	NET ORE FINES FEED TO MICRO-PELL.	1.7511		1.7511
	BINDER TO MICRO-PELLET	0.0015		0.0015
	FUEL (DRYING, INDURATION, ETC.)		0.0457	
	MICRO-PELLET ELEC. POWER REQ'D - (kWhr/yr)	28.9590		
DIRECT REDUCTION - MULTI-STAGE FLUIDIZED BED:				
	NET IND. MICRO-PELLETS, ETC. TO FB	1.5091		1.5091
	NET HBI TO EAF (1.0% C)	1.0890		1.0890
	FUEL TO DRI		0.2830	
	DRI/HBI ELECTRICAL POWER REQ'D - (kWhr/mt)	187.5973		
EAF STEELMAKING:				
	HBI FEED TO EAF	1.0890		1.0890
	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0120	0.0000	0.0120
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		11.0000	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (kWhr/mt)	597.4453		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (kWhr/mt)	34.8703		
	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

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SUMMARY CONSUMABLES
FINMET FLUIDED BED DIRECT REDUCTION HBI/EAF
100% DRI CHARGE - 1.0 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)
17.00	ELECTRIC POWER HOT BRIQUETTING - (kWhr/mt)
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE FINES DELIVERED - ($/mt DRY)	1.7511	$37,106,044	$37.11	$21.19
	FINE ORE MICROPELLETIZING:				
	ORE FINES DELIVERED TO PLANT SITE	1.7511			
	NET IND. MICRO-PELLETS, ETC. TO FB	1.5091			
$90.02	BINDER TO MICRO-PELLET	0.0015	$134,778	$0.13	$0.09
INCL. CRD	LABOR MICROPELLETIZING - (MN-HR/mt)				
INCL. CRD	OTHER MICROPELLETIZING - ($/mt)				
$0.033	MICRO-PELLET ELEC. POWER REQ'D - (MM kWhr/yr)	28.9590	$955,647	$0.96	$0.63
$124.45	FUEL (DRYING, INDURATION, ETC.)	0.0457	$5,684,295	$5.68	$3.77
	SUB-TOTAL PELLETIZING:		$6,774,720	$6.77	$4.49
	DIRECT REDUCTION IN CFB/BB FLUID BED REACTORS:				
	DRI TO EAF (1.0% C)	1.0890			
0.1848	DRI/MICROPEL. LABOR - (MN-HR/mt DRI)	1.0890	$7,748,978	$7.75	$7.12
$20.55	DRI OTHER - ($/mt DRI)	1.0890	$22,378,958	$22.38	$20.55
$7.00	HOT BRIQUETTING MAINTENANCE - ($/mt)	1.0890	$7,623,003	$7.62	$7.00
$0.033	HOT BRIQUETTING POWER REQ'D - ($/mt)	17.0000	$561,000	$0.56	$0.52
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	187.5973	$6,190,712	$6.19	$5.68
$124.45	N.G. FUEL TO DRI - ($/mt)	0.2830	$35,214,164	$35.21	$32.34
	SUB-TOTAL DRI PRODUCTION:		$79,716,815	$79.72	$73.20
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$647,901	$0.65	$0.61
$1,075.81	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0120	$698,479	$0.70	$0.66
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,941,017	$3.94	$3.74
$77.10	LIME CHARGED	0.0124	$952,968	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	11.0000	$462,000	$0.46	$0.44
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,250	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	597.4453	$19,715,695	$19.72	$18.70
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,652	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$55,601,961	$55.60	$52.74
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0000	$0	$0.00	$0.00
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,299	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8703	$1,150,721	$1.15	$1.15
	SUB-TOTAL LRF:		$5,921,802	$5.92	$5.92
	TOTAL THROUGH LIQUID STEEL:		**$185,121,343**	**$185.12**	

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SUMMARY CONSUMABLES
GENERIC IRON CARBIDE/EAF
100% IC CHARGE - 6.5 wt.% CARBON

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

1.701 MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP) 13.40
1.229 MM MT/YEAR NET IC TO EAF 268.86
33.075

ASSUMPTIONS:

0.0154 TOTAL FUEL FOR ORE SHIPPING (MT/mt FINE ORE) 0.0364
6.50% EFFECTIVE IC PERCENT CARBON - (WT.% C)
67.20% ORE FINES PERCENT IRON - (WT.% Fe DRY) 9,000.00
1.0763

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE HANDLING/DELIVERY:				
	ORE FINES DELIVERED TO PLANT SITE	1.7011		1.7011
FLUID-BED REDUCTION PROCESS:				
	NET IRON CARBIDE TO EAF (1.0% C)	1.2289		1.2289
	FUEL TO IRON CARBIDE REACTOR		0.3304	
	IRON CARBIDE ELEC. POWER REQ'D - (MM kWhr/yr)	253.4460		
EAF STEELMAKING:				
	IRON CARBIDE FEED TO EAF	1.2289		1.2289
	TOTAL STEEL SCRAP (100% IC, REVERT ONLY)	0.0648	0.0000	0.0648
	MISC. ADDITIVES	0.0070	0.0000	0.0070
	STEEL C (CHARGE+SLAG INJ)	0.0000	0.0000	0.0000
	EAF ELECTRODES	0.0038	0.0000	0.0038
	LIME CHARGED	0.0124	0.0000	0.0124
	O2 GAS TO EAF (MM Nm3/YR)		71.5000	
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	509.2178		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0543	1.0543
	SLAG/WIRE DESULFURIZER TO LRF	0.0004	0.0000	0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.0633	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	34.8703		
	REFINED STEEL TO CASTING	0.0000	1.0521	1.0521
	NET STEEL SLAB PRODUCED	0.9768	0.0000	0.9768

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SUMMARY CONSUMABLES
GENERIC IRON CARBIDE/EAF
100% IC CHARGE - 6.5 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE FINES DELIVERED - ($/mt DRY)	1.7011	$36,045,872	$36.05	$21.19
	DIRECT REDUCTION IN CFB/BB FLUID BED REACTORS:				
	IC TO EAF (1.0% C)	1.2289			
0.1607	IC & OSBL LABOR - (MN-HR/mt DRI)	1.2289	$7,604,364	$7.60	$6.19
$19.74	IC OTHER - ($/mt DRI)	1.2289	$24,258,267	$24.26	$19.74
$0.033	IC ELECTRICAL POWER REQ'D (MM kWhr/yr)	253.4460	$8,363,719	$8.36	$6.81
$124.45	N.G. FUEL TO IC - ($/mt)	0.3304	$41,118,476	$41.12	$33.46
	SUB-TOTAL DRI PRODUCTION:		$81,344,826	$81.34	$66.19
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0543			
$10.00	TOTAL STEEL SCRAP (100% DRI, REVERT ONLY)	0.0648	$647,901	$0.65	$0.61
$1,075.81	MISC. ADDITIVES - (AVG. $/mt)	0.0070	$7,580,000	$7.58	$7.19
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0000	$0	$0.00	$0.00
$1,031.03	EAF ELECTRODES - ($/mt)	0.0038	$3,941,017	$3.94	$3.74
$77.10	LIME CHARGED	0.0124	$952,968	$0.95	$0.90
$0.042	O2 GAS TO EAF (MM Nm3/YR)	71.5000	$3,003,000	$3.00	$2.85
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.25
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$15.96
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	509.2178	$16,804,187	$16.80	$15.94
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,652	$0.29	$0.27
	SUB-TOTAL EAF STEELMAKING:		$54,532,724	$54.53	$51.73
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0000	$0	$0.00	$0.00
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,299	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,182	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	34.8703	$1,150,721	$1.15	$1.15
	SUB-TOTAL LRF:		$5,921,802	$5.92	$5.92
	TOTAL THROUGH LIQUID STEEL:		**$177,845,224**	**$177.85**	

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SUMMARY CONSUMABLES
IRON CARBIDE/SAF MELTER/EAF
40% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

BASIS:

1.000 MM MT/YEAR LIQUID STEEL PRODUCT
0.977 MM MT/YEAR NET SLAB PRODUCT

SUMMARY:

0.680 MM MT/YEAR FINE ORE FEED (BY-PRODUCT OF LUMP)
0.492 MM MT/YEAR NET IC TO SAF

ASSUMPTIONS:

18.6200 ELECTRIC POWER CONSUMMED IN SAF - (kWhr/mt GB)
350.00 ELECTRIC POWER CONSUMPTION SAF - (kWhr/mt HM)
0.9301 NET IRON RECOVERY IN SAF + LTF

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
ORE HANDLING/DELIVERY:				
	ORE FINES DELIVERED TO PLANT SITE	0.6804		0.6804
FLUID-BED REDUCTION PROCESS:				
	NET IRON CARBIDE TO SAF (6.5% C)	0.4916		0.4916
	FUEL TO IRON CARBIDE REACTOR		0.1322	
	IRON CARBIDE ELEC. POWER REQ'D - (kWhr/yr)	101.3784		
SUBMERGED ARC MELTING FURNACE FOR IC:				
	NET IC CHARGE TO SAF	0.4916	0.0000	0.4916
	LIME FLUX TO SAF	0.0298		
	SILICA FLUX TO SAF	0.0157		
	ELECTRODES TO SAF	0.0010		
	SAF CHARGE CARBON	0.0000		
	SLAG/WIRE DESULFURIZER TO LTF	0.0021		
	ELECTRIC POWER CONSUMP. SAF - (kWhr/yr)	149.8423		
EAF STEELMAKING:				
	NET HOT METAL CHARGE TO EAF	0.4281		
	TOTAL STEEL SCRAP TO EAF	0.6375		0.1544
	MISC. ADDITIVES	0.0155		0.0155
	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130
	EAF ELECTRODES	0.0029		0.0005
	LIME CHARGED	0.0243		0.0243
	O2 GAS TO EAF (MM Nm3/YR)		44.48	
	AUX. FUEL TO EAF		0.0023	0.0053
	EAF ELECTRICAL POWER REQ'D - (MM kWhr/yr)	268.3688	0.063	
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0317	1.0317
	LIME TO LADLE REF. FCE.	0.0053		0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0004		0.0004
	ARGON GAS TO LRF (MM Nm3/YR)	0.0000	0.063	0.0000
	LRF ELECTRICAL POWER REQ'D	30.0950	0.0000	0.9770
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

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SUMMARY CONSUMABLES
IRON CARBIDE/SAF MELTER/EAF
40% IRON CARBIDE CHARGE - 6.5 wt.% CARBON

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE FINES DELIVERED - ($/mt DRY)	0.6804	$14,418,349	$14.42	$21.19
	DIRECT REDUCTION IN CFB/BB FLUID BED REACTORS:				
	IC TO SAF (6.5% C)	0.4916			
0.1607	IC & OSBL LABOR - (MN-HR/mt DRI)	0.4916	$3,041,230	$3.04	$6.19
$19.74	IC OTHER - ($/mt DRI)	0.4916	$9,703,307	$9.70	$19.74
$0.033	IC ELECTRICAL POWER REQ'D (MM kWhr/yr)	101.3784	$3,345,488	$3.35	$6.81
$124.45	FUEL TO IRON CARBIDE REACTOR	0.1322	$16,447,390	$16.45	$33.46
	SUB-TOTAL DRI PRODUCTION:		$32,537,414	$32.54	$66.19
	IRONMAKING IN SAF FURNACE:				
	NET DRI CHARGE TO SAF (>450 °C)	16.2213			
	NET HOT METAL CHARGE TO EAF	0.4281			
$77.83	LIME FLUX TO SAF	0.0298	$2,320,639	$2.32	$5.42
$50.00	SILICA FLUX TO SAF	0.0157	$785,602	$0.79	$1.84
$1,031.03	ELECTRODES TO SAF	0.0010	$993,167	$0.99	$2.32
$0.00	SAF CHARGE CARBON	0.0000	$0	$0.00	$0.00
$700.00	SLAG/WIRE DESULFURIZER TO LTF - (AVG.$/MM mt)	0.0021	$1,498,423	$1.50	$3.50
$0.72	LADLE COSTS - ($/mt)	0.4281	$308,247	$0.31	$0.72
$0.033	ELECTRIC POWER CONSUMP. SAF/LTF - (MM kWhr/y	149.8423	$4,944,797	$4.94	$11.55
0.1019	SAF LABOR - (MN-HR/mt)	0.4281	$1,679,213	$1.68	$3.92
10.46	SAF OTHER - ($/mt)	0.4281	$4,478,145	$4.48	$10.46
	SUB-TOTAL HM PRODUCTION IN SAF:		$17,008,232	$17.01	$39.73
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0317			
	NET HOT METAL CHARGE TO EAF	0.4281			
$140.00	TOTAL STEEL SCRAP (PURCHASED & REVERT)	0.6375	$89,247,071	$89.25	$86.51
$490.53	MISC. ADDITIVES - (AVG. $/mt)	0.0155	$7,580,000	$7.58	$7.35
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0130	$755,950	$0.76	$0.73
$1,031.03	EAF ELECTRODES - ($/mt)	0.0029	$2,990,000	$2.99	$2.90
$77.10	LIME CHARGED	0.0243	$1,872,407	$1.87	$1.81
$0.042	O2 GAS TO EAF (MM Nm3/YR)	44.4835	$1,868,305	$1.87	$1.81
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0000	$4,485,000	$4.49	$4.35
$16.83	EAF OTHER - ($/mt L.S.)	1.0000	$16,830,000	$16.83	$16.31
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	268.3688	$8,856,170	$8.86	$8.58
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.28
	SUB-TOTAL EAF STEELMAKING:		$134,773,608	$134.77	$130.64
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0004	$258,347	$0.26	$0.26
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.0950	$993,135	$0.99	$0.99
	SUB-TOTAL LRF:		$6,657,409	$6.66	$6.66
	TOTAL THROUGH LIQUID STEEL:		**$205,395,012**	**$205.40**	

OTHER PROCESSES

ASLRN

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Rev. 3

SUMMARY CONSUMABLES
SL/RN PROCESS TO PRODUCE DRI
MAXIMUM DRI CHARGED - 85.8 WT.%

BASIS:

0.1181	MM MT/YEAR PURCHASED SCRAP CHARGED
0.0363	MM MT/YEAR RECYCLED SCRAP CHARGED
0.9365	MM MT/YEAR DRI CHARGED
0.0000	MM MT/YEAR LIQUID HOT METAL (TARGET)
0.0000	MM MT/YEAR LIQUID HOT METAL (CALC.)
1.0000	MM MT/YEAR LIQUID STEEL (TARGET)
0.9770	MM MT/YEAR CAST SLAB EQUIVALENT (CALC.)

SUMMARY:

1.356	MMM MT/YEAR FINE ORE FEED
3,344.5	MMM Nm3/YEAR AIR
12.6	MMM Nm3/YEAR OXYGEN
55.5	MMM Nm3/YEAR NATURAL GAS
0.702	MMM MT/YEAR COAL
0.052	MMM MT/YEAR FLUX ADDED
2.014	MMM MT/YEAR NET G.B. PELLETS PRODUCED
3,442.3	MMM Nm3/YEAR WASTE FLUE GASES SAF
0.00	MM MT/YEAR NET SLAG PRODUCED

ASSUMPTIONS:

51.38	ELECTRIC POWER CONSUMPTION IN RK - (kWhr/mt DRI)
18.6200	ELECTRIC POWER CONSUMMED IN G-B PELLET. - (kWhr/mt GB)
686.2	EAF ELEC. POWER (TOTAL) - (kWhr/mt LIQ. STEEL)

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
GREEN-BALL PELLETIZING:				
	IRON ORE FINES TO PELLETIZING	1.3560	0.000	1.3560
	COAL FINES TO PELLETIZING	0.7024	0.0000	0.7024
	BINDER TO PELLETIZING	0.0937	0.0015	0.0951
	RECYCLE DUST TO PELLETIZING	0.2046	0.2046	0.4092
	RECYCLE PELLETS TO PELLETIZING	0.0516	0.0070	0.0587
	GROSS PELLETS	2.0653	0.2816	2.3469
	ELEC. POWER IN G-B PELLETIZING - (MM kWhr/yr)	38.4560		
ROTARY KILN REDUCTION:				
	PELLETS FEED TO RK	2.0137	0.2746	2.2883
	NATURAL GAS FUEL TO RK - (MM mt/yr)		0.04396	
	COMBUSTION AIR TO RK - (MM mt/yr)		4.32383	
	DRI LEAVING RK	1.0261	0.000	1.0261
	ELECT. POWER CONSUMMED IN RK - (MM kWhr/yr)	52.7222		

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SUMMARY CONSUMABLES
SL/RN PROCESS TO PRODUCE DRI
MAXIMUM DRI CHARGED - 85.8 WT.%

PROCESS OPERATION	STREAM LABLE	DRY SOLIDS (MM T/YR)	LIQUID (MM T/YR)	TOTAL (MM T/YR)
EAF STEELMAKING:				
	NET DRI CHARGE	0.9365	0.0000	0.9365
	TOTAL PURCHASED STEEL SCRAP TO EAF	0.1181		0.1544
	TOTAL REVERT STEEL SCRAP TO EAF	0.0363		0.1544
	MISC. ADDITIVES	0.0155		0.0155
	STEEL C (CHARGE+SLAG INJ)	0.0130		0.0130
	EAF ELECTRODES	0.0045		0.0005
	LIME CHARGED	0.0243		0.0243
	O2 GAS TO EAF (MM Nm3/YR)		52.60	
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
	AUX. FUEL TO EAF		0.0023	
	EAF ELECTRICAL POWER REQ'D	686.2000		
LADLE REFINING:				
	LIQ. EAF STEEL TO LRF	0.0000	1.0032	1.0032
	LIME TO LADLE REF. FCE.	0.0053		0.0053
	SLAG/WIRE DESULFURIZER TO LRF	0.0038		0.0004
	ARGON GAS TO LRF (MM Nm3/YR)		0.063	
	LRF ELECTRICAL POWER REQ'D - (MM kWhr/mt)	30.0950		
	REFINED STEEL TO CASTING	0.0000	1.0000	1.0000
	NET STEEL SLAB PRODUCED	0.9770	0.0000	0.9770

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SUMMARY CONSUMABLES
SL/RN PROCESS TO PRODUCE DRI
MAXIMUM DRI CHARGED - 85.8 WT.%

ASSUMPTIONS: CENTRAL, UPPER MID-WEST U.S. LOCATION

$38.50	LABOR RATE - $/MAN-HOUR BURDENED
$124.45	N.G. FUEL COSTS - $/mt
$413.85	DIESEL FUEL COSTS - $/mt
$0.033	ELECTRICAL POWER RATE - ($/kWhr)

COSTS: PER UNIT		(MM mt/YR)	$/YEAR	$/mt L.S.	$/mt UNIT
	ORE:				
$21.19	IRON ORE CONC. DELIVERED - ($/mt DRY)	1.3560	$28,733,640	$28.73	$21.19
	PELLETIZING:				
	NET GREENBALL PELLETS:	2.0137			
0.0742	PELLETIZATION LABOR - (MN-HR/mt PELLETS)	2.0653	$5,903,673	$5.90	$2.93
$40.71	LOW S FINE COAL TO PELLET. - ($/mt PELLETS)	0.7024	$28,595,091	$28.60	$14.20
$90.02	BINDER TO PELLETIZING - ($/mt BINDER)	0.0937	$8,430,373	$8.43	$4.19
$2.36	PELLET OTHER - ($/mt PELLETS)	2.0653	$4,874,121	$4.87	$2.42
$0.033	PELLET ELECTRICAL - (MM kWhr/yr)	38.4560	$1,269,048	$1.27	$0.63
	SUB-TOTAL PELLETIZING:		$49,072,305	$49.07	$24.37
	DIRECT REDUCTION IN ROTARY KILN:				
	DRI TO EAF (4.0% C)	0.9365			
0.0676	DRI LABOR - (MN-HR/mt DRI)	0.9365	$2,437,335	$2.44	$2.60
11.39	DRI OTHER - ($/mt DRI)	0.9365	$10,666,735	$10.67	$11.39
$0.033	DRI ELECTRICAL POWER REQ'D (MM kWhr/yr)	52.7222	$1,739,832	$1.74	$1.86
$124.45	N.G. FUEL TO DRI - ($/mt)	0.0440	$5,470,822	$5.47	$5.84
	SUB-TOTAL DRI PRODUCTION:		$20,314,724	$20.31	$21.69
	EAF STEELMAKING:				
	REFINED STEEL TO LRF	1.0032			
$140.00	PURCHASED STEEL SCRAP (86.5% DRI)	0.1181	$16,530,376	$16.53	$16.48
$10.00	REVERT STEEL SCRAP (86.5% DRI)	0.0363	$362,919	$0.36	$0.36
$490.53	MISC. ADDITIVES - (AVG. $/mt)	0.0155	$7,580,000	$7.58	$7.56
$58.15	STEEL C (CHARGE+SLAG INJ)	0.0130	$753,636	$0.75	$0.75
$1,031.03	EAF ELECTRODES - ($/mt)	0.0045	$4,639,655	$4.64	$4.63
$77.10	LIME CHARGED	0.0243	$1,872,407	$1.87	$1.87
$0.042	O2 GAS TO EAF (MM Nm3/YR)	52.5985	$2,209,137	$2.21	$2.20
0.1165	EAF LABOR - (MN-HR/mt L.S.)	1.0032	$4,499,202	$4.50	$4.49
$16.83	EAF OTHER - ($/mt L.S.)	1.0032	$16,883,291	$16.88	$16.83
$0.033	EAF ELECTRICAL POWER REQ'D (MM kWhr/yr)	686.2000	$22,644,600	$22.64	$22.57
$124.45	N.G. AUX. FUEL TO EAF	0.0023	$288,705	$0.29	$0.29
	SUB-TOTAL EAF STEELMAKING:		$78,263,927	$78.26	$78.02
	LADLE REFINING:				
	LIQ. EAF STEEL TO CASTING	1.0000			
$169.40	PULV. LIME TO LADLE REF. FCE. - ($/mt)	0.0053	$893,142	$0.89	$0.89
$700.00	SLAG/WIRE DESULFURIZER TO LRF	0.0038	$2,660,000	$2.66	$2.66
$0.240	ARGON GAS TO LRF (MM Nm3/YR)	0.0633	$15,184	$0.02	$0.02
$4.498	LRF OTHER - ($/mt L.S.)	1.0000	$4,497,600	$4.50	$4.50
$0.033	LRF ELECTRICAL POWER REQ'D (MM kWhr/yr)	30.0950	$993,135	$0.99	$0.99
	SUB-TOTAL LRF:		$9,059,062	$9.06	$9.06
	TOTAL THROUGH LIQUID STEEL:		**$185,443,658**	**$185.44**	

APPENDIX F-3

IRONMAKING PROCESS SUMMARIES

F-3 Ironmaking Process Summaries (Cumulative CO_2 Emissions, Electrical Power Requirements)

The detailed Energy and Mass balance spreadsheets (Appendix C) for the Ironmaking processes considered in this evaluation of Alternative Ironmaking Processes yield estimates of the Total Cumulative CO_2 Emission from the various Process Steps required to produce an equivalent 1.0 million metric tonnes of refined Liquid Steel product. In addition, the total Cumulative Electrical Power Requirements to produce the Liquid Steel product are also defined by the Spreadsheet Energy and Mass Balances.

Utilizing the equivalent emissions (North American Average) of CO_2 from the generation of electrical power (Appendix A3.1), estimates of the cumulative CO_2 emissions from that source were also made. Thus the combined equivalent CO_2 emissions for the total Ironmaking Process could be made by adding the two components (process and electrical power generation source).

The estimates for each Ironmaking Alternative Process (through Refined Liquid Steel Production) are presented in a summary table in this section.

SUMMARY OF VARIOUS PROCESSES FOR IRONMAKING/STEELMAKING
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

APPENDIX	IRONMAKING PROCESS	PROCESS ELEC. POWER REQ'D. (kWhr/mt LS)	COMPONENT ELEC. POWER REQ'D. (kWhr/mt LS)	TOTAL ELEC. POWER REQ'D. (kWhr/mt LS)	PROCESS CO2 PRODUCED (mt/mt LS)	EQUIV. E.P. CO2 PRODUCED (mt/mt LS)	TOTAL CO2 EQUIVALENT (mt/mt LS)
SHAFT FURNACE DRI - VARIATION IN CARBON AND SCRAP CHARGE							
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON	1,263.96	62.77	1,326.73	1.0514	1.2103	2.2617
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON	1,267.15	86.27	1,353.42	1.1562	1.2345	2.3907
C-3	100% STEEL SCRAP CHARGE TO EAF	761.83	60.62	822.45	0.0874	0.8035	0.8909
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON	967.43	62.94	1,030.37	0.4283	0.9398	1.3681
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON	968.31	96.50	1,064.81	0.4599	0.9712	1.4311
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF	1,134.50	132.87	1,267.37	0.9086	1.1560	2.0646
HOT METAL VARIATIONS							
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	607.84	187.60	795.44	0.8974	0.7771	1.6746
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	607.84	193.59	801.43 (141.08)	0.9594	0.6021	1.5615
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	807.06	195.33	1,002.39	0.9027	0.9143	1.8170
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION	568.06	117.64	685.69 (378.11)	1.1545	0.2805	1.4350
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION	568.06	117.64	685.69	1.1545	0.6254	1.7799
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	563.70	379.21	942.91	2.9239	0.8600	3.7839
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF	583.99	263.37	847.37	0.8689	0.7729	1.6418

SUMMARY OF VARIOUS PROCESSES FOR IRONMAKING/STEELMAKING
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

APPENDIX	IRONMAKING PROCESS	PROCESS ELEC. POWER REQ'D. (kWhr/mt LS)	COMPONENT ELEC POWER REQ'D. (kWhr/mt LS)	TOTAL ELEC. POWER REQ'D. (kWhr/mt LS)	PROCESS CO_2 PRODUCED (mt/mt LS)	EQUIV. E.P. CO_2 PRODUCED (mt/mt LS)	TOTAL CO_2 EQUIVALENT (mt/mt LS)
ROTARY HEARTH FURNACES							
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	513.46	176.82	690.28	1.3624	0.6296	1.9921
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	837.27	128.82	966.09	1.1498	0.8812	2.0310
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	670.17	155.23	825.40	1.5213	0.7529	2.2742
FLUID-BED DRI/HBI							
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	841.96	58.89	900.84	1.1999	0.8217	2.0217
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	594.19	186.80	780.99	1.6404	0.7124	2.3528
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	848.87	58.89	907.76	1.0742	0.8280	1.9022
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	797.53	175.42	972.95	1.2864	0.8874	2.1738
OTHER PROCESSES							
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	807.27	192.47	999.74	2.2869	0.9119	3.1988

APPENDIX F-4

IRONMAKING PROCESS RELATIVE OPERATING COSTS (OPEX)

F-4 Ironmaking Process Relative Operating Costs (OPEX)

Operating costs for each Ironmaking Process (OPEX) were developed and built up from breakdowns of the operating cost components for each process unit operation in the sequence. That is, from the mines (for iron ore or other components) through ore preparation, the ironmaking process steps and the EAF/LRF to produce the refined liquid steel product. All costs are normalized on the 1.0 million annual metric tonnes of Refined Liquid Steel product basis.

Since the same procedures and common elements, where appropriate, were utilized in developing the estimates of the OPEX for each process, the relative accuracy and precision of these estimates when utilized for comparing the processes is believed to be very good. The built-up OPEX estimates produced in this manner were also compared to historical reported operating costs for the processes, to Vendor-supplied estimates and to internal detailed feasibility estimates prepared by Lockwood Greene for various commercial clients. The built-up estimates, considering differences in commodity and energy cost components, compared closely with those more detailed internal estimates.

The key methodology followed for the Operating Cost Estimates (OPEX) for each process were:

- The primary basis for consumables were the Energy and Mass Balance Spreadsheets (Appendix C).
- Commodity or consumable costs were either local (i.e. Upper Mid-West U.S.A. location) or built up from the individual commodity process components (Appendix F-1).
- Labor rates utilized was from a recent LGE Feasibility Study. It is an all-in rate (including supervision component, overhead and burden) for the Upper Mid-West location.
- Labor man-hours (as man-hours/mt of product) for each of the Process unit operations or steps were either based on Vendor inputs for those process steps or were factored from LGE internal, detailed feasibility studies.

- Other considerations, including: allowances for Outside Boundary Limit (OSBL) facilities and ancillaries, Vendor or Licensing Fees, maintenance spare parts and supplies, etc. were also factored from the recent LGE feasibility studies for the similar process unit operations or steps.
- The factors, as required, were defined utilizing the operating cost components of the detailed internal LGE feasibility studies for the appropriate process operation (i.e. mining, concentration, pelletizing, ironmaking process, EAF, LRF, etc.).

The OPEX spreadsheets for the individual Ironmaking Processes are provided in Appendix F-2. The results are summarized in the tables in this Appendix Section.

LIQUID STEEL PRODUCTION COSTS - STEEL SCRAP SENSITIVITY

Early in the Alternative Ironmaking Process Study it was realized that two factors in developing the OPEX costs needed to be addressed:

- The processes for producing iron units needed to be compared on an equalized basis. That is, processes producing molten iron products needed to be compared to processes producing solid, direct-reduced iron products.
- In addition, a normalized ultimate product (i.e. refined liquid steel from an EAF/LRF process) at a consistent rate of production (i.e. 1.0 million metric tonnes per year of L.S.) was the uniform target rate for all ironmaking processes.

The problem with this, however, is that some of the Ironmaking processes require (or typically are used) with a specified amount of steel scrap as the charge to an EAF. In some cases also, the optimal utilization of the Ironmaking process or the technically-feasible process is not to charge 100% of the iron units from the ironmaking process to the EAF. The balance of the iron units (or requirements for coolant, or product purity, etc.) would come from a combination of recycled and purchased steel scrap.

The cost of steel scrap (a composite scrap charge is assumed as the basis for these EAF processes) has widely fluctuated during the past 2 or 3 years (see Appendix F1.10). As a consequence, when developing an OPEX through the liquid steel production or when trying to compare the relative economic viability of the overall processes (i.e. as a simple Internal Rate of Return calculation), the scrap price (or cost) is a significant variable in this analysis. Therefore, the OPEX costs for production of Liquid Steel are sensitized on the steel scrap price. For the basis of this analysis, costs for steel scrap of \$100, \$120 and \$140 per metric tonne of steel scrap are sensitized in the Summary OPEX tables in this section.

Subsequent financial analyses comparisons of the Alternative Ironmaking Processes (by utilizing a simple Internal Rate of Return calculation) utilized the operating costs reflecting each of the above steel scrap price (i.e. \$100, \$120 and \$140 per metric tonne) sensitivities. **The value of the refined Liquid Steel produced, after EAF steelmaking and LRF treatment, was taken to be \$250 per metric tonne for all of the Internal Rate of Return calculations.** This assumed value of the Liquid Steel (prior to continuous casting and/or hot band production) was consistent for all Alternative Ironmaking Processes. Thus, a relative financial comparison between the various processes could be made,

The OPEX estimates for each process evaluated are summarized and tabulated for each of the steel scrap prices in this Section.

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $100.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$102.80	$67.21	$6.82	$176.83
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$73.64	$59.68	$6.82	$188.64
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$73.64	$60.73	$6.82	$189.99
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$73.66	$53.98	$6.82	$189.65
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$73.66	$53.98	$6.82	$178.23
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$73.66	$61.57	$6.82	$198.05
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$73.66	$52.05	$6.82	$177.67
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$73.66	$52.05	$6.82	$190.98
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$20.84	$75.27		$49.51	$6.82	$228.34
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$81.03	$52.06	$8.31	$190.82

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $100.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$11.81	$46.24	$6.67	$188.31
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$11.81	$58.47	$8.32	$178.76
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$63.75	$45.52	$6.66	$179.90
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$11.81	$61.73	$9.09	$180.74

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $120.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$123.36	$67.21	$6.82	$197.39
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$88.36	$59.68	$6.82	$203.36
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$88.37	$60.73	$6.82	$204.72
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$88.40	$53.98	$6.82	$204.39
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$88.40	$53.98	$6.82	$192.97
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$88.40	$61.57	$6.82	$212.79
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$88.40	$52.05	$6.82	$192.41
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$88.40	$52.05	$6.82	$205.72
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$20.84	$75.27		$49.51	$6.82	$228.34
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$88.40	$52.06	$8.31	$198.19

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $120.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$14.17	$46.24	$6.67	$190.67
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$14.17	$58.47	$8.32	$181.12
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$76.50	$45.52	$6.66	$192.65
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$14.17	$61.73	$9.09	$183.10

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $140.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$143.92	$67.21	$6.82	$217.95
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$103.09	$59.68	$6.82	$218.09
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$103.10	$60.73	$6.82	$219.45
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$103.13	$53.98	$6.82	$219.12
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$103.13	$53.98	$6.82	$207.70
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$103.13	$61.57	$6.82	$227.52
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$103.13	$52.05	$6.82	$207.14
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$103.13	$52.05	$6.82	$220.45
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$10.67	$75.27		$49.51	$6.82	$218.17
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$103.13	$52.06	$8.31	$212.92

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $140.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$16.53	$46.24	$6.67	$193.03
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$16.53	$58.47	$8.32	$183.48
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$89.25	$45.52	$6.66	$205.40
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$16.53	$61.73	$9.09	$185.46

APPENDIX F-5

IRONMAKING PROCESS RELATIVE CAPITAL COSTS (CAPEX)

F-5 Ironmaking Process Relative Capital Costs (CAPEX)

The Relative Capital Cost (CAPEX) estimates for each of the Alternative Ironmaking Processes were developed from appropriate sections of several internal LGE Project Feasibility and Detailed Design Studies. The installed cost estimates were factored using the costs for similar scopes for the plant and processing areas involved with each of the Ironmaking Processes.

The costs used were updated to a year 2000 basis and normalized using the process Mass Balances (Appendix C) to a uniform 1.0 million metric tonnes per year Refined Liquid Steel production basis. Specific differences in scope required for a particular process were accounted for in the individual components considered in the overall process CAPEX estimates. The CAPEX is reported as $/annual metric tonne of production.

The built-up CAPEX costs are summarized in this section.

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
SHAFT FURNACE DRI PROCESSES:								
C-1	**100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON**							
	IRON UNIT INPUT:	Concentrate delivered to pelletizing plant.	1.4652					
	INDURATED PELLET PRODUCTION:	Composite of four Vendor quotations for similar scope.	3.3000	$135.0	$40.91			
			3.5000	$155.0	$44.29			
			4.2000	$175.0	$41.67			
			5.0000	$300.0	$60.00			
				AVERAGE:	$46.72	1.7807	$83.19	
	KOBE/MIDREX SHAFT FURNACE:	Composite of three Vendor quotations for similar scope.	4.5000	$670.0	$148.89			
			4.0000	$565.0	$141.25			
			4.5000	$655.0	$145.56			
				AVERAGE:	$145.23	1.0450	$151.77	
	ELECTRIC ARC STEELMAKING/LRF:	Composite of three Vendor quotations for similar scope.	4.9200	$410.0	$83.33			
			4.9200	$385.0	$78.25			
			4.9200	$400.0	$81.30			
				AVERAGE:	$80.96	1.0549	$85.41	
	OUTSIDE BOUNDARY LIMITS:	Includes: ore/concentrate storage, water services, waste disposal, off-gas treatment, offices, labs, etc.	4.0000 (L.S.)	$180.0	$45.00	1.0000	$45.00	**$365.36**
C-2	**100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON**							
	IRON UNIT INPUT:	Same as C-1.	1.4670					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	1.7826	$83.27	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	1.0450	$151.77	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0549	$85.41	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$365.45**

NOTES: (1) 2000 BASIS

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-3	**100% STEEL SCRAP CHARGE TO EAF**							
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$145.23	1.0543	$153.12	
	OUTSIDE BOUNDARY LIMITS:	Includes: scrap receiving/ handling/storage, water services, waste disposal, off-gas treatment, offices, labs, etc. for EAF/LRF only.	4.0000 (L.S.)	$80.0	$20.00	1.0280	$20.56	**$173.68**
C-4	**30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON**							
	IRON UNIT INPUT:	Same as C-1.	0.4860					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	0.7612	$35.56	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	0.3527	$51.22	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0541	$85.34	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$231.85**
C-5	**30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON**							
	IRON UNIT INPUT:	Same as C-1.	0.4863					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	0.7615	$35.57	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	0.3584	$52.05	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0542	$85.35	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$232.70**
C-6	**HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF**							
	IRON UNIT INPUT:	Same as C-1.	1.4650					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	1.7807	$83.19	
	HYLIVM SHAFT FURNACE:	Composite of two Vendor	4.2000	$612.0	$145.71			
		quotations for similar scope.	2.8000	$390.8	<u>$139.56</u>			
				AVERAGE:	$142.64	1.0450	$149.05	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$362.60**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
HOT METAL VARIATIONS								
C-7	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE**							
	IRON UNIT INPUT:	Lump ore, Pellets, Sinter, Scrap,	0.1054					
		etc. delivered to stockpiles	0.2097					
		with reclaim and handling systems	0.2097					
		included in OSBL.	0.0337					
	INTEGRATED BLAST FURNACE:	Based on Vendor quotation.	2.3100	$635.00	$275.00	0.3584	$98.56	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0542	$85.35	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$243.64**
C-7a	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE (MINI BLAST FURNACE FOR REFERENCE)**							
	IRON UNIT INPUT:	Same as C-7.						
	MINI BLAST FURNACE FACILITY:	Based on Vendor quotation.	0.9000	$133.05	$147.83	0.3584	$52.98	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$198.05**
C-8	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE**							
	IRON UNIT INPUT:	Same as C-7.						
	INTEGRATED BLAST FURNACE:	Same as C-7.			$275.00	0.3584	$98.56	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$243.63**
C-9	**30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG**							
	IRON UNIT INPUT:	Same as C-7.						
	INTEGRATED BLAST FURNACE:	Same as C-7.			$275.00	0.3584	$98.56	
	PIG IRON CASTING/HANDLING:	Based on Vendor quotation.	3.5600	$44.0	$12.36	0.3584	$4.43	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$248.06**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-10	**30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION**							
	IRON UNIT INPUT (AS FINE ORE):	Iron ore fines received into stockpiles with reclaim systems to green-ball pelletizing.	0.5080					
	GREEN-BALL PELLET PRODUCTION:	Internal LGE cost estimate for confidential client.	0.3020	$14.1	$46.62	0.6377	$29.73	
	TECHNORED FURNACE & ANCILLARIES:	Internal LGE cost estimate for confidential client.	0.3020	$29.5	$97.59	0.3584	$34.98	
	CO-GENERATION:	Internal LGE cost estimate for confidential client.	0.3020	$7.4	$24.57	0.3584	$8.81	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0540	$63.24	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$196.48**
C-11	**30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	0.5080					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10.	0.3020	$14.1	$46.62	0.6377	$29.73	
	TECHNORED FURNACE & ANCILLARIES:	Same as C-10.	0.3020	$29.5	$97.68	0.3584	$35.01	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0540	$63.24	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$187.71**
C-12	**COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF**							
	IRON UNIT INPUT (COREX):	Iron ore as lump and as pellets are on a purchased basis.	0.4313 0.4313					
	MIDREX SHAFT FURNACE:	Iron ore pellets are purchased.	0.7124					
	COREX FURNACE & ANCILLARIES:	Based on Vendor quotation.	0.3020	$104.1	$344.83	0.6237	$215.07	
	MIDREX SHAFT FURNACE:	Same as C-1.	0.1480	$17.8	$120.00	0.4180	$50.16	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$60.00	1.0545	$63.27	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$373.50**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
		COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
C-13	**HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	0.5345					
	HISMELT SRV FURNACE:	Based on Vendor quotation.	0.3650	$116.6	$319.45	0.3585	$114.52	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0545	$85.37	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$259.63**
ROTARY HEARTH FURNACES								
C-14	**REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	1.4545					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10 with adjustments.			$23.32	2.0653	$48.16	
	ROTARY HEARTH REDUCTION FCE.:	Based on three Vendor quotations.	0.3020	$42.2	$139.67			
			3.4000	$465.0	$136.76			
			1.2500	$166.2	$132.98			
				AVERAGE:	$136.47	1.0261	$140.03	
	SUBMERGED ARC MELTING FURNACE:	Based on three Vendor quotations.	0.3020	$14.0	$46.36			
			3.4000	$160.0	$47.06			
			1.2500	$53.1	$42.50			
				AVERAGE:	$45.31	0.9112	$41.28	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0032	$60.19	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.1544	$3.09	**$334.67**
C-15	**MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.5735					
	GREEN BRIQUETTE PRODUCTION:	Based on Vendor quotation.	0.1200	$4.3	$35.83	1.9932	$71.42	
	ROTARY HEARTH REDUCTION FCE.:	Based on Vendor quotation.	0.1200	$14.5	$120.83	1.1217	$135.54	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-3.			$45.00	1.0000	$45.00	**$292.32**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-16	**ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.4535					
	GREEN BRIQUETTE PRODUCTION:	Same as C-10 with adjustments.			$23.32	1.8809	$43.86	
	ROTARY HEARTH REDUCTION FCE.:	Based on Vendor quotation.	0.6000	$100.0	$166.67	1.0261	$171.02	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0032	$81.22	
	OUTSIDE BOUNDARY LIMITS:	Same as C-3.			$45.00	1.0000	$45.00	**$296.10**
FLUID-BED DRI/HBI								
C-17	**CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7905					
	MICRO-PELLET PRODUCTION:	Based on Vendor quotation.	4.0000	$40.0	$10.00	1.5340	$15.34	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$420.0	$105.00	1.0890	$114.35	
	HOT BRIQUETTING:	Based on Vendor quotation.	4.0000	$120.0	$30.00	1.0890	$32.67	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$232.37**
C-18	**CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7387					
	MICRO-PELLET PRODUCTION:	Same as C-17.			$10.00	1.5340	$15.34	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$466.6	$116.65	1.0890	$127.03	
	SUBMERGED ARC MELTING FURNACE:	Same as C-14.			$45.31	1.0890	$49.34	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$60.00	1.0543	$63.26	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$239.63**
C-19	**FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7511					
	MICRO-PELLET PRODUCTION:	Based on Vendor quotation.	4.0000	$40.0	$10.00	1.5091	$15.09	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$649.0	$162.25	1.0890	$176.69	
	HOT BRIQUETTING:	Based on Vendor quotation.	4.0000	$180.0	$45.00	1.0890	$49.01	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$35.83	1.0543	$37.78	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$30.00	1.0000	$30.00	**$263.47**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-20a	**GENERIC IRON CARBIDE/EAF**							
	RECYCLE SCRAP CHARGE TO EAF (2)							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7011					
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	3.9600	$700.0	$176.77	1.2289	$217.23	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$347.59**
C-20b	**GENERIC IRON CARBIDE/SAF/EAF**							
	60% SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	0.6804					
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	3.9600	$700.0	$176.77	0.4916	$86.90	
	SUBMERGED ARC MELTING FURNACE:	Same as C-14.			$45.31	1.0890	$49.34	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$60.00	1.0543	$63.26	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.6375	$12.75	**$257.24**
OTHER PROCESSES								
C-21	**SL/RN ROTARY KILN WITH ONLY**							
	RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.3560					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10.			$46.62	2.0137	$93.88	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	2.8000	$350.0	$125.00	0.9365	$117.06	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.1544	$3.09	**$344.39**

NOTE: (2) 100% IC CHARGE HAS NOT BEEN PROVEN TO BE FEASIBLE.

APPENDIX F-6

SORTING OF PROCESSES

BY CAPITAL COSTS/ANNUAL MT L.S.

BY IRON UNIT COSTS/MT I.U.

BY OPERATING COST/MT L.S.

BY INTERNAL RATE OF RETURN

BY TOTAL ELECTRICAL POWER REQUIRED

BY TOTAL CUMULATIVE CO_2 EMISSIONS – PROCESS ONLY

BY TOTAL CUMULATIVE CO_2 EMISSIONS – TOTAL INCLUDING ELECTRICAL POWER GENERATION

F-6 Sorting of Processes

In order to compare the merits of each of the Ironmaking Processes considered (i.e. 21 total processes through Refined Liquid Steel production) with each other on an equalized basis, a Sorting and Ranking procedure was utilized. The procedures utilized are described below and in Appendix G:

Sort on Variables

The following specific variables (from the previous Appendix F sections) for each process were utilize to sort and rank the processes:

- Capital Costs (CAPEX, as $/annual metric tonne Liquid Steel product)
- Operating Costs to produce Iron Units (OPEX I.U. as $/metric tonne iron product to EAF steelmaking)
- Operating Costs to produce Refined Liquid Steel (OPEX L.S. as $/metric tonne Refined Liquid Steel product)
- Simple Internal Rate of Return (I.R.R. based on a $250 in-process value/metric tonne Liquid Steel product, all CAPEX in year 1 and full production for years 2-21)
- Total Electric Power (Cumulative total electric power consumption for all sub-processes to produce the Refined Liquid Steel product for each alternative)
- Total Cumulative CO_2 Emissions for the Process only (all fuel gas and carbon component emissions for all of the sub-processes, expressed as the CO_2 equivalent through the Refined Liquid product)
- Total Cumulative CO_2 Emissions (the sum of the Process CO_2 emissions and the equivalent CO_2 emissions for the Total Electric Power required) (Reference Appendix A3.1 based on North American average generation fuel distributions)

The various Alternative Ironmaking Processes were resequenced such that minor variations of specific processes considered (e.g. 2.5 wt.% carbon DRI, Appendix C-2 and C-4) were not considered in the sorting and ranking. The listings of the processes were sorted by the index variables above based on these resequenced tabulations.

These sorted listings were grouped into three groupings for each variable:

- LOWEST THIRD - A grouping of the lowest seven processes by the variable of interest.
- MIDDLE THIRD - A grouping of the middle seven processes by the variable of interest.
- HIGHEST THIRD - A grouping of the highest seven processes by the variable of interest.

Within each grouping, the processes are in sequence with the lowest first and the highest last. Thus the first process sorted in the Lowest Group (for all variables except the I.R.R.) would be the "best" process by that index variable. Similarly, the last process in the Highest Group (except for the I.R.R) would be the "worst" process by that index variable. By examining the processes in each grouping some consensus as to the most desirable and perhaps the least desirable Alternative Ironmaking Processes might be gained (based on the index variable sensitivities).

Since the cost-related variables of OPEX L.S. and the I.R.R. are a significant function of the Steel Scrap Price, sensitivities for these variables at \$100, \$120 and \$140 per metric tonnes of steel scrap were done to clarify the impact of this key sub-variable (Reference Appendix F1.10).

The tabulations for each of these sorts are provided in this section.

CAPITAL AND OPERATING COST ESTIMATES - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN
SHAFT FURNACE DRI PROCESSES:					
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON	$365.36	$132.44	$205.39	10.57%
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON	$365.45	$132.55	$206.42	10.22%
C-3	100% STEEL SCRAP CHARGE TO EAF	$173.68	$0.00	$197.39	30.14%
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON	$231.85	$137.51	$203.36	19.55%
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON	$232.70	$136.14	$204.72	18.84%
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF	$362.60	$125.52	$196.15	13.72%
HOT METAL VARIATIONS					
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$243.64	$142.86	$204.39	18.04%
C-7a	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, MINI BLAST FURNACE	$198.05	$142.86	$204.39	22.64%
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$243.63	$110.77	$192.97	23.04%
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$248.06	$145.12	$212.79	13.89%
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION	$196.48	$125.95	$192.41	29.14%
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION	$187.71	$163.09	$205.72	23.23%
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$373.50	$208.88	$228.34	1.46%
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF	$259.63	$137.85	$198.19	19.38%
ROTARY HEARTH FURNACES					
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$334.67	$101.83	$190.67	16.96%
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$292.32	$66.44	$177.03	24.66%

CAPITAL AND OPERATING COST ESTIMATES - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$296.10	$67.60	$181.12	22.89%
FLUID-BED DRI/HBI					
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$232.37	$78.79	$185.27	27.64%
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$239.63	$96.20	$188.55	25.37%
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$263.47	$79.42	$185.12	24.31%
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF (2)	$347.59	$66.19	$177.84	20.24%
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$257.24	$100.79	$192.65	21.87%
OTHER PROCESSES					
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$344.39	$74.08	$183.10	18.81%

NOTES: (1) Operating costs based on purchased scrap composite price of $120/mt.
(2) Sales (or transfer) price of Liquid Steel taken to be ($/mt). $250.00
(3) Internal Rate of Return Scenario based on 1.00 MM mt/year production of liquid refined steel (as caster feed). Project life is 21 years and all Capital investment is in year 1, with full production and revenue in years 2 through 21.

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON CAPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
HIGHEST THIRD								
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$208.88	$228.34	1.46%	942.91	3.1398	3.9998

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON I.U. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
MIDDLE THIRD								
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
HIGHEST THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
HIGHEST THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
MIDDLE THIRD								
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
LOWEST THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON TOTAL ELECTRICITY

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
MIDDLE THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
HIGHEST THIRD								
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON PROCESS CO2

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
MIDDLE THIRD								
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
HIGHEST THIRD								
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - TOTAL CUMULATIVE CO2

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
MIDDLE THIRD								
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
HIGHEST THIRD								
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
MIDDLE THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
HIGHEST THIRD								
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
MIDDLE THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
LOWEST THIRD								
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
MIDDLE THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
LOWEST THIRD								
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE CAPITAL COSTS*

LOWEST THIRD

100% STEEL SCRAP
TECHNORED W/O COGEN
TECHNORED WITH COGEN
MINI BLAST FURNACE
30% DRI/70% STEEL SCRAP
CIRCORED
CIRCOFER

MIDDLE THIRD

BLAST FURNACE - N.R. COKE
BLAST FURNACE - C.P. COKE
30% COLD PIG IRON/70% SCRAP
40% GEN. IRON CARBIDE/60% SCRAP
HISMELT
FINMET
MAUMEE BRIQUETTE RHF

HIGHEST THIRD

ITMK3
REDSMELT RHF
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (100%)
HYLSA IVM SHAFT FCE. DRI (100%)
MIDREX SHAFT FURNACE DRI (100%)
COREX/MIDREX

*NOTE: THROUGH LIQUID STEEL PRODUCTION

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR IRON UNIT*

LOWEST THIRD

GENERIC IRON CARBIDE (100%)
MAUMEE BRIQUETTE RHF
ITMK3
SL/RN ROTARY KILN
CIRCORED
FINMET

MIDDLE THIRD

CIRCOFER
40% GEN. IRON CARBIDE/60% SCRAP
REDSMELT
BLAST FURNACE H.M. - NR COKE
HYLSA IVM (100%)
TECNORED H.M. WITH COGEN
MIDREX SHAFT FCE. DRI (100%)

HIGHEST THIRD

30% MIDREX SHAFT FCE. DRI
HISMELT
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
30% PIG IRON/70% SCRAP
COREX/MIDREX
TECNORED H.M. W/O COGEN

*NOTE: THROUGH PRODUCTION OF IRON UNIT FEED TO EAF

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$100/mt STEEL SCRAP COST

LOWEST THIRD

100% STEEL SCRAP
MAUMEE BRIQUETTE RHF
TECNORED H.M. WITH COGEN
GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - N.R. COKE
ITMK3
GENERIC IRON CARBIDE (40%)

MIDDLE THIRD

SL/RN ROTARY KILN
FINMET
CIRCORED
REDSMELT
CIRCOFER
MIDREX SHAFT FCE. DRI (30%)
BLAST FURNACE H.M. - C.P. COKE

HIGHEST THIRD

MINI BLAST FURNACE
HISMELT
TECNORED H.M. W/O COGEN
HYLSA IVM
30% COLD PIG IRON/70% SCRAP
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$120/mt STEEL SCRAP COST

LOWEST THIRD

MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (100%)
ITMK3
SL/RN ROTARY KILN
FINMET
CIRCORED
CIRCOFER

MIDDLE THIRD

REDSMELT
TECNORED H.M. WITH COGEN
40% GEN. IRON CARBIDE/60% SCRAP
BLAST FURNACE H.M. - NR COKE
HYLSA IVM (100%)
100% STEEL SCRAP
HISMELT

HIGHEST THIRD

30% MIDREX SHAFT FCE. DRI
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FCE. DRI (100%)
TECNORED H.M. W/O COGEN
30% PIG IRON/70% SCRAP
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$140/mt STEEL SCRAP COST

LOWEST THIRD

MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (100%)
ITMK3
FINMET
CIRCORED
SL/RN ROTARY KILN
CIRCOFER

MIDDLE THIRD

REDSMELT
HYLSA IVM
MIDREX SHAFT FCE. DRI (100%)
GENERIC IRON CARBIDE (40%)
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
HISMELT

HIGHEST THIRD

100% STEEL SCRAP
MIDREX SHAFT FURNACE (30%)
COREX/MIDREX
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
TECNORED H.M. W/O COGEN
30% COLD PIG IRON/70% SCRAP

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$100/mt STEEL SCRAP COST

HIGHEST THIRD

100% STEEL SCRAP
TECNORED HM WITH COGEN
TECNORED HM W/O COGEN
30% MINI BLAST FURNACE H.M.
BLAST FCE. H.M. - N.R. COKE
CIRCORED
GENERIC IRON CARBIDE (40%)

MIDDLE THIRD

30% MIDREX SHAFT FCE. DRI/70% SCRAP
CIRCOFER
MAUMEE BRIQUETTE RHF
BLAST FURNACE H.M. - C.P. COKE
FINMET
ITMK3
HISMELT

LOWEST THIRD

30% COLD PIG IRON/70% SCRAP
GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
REDSMELT
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$120/mt STEEL SCRAP COST

HIGHEST THIRD

100% STEEL SCRAP
TECNORED HM WITH COGEN
CIRCORED
CIRCOFER
MAUMEE BRIQUETTE RHF
FINMET
BLAST FCE. H.M. - N.R. COKE

MIDDLE THIRD

ITMK3
MINI BLAST FURNACE
40% GEN. IRON CARBIDE/60% SCRAP
TECNORED W/O COGEN
GENERIC IRON CARBIDE (100%)
30% MIDREX SHAFT FCE. DRI/70% SCRAP
HISMELT

LOWEST THIRD

SL/RN ROTARY KILN
BLAST FURNACE H.M. - CP COKE
REDSMELT
30% COLD PIG IRON/70% SCRAP
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$140/mt STEEL SCRAP COST

HIGHEST THIRD

CIRCORED
CIRCOFER
MAUMEE BRIQUETTE RHF
FINMET
ITMK3
TECNORED H.M. WITH COGEN
GENERIC IRON CARBIDE (100%)

MIDDLE THIRD

SL/RN ROTARY KILN
100% STEEL SCRAP
BLAST FURNACE H.M. - N.R. COKE
GENERIC IRON CARBIDE (40%)
REDSMELT
TECNORED H.M. W/O COGEN
MINI BLAST FURNACE H.M.

LOWEST THIRD

HYLSA IVM
HISMELT
MIDREX SHAFT FURNACE DRI (30%)
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FURNACE DRI (100%)
30% COLD PIG IRON/70% SCRAP
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

Rev. 06-Aug-00

IRONMAKING PROCESSES SORTED BY ESTIMATED TOTAL ELECTRIC POWER CONSUMPTION*

LOWEST THIRD

TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
TECNORED H.M. W/O COGEN
REDSMELT
CIRCOFER
BLAST FURNACE H.M. - C.P. COKE
MINI BLAST FURNACE

MIDDLE THIRD

100% STEEL SCRAP
ITMK3
HISMELT
CIRCORED
FINMET
COREX/MIDREX
MAUMEE BRIQUETTE RHF

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
30% PIG IRON/70% SCRAP
30% MIDREX SHAFT FCE. DRI
40% GENERIC IRON CARBIDE
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED PROCESS ONLY CO2 EVOLUTION*

LOWEST THIRD

100% STEEL SCRAP
30% MIDREX SHAFT FCE. DRI
HISMELT
BLAST FURNACE H.M. - C.P. COKE
MINI BLAST FURNACE
30% COLD PIG IRON/SCRAP
HYLSA IVM

MIDDLE THIRD

BLAST FURNACE H.M. - N.R. COKE
MIDREX SHAFT FCE. DRI (100%)
FINMET
MAUMEE BRIQUETTE RHF
TECNORED H.M. W/O COGEN
TECNORED H.M. WITH COGEN
CIRCORED

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
40% GENERIC IRON CARBIDE/SCRAP
REDSMELT
ITMK3
CIRCOFER
SL/RN ROTARY KILN
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

Rev. 04-Aug-00

IRONMAKING PROCESSES SORTED BY ESTIMATED TOTAL CUMULATIVE CO2 EVOLUTION*

LOWEST THIRD

100% STEEL SCRAP
30% MIDREX SHAFT FCE. DRI
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
HISMELT
BLAST FURNACE - C.P. COKE
MINI BLAST FURNACE

MIDDLE THIRD

TECNORED H.M. W/O COGEN
30% COLD PIG IRON/70% SCRAP
FINMET
REDSMELT
CIRCORED
MAUMEE BRIQUETTE RHF
HYLSA IVM

HIGHEST THIRD

40% GENERIC IRON CARBIDE/SCRAP
GENERIC IRON CARBIDE (100%)
MIDREX SHAFT FURNACE DRI (100%)
ITMK3
CIRCOFER
SL/RN ROTARY KILN
COREX/MIDREX

*NOTE: INCLUDES ELECTRICAL POWER GENERATION EMISSIONS THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

Rev. 04-Aug-00

IRONMAKING PROCESSES SORTED BY RANKING SUM - ENERGY & ENVIRONMENTAL VARIABLES 5-7

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
BLAST FURNACE H.M. - N.R. COKE
BLAST FURNACE H.M. - C.P. COKE
TECNORED H.M. WITH COGEN
HISMELT
MINI BLAST FURNACE
MIDREX SHAFT FCE. DRI (30%)

MIDDLE THIRD

TECNORED H.M. - W/O COGEN
COLD PIG IRON (30%)/SCRAP (70%)
FINMET
REDSMELT
CIRCORED
MAUMEE BRIQUETTE RHF
HYLSA IVM (100%)

HIGHEST THIRD

CIRCOFER
ITMK3
GENERIC IRON CARBIDE (100%)
MIDREX SHAFT FCE. DRI (100%)
GENERIC IRON CARBIDE (40%)
COREX/MIDREX
SL/RN ROTARY KILN

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$100/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
CIRCORED
BLAST FURNACE H.M. - N.R. COKE
MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (40%)
CIRCOFER

MIDDLE THIRD

ITMK3
GENERIC IRON CARBIDE (100%)
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
FINMET
TECNORED H.M. - W/O COGEN
SL/RN ROTARY KILN

HIGHEST THIRD

BLAST FURNACE H.M. - C.P. COKE
REDSMELT
HISMELT
COLD PIG IRON (30%)/SCRAP (70%)
HLYSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$120/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
CIRCORED
MAUMEE BRIQUETTE RHF
CIRCOFER
TECNORED H.M. WITH COGEN
ITMK3
FINMET

MIDDLE THIRD

GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - N.R. COKE
GENERIC IRON CARBIDE (40%)
SL/RN ROTARY KILN
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
REDSMELT

HIGHEST THIRD

TECHNORED H.M. - W/O COGEN
HISMELT
BLAST FURNACE H.M. - C.P. COKE
HYLSA IVM (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

Rev. 07-Aug-00

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$140/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

CIRCORED
MAUMEE BRIQUETTE RHF
CIRCOFER
100% STEEL SCRAP
ITMK3
FINMET
GENERIC IRON CARBIDE (100%)

MIDDLE THIRD

TECNORED H.M. WITH COGEN
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (40%)
BLAST FURNACE H.M. - N.R. COKE
REDSMELT
MIDREX SHAFT FCE. DRI (30%)
MINI BLAST FURNACE H. M. (30%)

HIGHEST THIRD

TECHNORED H.M. - W/O COGEN
HISMELT
HYLSA IVM (100%)
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FCE. DRI (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

Rev. 07-Aug-00

IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$100/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
MINI BLAST FURNACE
MIDREX SHAFT FCE. DRI (30%)
CIRCORED
TECNORED H.M. W/O COGEN

MIDDLE THIRD

MAUMEE BRIQUETTE RHF
BLAST FURNACE H.M. - C.P. COKE
FINMET
HISMELT
CIRCOFER
ITMK3
GENERIC IRON CARBIDE (40%)

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
REDSMELT
COLD PIG IRON (30%)/ SCRAP (70%)
SL/RN ROTARY KILN
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$120/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
CIRCORED
MAUMEE BRIQUETTE RHF
FINMET
MINI BLAST FURNACE H.M. (30%)

MIDDLE THIRD

CIRCOFER
MIDREX SHAFT FCE. DRI (30%)
HISMELT
BLAST FURNACE H.M. - C.P. COKE
ITMK3
TECNORED H.M. - W/O COGEN
GENERIC IRON CARBIDE (100%)

HIGHEST THIRD

REDSMELT
GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
COLD PIG IRON (30%)/ SCRAP (70%)
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$140/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
CIRCORED
BLAST FURNACE H.M. - N.R. COKE
MAUMEE BRIQUETTE RHF
FINMET
CIRCOFER

MIDDLE THIRD

ITMK3
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - C.P. COKE
HISMELT
REDSMELT

HIGHEST THIRD

TECNORED H.M. - W/O COGEN
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (100%)
HYLSA IVM (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

APPENDIX F-4

IRONMAKING PROCESS RELATIVE OPERATING COSTS (OPEX)

F-4 Ironmaking Process Relative Operating Costs (OPEX)

Operating costs for each Ironmaking Process (OPEX) were developed and built up from breakdowns of the operating cost components for each process unit operation in the sequence. That is, from the mines (for iron ore or other components) through ore preparation, the ironmaking process steps and the EAF/LRF to produce the refined liquid steel product. All costs are normalized on the 1.0 million annual metric tonnes of Refined Liquid Steel product basis.

Since the same procedures and common elements, where appropriate, were utilized in developing the estimates of the OPEX for each process, the relative accuracy and precision of these estimates when utilized for comparing the processes is believed to be very good. The built-up OPEX estimates produced in this manner were also compared to historical reported operating costs for the processes, to Vendor-supplied estimates and to internal detailed feasibility estimates prepared by Lockwood Greene for various commercial clients. The built-up estimates, considering differences in commodity and energy cost components, compared closely with those more detailed internal estimates.

The key methodology followed for the Operating Cost Estimates (OPEX) for each process were:

- The primary basis for consumables were the Energy and Mass Balance Spreadsheets (Appendix C).
- Commodity or consumable costs were either local (i.e. Upper Mid-West U.S.A. location) or built up from the individual commodity process components (Appendix F-1).
- Labor rates utilized was from a recent LGE Feasibility Study. It is an all-in rate (including supervision component, overhead and burden) for the Upper Mid-West location.
- Labor man-hours (as man-hours/mt of product) for each of the Process unit operations or steps were either based on Vendor inputs for those process steps or were factored from LGE internal, detailed feasibility studies.

- Other considerations, including: allowances for Outside Boundary Limit (OSBL) facilities and ancillaries, Vendor or Licensing Fees, maintenance spare parts and supplies, etc. were also factored from the recent LGE feasibility studies for the similar process unit operations or steps.
- The factors, as required, were defined utilizing the operating cost components of the detailed internal LGE feasibility studies for the appropriate process operation (i.e. mining, concentration, pelletizing, ironmaking process, EAF, LRF, etc.).

The OPEX spreadsheets for the individual Ironmaking Processes are provided in Appendix F-2. The results are summarized in the tables in this Appendix Section.

LIQUID STEEL PRODUCTION COSTS - STEEL SCRAP SENSITIVITY

Early in the Alternative Ironmaking Process Study it was realized that two factors in developing the OPEX costs needed to be addressed:

- The processes for producing iron units needed to be compared on an equalized basis. That is, processes producing molten iron products needed to be compared to processes producing solid, direct-reduced iron products.
- In addition, a normalized ultimate product (i.e. refined liquid steel from an EAF/LRF process) at a consistent rate of production (i.e. 1.0 million metric tonnes per year of L.S.) was the uniform target rate for all ironmaking processes.

The problem with this, however, is that some of the Ironmaking processes require (or typically are used) with a specified amount of steel scrap as the charge to an EAF. In some cases also, the optimal utilization of the Ironmaking process or the technically-feasible process is not to charge 100% of the iron units from the ironmaking process to the EAF. The balance of the iron units (or requirements for coolant, or product purity, etc.) would come from a combination of recycled and purchased steel scrap.

The cost of steel scrap (a composite scrap charge is assumed as the basis for these EAF processes) has widely fluctuated during the past 2 or 3 years (see Appendix F1.10). As a consequence, when developing an OPEX through the liquid steel production or when trying to compare the relative economic viability of the overall processes (i.e. as a simple Internal Rate of Return calculation), the scrap price (or cost) is a significant variable in this analysis. Therefore, the OPEX costs for production of Liquid Steel are sensitized on the steel scrap price. For the basis of this analysis, costs for steel scrap of \$100, \$120 and \$140 per metric tonne of steel scrap are sensitized in the Summary OPEX tables in this section.

Subsequent financial analyses comparisons of the Alternative Ironmaking Processes (by utilizing a simple Internal Rate of Return calculation) utilized the operating costs reflecting each of the above steel scrap price (i.e. \$100, \$120 and \$140 per metric tonne) sensitivities. **The value of the refined Liquid Steel produced, after EAF steelmaking and LRF treatment, was taken to be \$250 per metric tonne for all of the Internal Rate of Return calculations.** This assumed value of the Liquid Steel (prior to continuous casting and/or hot band production) was consistent for all Alternative Ironmaking Processes. Thus, a relative financial comparison between the various processes could be made,

The OPEX estimates for each process evaluated are summarized and tabulated for each of the steel scrap prices in this Section.

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $100.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$102.80	$67.21	$6.82	$176.83
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$73.64	$59.68	$6.82	$188.64
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$73.64	$60.73	$6.82	$189.99
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$73.66	$53.98	$6.82	$189.65
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$73.66	$53.98	$6.82	$178.23
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$73.66	$61.57	$6.82	$198.05
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$73.66	$52.05	$6.82	$177.67
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$73.66	$52.05	$6.82	$190.98
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$20.84	$75.27		$49.51	$6.82	$228.34
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$81.03	$52.06	$8.31	$190.82

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $100.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$11.81	$46.24	$6.67	$188.31
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$11.81	$58.47	$8.32	$178.76
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$63.75	$45.52	$6.66	$179.90
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$11.81	$61.73	$9.09	$180.74

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $120.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$123.36	$67.21	$6.82	$197.39
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$88.36	$59.68	$6.82	$203.36
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$88.37	$60.73	$6.82	$204.72
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$88.40	$53.98	$6.82	$204.39
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$88.40	$53.98	$6.82	$192.97
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$88.40	$61.57	$6.82	$212.79
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$88.40	$52.05	$6.82	$192.41
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$88.40	$52.05	$6.82	$205.72
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$20.84	$75.27		$49.51	$6.82	$228.34
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$88.40	$52.06	$8.31	$198.19

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $120.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$14.17	$46.24	$6.67	$190.67
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$14.17	$58.47	$8.32	$181.12
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$76.50	$45.52	$6.66	$192.65
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$14.17	$61.73	$9.09	$183.10

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES

SENSITIVITY: $140.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
SHAFT FURNACE DRI PROCESSES:										
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON		$64.31	$24.10	$49.99			$60.17	$6.82	$205.39
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON		$64.39	$24.13	$49.99			$61.09	$6.82	$206.42
C-3	100% STEEL SCRAP CHARGE TO EAF						$143.92	$67.21	$6.82	$217.95
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON		$21.33	$10.30	$16.87		$103.09	$59.68	$6.82	$218.09
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON		$21.34	$10.31	$17.14		$103.10	$60.73	$6.82	$219.45
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF		$64.31	$24.10	$42.76			$58.16	$6.82	$196.15
HOT METAL VARIATIONS										
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$3.99	$18.45			$32.75	$103.13	$53.98	$6.82	$219.12
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$4.07	$10.29			$29.41	$103.13	$53.98	$6.82	$207.70
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$3.99	$18.45			AS PIG $33.56	$103.13	$61.57	$6.82	$227.52
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION			$21.28		$23.86	$103.13	$52.05	$6.82	$207.14
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION			$21.28		$37.17	$103.13	$52.05	$6.82	$220.45
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$41.73		$34.17	$10.67	$75.27		$49.51	$6.82	$218.17
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF		$23.46			$25.96	$103.13	$52.06	$8.31	$212.92

SUMMARY OF RELATIVE OPERATING COSTS - IRONMAKING PROCESSES
(BASIS: 1.00 MM mt/yr LIQUID STEEL PRODUCTION)

SENSITIVITY: $140.00/mt STEEL SCRAP PRICE

SEQ. NO.	PROCESS	COST PER NET MT LIQUID STEEL								
		ORE, OTHER IRON UNITS	CONC. DELIVERED	PELLETIZING/ BRIQUETTING	REDUCTION	HOT METAL PROD.	PURCHASED EAF SCRAP	EAF STEELMKG.	LADLE REFINING	TOTAL LIQ. STEEL
ROTARY HEARTH FURNACES										
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$31.78	$22.33	$38.68	$16.53	$46.24	$6.67	$193.03
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$32.41		$41.93	$32.60			$60.97	$9.12	$177.03
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$30.80		$38.46	$30.90		$16.53	$58.47	$8.32	$183.48
FLUID-BED DRI/HBI										
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.95		$7.58	$78.22			$55.60	$5.92	$185.27
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$36.80		$15.08	$51.00	$38.68		$40.33	$6.66	$188.55
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$37.11		$6.77	$79.72			$55.60	$5.92	$185.12
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF	$36.05			$81.34			$54.53	$5.92	$177.84
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$14.42			$32.54	$17.01	$89.25	$45.52	$6.66	$205.40
OTHER PROCESSES										
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$28.73		$49.07	$20.31		$16.53	$61.73	$9.09	$185.46

APPENDIX F-5

IRONMAKING PROCESS RELATIVE CAPITAL COSTS (CAPEX)

F-5 Ironmaking Process Relative Capital Costs (CAPEX)

The Relative Capital Cost (CAPEX) estimates for each of the Alternative Ironmaking Processes were developed from appropriate sections of several internal LGE Project Feasibility and Detailed Design Studies. The installed cost estimates were factored using the costs for similar scopes for the plant and processing areas involved with each of the Ironmaking Processes.

The costs used were updated to a year 2000 basis and normalized using the process Mass Balances (Appendix C) to a uniform 1.0 million metric tonnes per year Refined Liquid Steel production basis. Specific differences in scope required for a particular process were accounted for in the individual components considered in the overall process CAPEX estimates. The CAPEX is reported as $/annual metric tonne of production.

The built-up CAPEX costs are summarized in this section.

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
SHAFT FURNACE DRI PROCESSES:								
C-1	**100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON**							
	IRON UNIT INPUT:	Concentrate delivered to pelletizing plant.	1.4652					
	INDURATED PELLET PRODUCTION:	Composite of four Vendor quotations for similar scope.	3.3000	$135.0	$40.91			
			3.5000	$155.0	$44.29			
			4.2000	$175.0	$41.67			
			5.0000	$300.0	$60.00			
				AVERAGE:	$46.72	1.7807	$83.19	
	KOBE/MIDREX SHAFT FURNACE:	Composite of three Vendor quotations for similar scope.	4.5000	$670.0	$148.89			
			4.0000	$565.0	$141.25			
			4.5000	$655.0	$145.56			
				AVERAGE:	$145.23	1.0450	$151.77	
	ELECTRIC ARC STEELMAKING/LRF:	Composite of three Vendor quotations for similar scope.	4.9200	$410.0	$83.33			
			4.9200	$385.0	$78.25			
			4.9200	$400.0	$81.30			
				AVERAGE:	$80.96	1.0549	$85.41	
	OUTSIDE BOUNDARY LIMITS:	Includes: ore/concentrate storage, water services, waste disposal, off-gas treatment, offices, labs, etc.	4.0000 (L.S.)	$180.0	$45.00	1.0000	$45.00	**$365.36**
C-2	**100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON**							
	IRON UNIT INPUT:	Same as C-1.	1.4670					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	1.7826	$83.27	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	1.0450	$151.77	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0549	$85.41	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$365.45**

NOTES: (1) 2000 BASIS

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-3	**100% STEEL SCRAP CHARGE TO EAF**							
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$145.23	1.0543	$153.12	
	OUTSIDE BOUNDARY LIMITS:	Includes: scrap receiving/ handling/storage, water services, waste disposal, off-gas treatment, offices, labs, etc. for EAF/LRF only.	4.0000 (L.S.)	$80.0	$20.00	1.0280	$20.56	**$173.68**
C-4	**30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON**							
	IRON UNIT INPUT:	Same as C-1.	0.4860					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	0.7612	$35.56	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	0.3527	$51.22	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0541	$85.34	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$231.85**
C-5	**30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON**							
	IRON UNIT INPUT:	Same as C-1.	0.4863					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	0.7615	$35.57	
	KOBE/MIDREX SHAFT FURNACE:	Same as C-1.			$145.23	0.3584	$52.05	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0542	$85.35	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$232.70**
C-6	**HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF**							
	IRON UNIT INPUT:	Same as C-1.	1.4650					
	INDURATED PELLET PRODUCTION:	Same as C-1.			$46.72	1.7807	$83.19	
	HYLIVM SHAFT FURNACE:	Composite of two Vendor	4.2000	$612.0	$145.71			
		quotations for similar scope.	2.8000	$390.8	$139.56			
				AVERAGE:	$142.64	1.0450	$149.05	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$362.60**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
HOT METAL VARIATIONS								
C-7	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE**							
	IRON UNIT INPUT:	Lump ore, Pellets, Sinter, Scrap,	0.1054					
		etc. delivered to stockpiles	0.2097					
		with reclaim and handling systems	0.2097					
		included in OSBL.	0.0337					
	INTEGRATED BLAST FURNACE:	Based on Vendor quotation.	2.3100	$635.00	$275.00	0.3584	$98.56	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0542	$85.35	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7364	$14.73	**$243.64**
C-7a	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE (MINI BLAST FURNACE FOR REFERENCE)**							
	IRON UNIT INPUT:	Same as C-7.						
	MINI BLAST FURNACE FACILITY:	Based on Vendor quotation.	0.9000	$133.05	$147.83	0.3584	$52.98	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$198.05**
C-8	**30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE**							
	IRON UNIT INPUT:	Same as C-7.						
	INTEGRATED BLAST FURNACE:	Same as C-7.			$275.00	0.3584	$98.56	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$243.63**
C-9	**30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG**							
	IRON UNIT INPUT:	Same as C-7.						
	INTEGRATED BLAST FURNACE:	Same as C-7.			$275.00	0.3584	$98.56	
	PIG IRON CASTING/HANDLING:	Based on Vendor quotation.	3.5600	$44.0	$12.36	0.3584	$4.43	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0540	$85.33	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$248.06**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-10	**30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION**							
	IRON UNIT INPUT (AS FINE ORE):	Iron ore fines received into stockpiles with reclaim systems to green-ball pelletizing.	0.5080					
	GREEN-BALL PELLET PRODUCTION:	Internal LGE cost estimate for confidential client.	0.3020	$14.1	$46.62	0.6377	$29.73	
	TECHNORED FURNACE & ANCILLARIES:	Internal LGE cost estimate for confidential client.	0.3020	$29.5	$97.59	0.3584	$34.98	
	CO-GENERATION:	Internal LGE cost estimate for confidential client.	0.3020	$7.4	$24.57	0.3584	$8.81	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0540	$63.24	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$196.48**
C-11	**30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	0.5080					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10.	0.3020	$14.1	$46.62	0.6377	$29.73	
	TECHNORED FURNACE & ANCILLARIES:	Same as C-10.	0.3020	$29.5	$97.68	0.3584	$35.01	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0540	$63.24	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$187.71**
C-12	**COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF**							
	IRON UNIT INPUT (COREX):	Iron ore as lump and as pellets are on a purchased basis.	0.4313 0.4313					
	MIDREX SHAFT FURNACE:	Iron ore pellets are purchased.	0.7124					
	COREX FURNACE & ANCILLARIES:	Based on Vendor quotation.	0.3020	$104.1	$344.83	0.6237	$215.07	
	MIDREX SHAFT FURNACE:	Same as C-1.	0.1480	$17.8	$120.00	0.4180	$50.16	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$60.00	1.0545	$63.27	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	**$373.50**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-13	**HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	0.5345					
	HISMELT SRV FURNACE:	Based on Vendor quotation.	0.3650	$116.6	$319.45	0.3585	$114.52	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0545	$85.37	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.7366	$14.73	**$259.63**
ROTARY HEARTH FURNACES								
C-14	**REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (AS FINE ORE):	Same as C-10.	1.4545					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10 with adjustments.			$23.32	2.0653	$48.16	
	ROTARY HEARTH REDUCTION FCE.:	Based on three Vendor quotations.	0.3020	$42.2	$139.67			
			3.4000	$465.0	$136.76			
			1.2500	$166.2	$132.98			
				AVERAGE:	$136.47	1.0261	$140.03	
	SUBMERGED ARC MELTING FURNACE:	Based on three Vendor quotations.	0.3020	$14.0	$46.36			
			3.4000	$160.0	$47.06			
			1.2500	$53.1	$42.50			
				AVERAGE:	$45.31	0.9112	$41.28	
	ELECTRIC ARC STEELMAKING/LRF:	Based on internal LGE estimate.	1.2500	$75.0	$60.00	1.0032	$60.19	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.1544	$3.09	**$334.67**
C-15	**MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF**							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.5735					
	GREEN BRIQUETTE PRODUCTION:	Based on Vendor quotation.	0.1200	$4.3	$35.83	1.9932	$71.42	
	ROTARY HEARTH REDUCTION FCE.:	Based on Vendor quotation.	0.1200	$14.5	$120.83	1.1217	$135.54	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-3.			$45.00	1.0000	$45.00	**$292.32**

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.4535					
	GREEN BRIQUETTE PRODUCTION:	Same as C-10 with adjustments.			$23.32	1.8809	$43.86	
	ROTARY HEARTH REDUCTION FCE.:	Based on Vendor quotation.	0.6000	$100.0	$166.67	1.0261	$171.02	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0032	$81.22	
	OUTSIDE BOUNDARY LIMITS:	Same as C-3.			$45.00	1.0000	$45.00	$296.10
FLUID-BED DRI/HBI								
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7905					
	MICRO-PELLET PRODUCTION:	Based on Vendor quotation.	4.0000	$40.0	$10.00	1.5340	$15.34	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$420.0	$105.00	1.0890	$114.35	
	HOT BRIQUETTING:	Based on Vendor quotation.	4.0000	$120.0	$30.00	1.0890	$32.67	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-1.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	$232.37
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7387					
	MICRO-PELLET PRODUCTION:	Same as C-17.			$10.00	1.5340	$15.34	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$466.6	$116.65	1.0890	$127.03	
	SUBMERGED ARC MELTING FURNACE:	Same as C-14.			$45.31	1.0890	$49.34	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$60.00	1.0543	$63.26	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	$239.63
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7511					
	MICRO-PELLET PRODUCTION:	Based on Vendor quotation.	4.0000	$40.0	$10.00	1.5091	$15.09	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	4.0000	$649.0	$162.25	1.0890	$176.69	
	HOT BRIQUETTING:	Based on Vendor quotation.	4.0000	$180.0	$45.00	1.0890	$49.01	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$35.83	1.0543	$37.78	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$30.00	1.0000	$30.00	$263.47

CAPITAL COST ESTIMATE BASIS - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	COST PER ANNUAL MT LIQUID STEEL PRODUCTION						
		BASIS FOR COST	CAPACITY (MM mt/yr)	INSTALLED COST(1)	COST PER ANNUAL mt	mt UNIT/ mt LIQ. ST.	UNIT CST./ mt LIQ. ST.	TOTAL SCOPE
C-20a	GENERIC IRON CARBIDE/EAF							
	RECYCLE SCRAP CHARGE TO EAF (2)							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.7011					
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	3.9600	$700.0	$176.77	1.2289	$217.23	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	$347.59
C-20b	GENERIC IRON CARBIDE/SAF/EAF							
	60% SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	0.6804					
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	3.9600	$700.0	$176.77	0.4916	$86.90	
	SUBMERGED ARC MELTING FURNACE:	Same as C-14.			$45.31	1.0890	$49.34	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$60.00	1.0543	$63.26	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.6375	$12.75	$257.24
OTHER PROCESSES								
C-21	SL/RN ROTARY KILN WITH ONLY							
	RECYCLE SCRAP CHARGE TO EAF							
	IRON UNIT INPUT (FINE ORE, ETC.):	Same as C-10.	1.3560					
	GREEN-BALL PELLET PRODUCTION:	Same as C-10.			$46.62	2.0137	$93.88	
	FLUIDIZED-BED FINES REDUCTION:	Based on Vendor quotation.	2.8000	$350.0	$125.00	0.9365	$117.06	
	ELECTRIC ARC STEELMAKING/LRF:	Same as C-14.			$80.96	1.0543	$85.36	
	OUTSIDE BOUNDARY LIMITS:	Same as C-1.			$45.00	1.0000	$45.00	
	SCRAP RECEIVING/HANDLING:	Same as C-3.			$20.00	0.1544	$3.09	$344.39

NOTE: (2) 100% IC CHARGE HAS NOT BEEN PROVEN TO BE FEASIBLE.

APPENDIX F-6

SORTING OF PROCESSES

BY CAPITAL COSTS/ANNUAL MT L.S.

BY IRON UNIT COSTS/MT I.U.

BY OPERATING COST/MT L.S.

BY INTERNAL RATE OF RETURN

BY TOTAL ELECTRICAL POWER REQUIRED

BY TOTAL CUMULATIVE CO_2 EMISSIONS – PROCESS ONLY

BY TOTAL CUMULATIVE CO_2 EMISSIONS – TOTAL INCLUDING ELECTRICAL POWER GENERATION

F-6 Sorting of Processes

In order to compare the merits of each of the Ironmaking Processes considered (i.e. 21 total processes through Refined Liquid Steel production) with each other on an equalized basis, a Sorting and Ranking procedure was utilized. The procedures utilized are described below and in Appendix G:

Sort on Variables

The following specific variables (from the previous Appendix F sections) for each process were utilize to sort and rank the processes:

- Capital Costs (CAPEX, as $/annual metric tonne Liquid Steel product)
- Operating Costs to produce Iron Units (OPEX I.U. as $/metric tonne iron product to EAF steelmaking)
- Operating Costs to produce Refined Liquid Steel (OPEX L.S. as $/metric tonne Refined Liquid Steel product)
- Simple Internal Rate of Return (I.R.R. based on a $250 in-process value/metric tonne Liquid Steel product, all CAPEX in year 1 and full production for years 2-21)
- Total Electric Power (Cumulative total electric power consumption for all sub-processes to produce the Refined Liquid Steel product for each alternative)
- Total Cumulative CO_2 Emissions for the Process only (all fuel gas and carbon component emissions for all of the sub-processes, expressed as the CO_2 equivalent through the Refined Liquid product)
- Total Cumulative CO_2 Emissions (the sum of the Process CO_2 emissions and the equivalent CO_2 emissions for the Total Electric Power required) (Reference Appendix A3.1 based on North American average generation fuel distributions)

The various Alternative Ironmaking Processes were resequenced such that minor variations of specific processes considered (e.g. 2.5 wt.% carbon DRI, Appendix C-2 and C-4) were not considered in the sorting and ranking. The listings of the processes were sorted by the index variables above based on these resequenced tabulations.

These sorted listings were grouped into three groupings for each variable:

- LOWEST THIRD - A grouping of the lowest seven processes by the variable of interest.
- MIDDLE THIRD - A grouping of the middle seven processes by the variable of interest.
- HIGHEST THIRD - A grouping of the highest seven processes by the variable of interest.

Within each grouping, the processes are in sequence with the lowest first and the highest last. Thus the first process sorted in the Lowest Group (for all variables except the I.R.R.) would be the "best" process by that index variable. Similarly, the last process in the Highest Group (except for the I.R.R) would be the "worst" process by that index variable. By examining the processes in each grouping some consensus as to the most desirable and perhaps the least desirable Alternative Ironmaking Processes might be gained (based on the index variable sensitivities).

Since the cost-related variables of OPEX L.S. and the I.R.R. are a significant function of the Steel Scrap Price, sensitivities for these variables at $100, $120 and $140 per metric tonnes of steel scrap were done to clarify the impact of this key sub-variable (Reference Appendix F1.10).

The tabulations for each of these sorts are provided in this section.

CAPITAL AND OPERATING COST ESTIMATES - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN
SHAFT FURNACE DRI PROCESSES:					
C-1	100% SHAFT FURNACE DRI CHARGE TO EAF, 1.0 WT.% CARBON	$365.36	$132.44	$205.39	10.57%
C-2	100% SHAFT FURNACE DRI CHARGE TO EAF, 2.5 WT.% CARBON	$365.45	$132.55	$206.42	10.22%
C-3	100% STEEL SCRAP CHARGE TO EAF	$173.68	$0.00	$197.39	30.14%
C-4	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 1.0 WT.% DRI CARBON	$231.85	$137.51	$203.36	19.55%
C-5	30% SHAFT FURNACE DRI/70% SCRAP TO EAF, 2.5 WT.% DRI CARBON	$232.70	$136.14	$204.72	18.84%
C-6	HYLSA SHAFT FURNACE WITHOUT REFORMER, HOT DRI CHARGE TO EAF	$362.60	$125.52	$196.15	13.72%
HOT METAL VARIATIONS					
C-7	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, CO-PRODUCT COKE	$243.64	$142.86	$204.39	18.04%
C-7a	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, MINI BLAST FURNACE	$198.05	$142.86	$204.39	22.64%
C-8	30% BLAST FURNACE HOT METAL/70% SCRAP TO EAF, N.R. COKE	$243.63	$110.77	$192.97	23.04%
C-9	30% COLD PIG IRON/70% SCRAP TO EAF, 4.5% CARBON PIG	$248.06	$145.12	$212.79	13.89%
C-10	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITH CO-GENERATION	$196.48	$125.95	$192.41	29.14%
C-11	30% TECNORED HOT METAL/70% SCRAP TO EAF, WITHOUT CO-GENERATION	$187.71	$163.09	$205.72	23.23%
C-12	COREX/MIDREX WITH 60% HOT METAL 40% DRI CHARGE TO EAF	$373.50	$208.88	$228.34	1.46%
C-13	HISMELT WITH 32.7% HOT METAL TO CHARGE TO EAF	$259.63	$137.85	$198.19	19.38%
ROTARY HEARTH FURNACES					
C-14	REDSMELT HOT METAL WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$334.67	$101.83	$190.67	16.96%
C-15	MAUMEE BRIQUETTE DRI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$292.32	$66.44	$177.03	24.66%

CAPITAL AND OPERATING COST ESTIMATES - IRONMAKING PROCESSES

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN
C-16	ITMK3 TO EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$296.10	$67.60	$181.12	22.89%
FLUID-BED DRI/HBI					
C-17	CIRCORED/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$232.37	$78.79	$185.27	27.64%
C-18	CIRCOFER/HBI/SAF/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$239.63	$96.20	$188.55	25.37%
C-19	FINMET/HBI/EAF WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$263.47	$79.42	$185.12	24.31%
C-20a	GENERIC IRON CARBIDE/EAF RECYCLE SCRAP CHARGE TO EAF (2)	$347.59	$66.19	$177.84	20.24%
C-20b	GENERIC IRON CARBIDE/SAF/EAF 60% SCRAP CHARGE TO EAF	$257.24	$100.79	$192.65	21.87%
OTHER PROCESSES					
C-21	SL/RN ROTARY KILN WITH ONLY RECYCLE SCRAP CHARGE TO EAF	$344.39	$74.08	$183.10	18.81%

NOTES: (1) Operating costs based on purchased scrap composite price of $120/mt.
(2) Sales (or transfer) price of Liquid Steel taken to be ($/mt). $250.00
(3) Internal Rate of Return Scenario based on 1.00 MM mt/year production of liquid refined steel (as caster feed). Project life is 21 years and all Capital investment is in year 1, with full production and revenue in years 2 through 21.

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON CAPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
HIGHEST THIRD								
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$208.88	$228.34	1.46%	942.91	3.1398	3.9998

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON I.U. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
MIDDLE THIRD								
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
HIGHEST THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
HIGHEST THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
MIDDLE THIRD								
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
LOWEST THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON TOTAL ELECTRICITY

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
MIDDLE THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
HIGHEST THIRD								
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON PROCESS CO2

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
MIDDLE THIRD								
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
HIGHEST THIRD								
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - TOTAL CUMULATIVE CO2

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$197.39	30.14%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$203.36	19.55%	1,030.37	0.4283	1.3681
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$192.41	29.14%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$192.97	23.04%	660.35	0.9594	1.5615
12	HISMELT 32.7% H.M.	$259.63	$137.85	$198.19	19.38%	847.37	0.8689	1.6418
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$204.39	18.04%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.	$198.05	$142.86	$204.39	22.64%	795.44	0.8974	1.6746
MIDDLE THIRD								
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$205.72	20.25%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$212.79	13.89%	1002.39	0.9027	1.8170
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
13	REDSMELT	$334.67	$101.83	$190.67	16.96%	690.28	1.3624	1.9921
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
HIGHEST THIRD								
20	GENERIC I.C. (40%)/SAF/EAF	$257.24	$100.79	$192.65	21.87%	1185.22	1.3320	2.0648
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$181.12	22.89%	825.40	1.5213	2.2742
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
21	SL/RN ROTARY KILN	$344.39	$74.08	$183.10	18.81%	999.74	2.2869	3.1988
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.16	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
MIDDLE THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
HIGHEST THIRD								
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$176.83	42.09%	822.45	0.0874	0.8909
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$177.67	36.74%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$190.98	31.30%	685.69	1.1545	1.7799
6	30% MINI-BF H.M.*	$198.05	$142.86	$189.65	30.32%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$178.23	29.28%	660.35	0.9594	1.5615
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$179.90	27.02%	1185.22	1.3320	2.0648
MIDDLE THIRD								
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$188.64	26.21%	1,030.37	0.4283	1.3681
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$189.65	24.46%	795.44	0.8974	1.6746
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$178.76	23.72%	825.40	1.5213	2.2742
12	HISMELT 32.7% H.M.	$259.63	$137.85	$190.82	22.39%	847.37	0.8689	1.6418
LOWEST THIRD								
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$198.05	20.43%	1002.39	0.9027	1.8170
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
21	SL/RN ROTARY KILN	$344.39	$74.08	$180.74	19.55%	999.74	2.2869	3.1988
13	REDSMELT	$334.67	$101.83	$188.31	17.73%	690.28	1.3624	1.9921
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - RESEQUENCED

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORT ON L.S. OPEX

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
LOWEST THIRD								
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
MIDDLE THIRD								
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
HIGHEST THIRD								
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170

VARIABLES FOR RANKING OF IRONMAKING PROCESSES - SORTED ON I.R.R.

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX ($/ANN. mt L.S.)	OPEX FOR I.U. ($/ANN. mt I.U.)	OPEX FOR L.S. ($/ANN. mt L.S.)	INTERNAL RATE OF RETURN	TOTAL ELEC. (kWhr/mt LS)	PROCESS CO2 (mt/mt LS)	TOTAL CO2 (mt/mt LS)
HIGHEST THIRD								
16	CIRCORED/HBI/EAF	$232.37	$78.79	$185.27	27.64%	900.84	1.1999	2.0217
17	CIRCOFER/HBI/SAF/EAF	$239.63	$96.20	$188.55	25.37%	780.99	1.6404	2.3528
14	MAUMEE BRIQUETTE DRI/EAF	$292.32	$66.44	$177.03	24.66%	966.09	1.1498	2.0310
18	FINMET/HBI/EAF	$263.47	$79.42	$185.12	24.31%	907.76	1.0742	1.9022
15	ITMK3 DR SHOT TO EAF	$296.10	$67.60	$183.48	22.05%	825.40	1.5213	2.2742
9	30% TECNORED H.M. W COGEN	$196.48	$125.95	$207.14	21.36%	307.58	1.1545	1.4350
19	GENERIC IRON CARBIDE (100%)/EAF	$347.59	$66.19	$177.84	20.24%	972.95	1.2864	2.1738
MIDDLE THIRD								
21	SL/RN ROTARY KILN	$344.39	$74.08	$185.46	18.06%	999.74	2.2869	3.1988
2	100% STEEL SCRAP	$173.68	$0.00	$217.95	17.75%	822.45	0.0874	0.8909
7	30% BF H.M./70% SCRAP NR COKE	$243.63	$110.77	$207.70	16.55%	660.35	0.9594	1.5615
20	GENERIC I.C. (40%)/SAF/EAF*	$257.24	$100.79	$205.40	16.52%	1185.22	1.3320	2.0648
13	REDSMELT	$334.67	$101.83	$193.03	16.17%	690.28	1.3624	1.9921
10	30% TECNORED H.M. W/O COGEN	$187.71	$163.09	$220.45	14.74%	685.69	1.1545	1.7799
6	30% MINI-BF H.M.*	$198.05	$142.86	$219.12	14.56%	795.44	0.8974	1.6746
LOWEST THIRD								
4	HYLSA IVM	$362.60	$125.52	$196.15	13.72%	1,267.37	0.9086	2.0646
12	HISMELT 32.7% H.M.	$259.63	$137.85	$212.92	13.05%	847.37	0.8689	1.6418
3	30% DRI, 1.0% C/70% SCRAP	$231.85	$137.51	$218.09	12.45%	1,030.37	0.4283	1.3681
5	30% BF H.M./70% SCRAP CP COKE	$243.64	$142.86	$219.12	11.14%	795.44	0.8974	1.6746
1	100% DRI, 1.0% C, MIDREX	$365.36	$132.44	$205.39	10.57%	1,326.73	1.0514	2.2617
8	30% COLD PIG IRON/70% SCRAP	$248.06	$145.12	$227.52	6.48%	1002.39	0.9027	1.8170
11	COREX/MIDREX WITH 60% H.M.	$373.50	$161.83	$218.17	5.72%	942.91	2.9239	3.7839

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE CAPITAL COSTS*

LOWEST THIRD

100% STEEL SCRAP
TECHNORED W/O COGEN
TECHNORED WITH COGEN
MINI BLAST FURNACE
30% DRI/70% STEEL SCRAP
CIRCORED
CIRCOFER

MIDDLE THIRD

BLAST FURNACE - N.R. COKE
BLAST FURNACE - C.P. COKE
30% COLD PIG IRON/70% SCRAP
40% GEN. IRON CARBIDE/60% SCRAP
HISMELT
FINMET
MAUMEE BRIQUETTE RHF

HIGHEST THIRD

ITMK3
REDSMELT RHF
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (100%)
HYLSA IVM SHAFT FCE. DRI (100%)
MIDREX SHAFT FURNACE DRI (100%)
COREX/MIDREX

*NOTE: THROUGH LIQUID STEEL PRODUCTION

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR IRON UNIT*

LOWEST THIRD

GENERIC IRON CARBIDE (100%)
MAUMEE BRIQUETTE RHF
ITMK3
SL/RN ROTARY KILN
CIRCORED
FINMET

MIDDLE THIRD

CIRCOFER
40% GEN. IRON CARBIDE/60% SCRAP
REDSMELT
BLAST FURNACE H.M. - NR COKE
HYLSA IVM (100%)
TECNORED H.M. WITH COGEN
MIDREX SHAFT FCE. DRI (100%)

HIGHEST THIRD

30% MIDREX SHAFT FCE. DRI
HISMELT
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
30% PIG IRON/70% SCRAP
COREX/MIDREX
TECNORED H.M. W/O COGEN

*NOTE: THROUGH PRODUCTION OF IRON UNIT FEED TO EAF

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IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$100/mt STEEL SCRAP COST

LOWEST THIRD

100% STEEL SCRAP
MAUMEE BRIQUETTE RHF
TECNORED H.M. WITH COGEN
GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - N.R. COKE
ITMK3
GENERIC IRON CARBIDE (40%)

MIDDLE THIRD

SL/RN ROTARY KILN
FINMET
CIRCORED
REDSMELT
CIRCOFER
MIDREX SHAFT FCE. DRI (30%)
BLAST FURNACE H.M. - C.P. COKE

HIGHEST THIRD

MINI BLAST FURNACE
HISMELT
TECNORED H.M. W/O COGEN
HYLSA IVM
30% COLD PIG IRON/70% SCRAP
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$120/mt STEEL SCRAP COST

LOWEST THIRD

MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (100%)
ITMK3
SL/RN ROTARY KILN
FINMET
CIRCORED
CIRCOFER

MIDDLE THIRD

REDSMELT
TECNORED H.M. WITH COGEN
40% GEN. IRON CARBIDE/60% SCRAP
BLAST FURNACE H.M. - NR COKE
HYLSA IVM (100%)
100% STEEL SCRAP
HISMELT

HIGHEST THIRD

30% MIDREX SHAFT FCE. DRI
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FCE. DRI (100%)
TECNORED H.M. W/O COGEN
30% PIG IRON/70% SCRAP
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

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IRONMAKING PROCESSES SORTED BY ESTIMATED RELATIVE OPERATING COSTS FOR LIQUID STEEL*

$140/mt STEEL SCRAP COST

LOWEST THIRD

MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (100%)
ITMK3
FINMET
CIRCORED
SL/RN ROTARY KILN
CIRCOFER

MIDDLE THIRD

REDSMELT
HYLSA IVM
MIDREX SHAFT FCE. DRI (100%)
GENERIC IRON CARBIDE (40%)
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
HISMELT

HIGHEST THIRD

100% STEEL SCRAP
MIDREX SHAFT FURNACE (30%)
COREX/MIDREX
MINI BLAST FURNACE
BLAST FURNACE H.M. - C.P. COKE
TECNORED H.M. W/O COGEN
30% COLD PIG IRON/70% SCRAP

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$100/mt STEEL SCRAP COST

HIGHEST THIRD

100% STEEL SCRAP
TECNORED HM WITH COGEN
TECNORED HM W/O COGEN
30% MINI BLAST FURNACE H.M.
BLAST FCE. H.M. - N.R. COKE
CIRCORED
GENERIC IRON CARBIDE (40%)

MIDDLE THIRD

30% MIDREX SHAFT FCE. DRI/70% SCRAP
CIRCOFER
MAUMEE BRIQUETTE RHF
BLAST FURNACE H.M. - C.P. COKE
FINMET
ITMK3
HISMELT

LOWEST THIRD

30% COLD PIG IRON/70% SCRAP
GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
REDSMELT
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$120/mt STEEL SCRAP COST

HIGHEST THIRD

100% STEEL SCRAP
TECNORED HM WITH COGEN
CIRCORED
CIRCOFER
MAUMEE BRIQUETTE RHF
FINMET
BLAST FCE. H.M. - N.R. COKE

MIDDLE THIRD

ITMK3
MINI BLAST FURNACE
40% GEN. IRON CARBIDE/60% SCRAP
TECNORED W/O COGEN
GENERIC IRON CARBIDE (100%)
30% MIDREX SHAFT FCE. DRI/70% SCRAP
HISMELT

LOWEST THIRD

SL/RN ROTARY KILN
BLAST FURNACE H.M. - CP COKE
REDSMELT
30% COLD PIG IRON/70% SCRAP
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

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IRONMAKING PROCESSES SORTED BY SIMPLE INTERNAL RATE OF RETURN*

$140/mt STEEL SCRAP COST

HIGHEST THIRD

CIRCORED
CIRCOFER
MAUMEE BRIQUETTE RHF
FINMET
ITMK3
TECNORED H.M. WITH COGEN
GENERIC IRON CARBIDE (100%)

MIDDLE THIRD

SL/RN ROTARY KILN
100% STEEL SCRAP
BLAST FURNACE H.M. - N.R. COKE
GENERIC IRON CARBIDE (40%)
REDSMELT
TECNORED H.M. W/O COGEN
MINI BLAST FURNACE H.M.

LOWEST THIRD

HYLSA IVM
HISMELT
MIDREX SHAFT FURNACE DRI (30%)
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FURNACE DRI (100%)
30% COLD PIG IRON/70% SCRAP
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED TOTAL ELECTRIC POWER CONSUMPTION*

LOWEST THIRD

TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
TECNORED H.M. W/O COGEN
REDSMELT
CIRCOFER
BLAST FURNACE H.M. - C.P. COKE
MINI BLAST FURNACE

MIDDLE THIRD

100% STEEL SCRAP
ITMK3
HISMELT
CIRCORED
FINMET
COREX/MIDREX
MAUMEE BRIQUETTE RHF

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
30% PIG IRON/70% SCRAP
30% MIDREX SHAFT FCE. DRI
40% GENERIC IRON CARBIDE
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY ESTIMATED PROCESS ONLY CO2 EVOLUTION*

LOWEST THIRD

100% STEEL SCRAP
30% MIDREX SHAFT FCE. DRI
HISMELT
BLAST FURNACE H.M. - C.P. COKE
MINI BLAST FURNACE
30% COLD PIG IRON/SCRAP
HYLSA IVM

MIDDLE THIRD

BLAST FURNACE H.M. - N.R. COKE
MIDREX SHAFT FCE. DRI (100%)
FINMET
MAUMEE BRIQUETTE RHF
TECNORED H.M. W/O COGEN
TECNORED H.M. WITH COGEN
CIRCORED

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
40% GENERIC IRON CARBIDE/SCRAP
REDSMELT
ITMK3
CIRCOFER
SL/RN ROTARY KILN
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

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IRONMAKING PROCESSES SORTED BY ESTIMATED TOTAL CUMULATIVE CO_2 EVOLUTION*

LOWEST THIRD

100% STEEL SCRAP
30% MIDREX SHAFT FCE. DRI
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
HISMELT
BLAST FURNACE - C.P. COKE
MINI BLAST FURNACE

MIDDLE THIRD

TECNORED H.M. W/O COGEN
30% COLD PIG IRON/70% SCRAP
FINMET
REDSMELT
CIRCORED
MAUMEE BRIQUETTE RHF
HYLSA IVM

HIGHEST THIRD

40% GENERIC IRON CARBIDE/SCRAP
GENERIC IRON CARBIDE (100%)
MIDREX SHAFT FURNACE DRI (100%)
ITMK3
CIRCOFER
SL/RN ROTARY KILN
COREX/MIDREX

*NOTE: INCLUDES ELECTRICAL POWER GENERATION EMISSIONS THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

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IRONMAKING PROCESSES SORTED BY RANKING SUM - ENERGY & ENVIRONMENTAL VARIABLES 5-7

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
BLAST FURNACE H.M. - N.R. COKE
BLAST FURNACE H.M. - C.P. COKE
TECNORED H.M. WITH COGEN
HISMELT
MINI BLAST FURNACE
MIDREX SHAFT FCE. DRI (30%)

MIDDLE THIRD

TECNORED H.M. - W/O COGEN
COLD PIG IRON (30%)/SCRAP (70%)
FINMET
REDSMELT
CIRCORED
MAUMEE BRIQUETTE RHF
HYLSA IVM (100%)

HIGHEST THIRD

CIRCOFER
ITMK3
GENERIC IRON CARBIDE (100%)
MIDREX SHAFT FCE. DRI (100%)
GENERIC IRON CARBIDE (40%)
COREX/MIDREX
SL/RN ROTARY KILN

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$100/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
CIRCORED
BLAST FURNACE H.M. - N.R. COKE
MAUMEE BRIQUETTE RHF
GENERIC IRON CARBIDE (40%)
CIRCOFER

MIDDLE THIRD

ITMK3
GENERIC IRON CARBIDE (100%)
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
FINMET
TECNORED H.M. - W/O COGEN
SL/RN ROTARY KILN

HIGHEST THIRD

BLAST FURNACE H.M. - C.P. COKE
REDSMELT
HISMELT
COLD PIG IRON (30%)/SCRAP (70%)
HLYSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$120/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
CIRCORED
MAUMEE BRIQUETTE RHF
CIRCOFER
TECNORED H.M. WITH COGEN
ITMK3
FINMET

MIDDLE THIRD

GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - N.R. COKE
GENERIC IRON CARBIDE (40%)
SL/RN ROTARY KILN
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
REDSMELT

HIGHEST THIRD

TECHNORED H.M. - W/O COGEN
HISMELT
BLAST FURNACE H.M. - C.P. COKE
HYLSA IVM (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - COST-RELATED VARIABLES 1-4

$140/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

CIRCORED
MAUMEE BRIQUETTE RHF
CIRCOFER
100% STEEL SCRAP
ITMK3
FINMET
GENERIC IRON CARBIDE (100%)

MIDDLE THIRD

TECNORED H.M. WITH COGEN
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (40%)
BLAST FURNACE H.M. - N.R. COKE
REDSMELT
MIDREX SHAFT FCE. DRI (30%)
MINI BLAST FURNACE H. M. (30%)

HIGHEST THIRD

TECHNORED H.M. - W/O COGEN
HISMELT
HYLSA IVM (100%)
BLAST FURNACE H.M. - C.P. COKE
MIDREX SHAFT FCE. DRI (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

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IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$100/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
MINI BLAST FURNACE
MIDREX SHAFT FCE. DRI (30%)
CIRCORED
TECNORED H.M. W/O COGEN

MIDDLE THIRD

MAUMEE BRIQUETTE RHF
BLAST FURNACE H.M. - C.P. COKE
FINMET
HISMELT
CIRCOFER
ITMK3
GENERIC IRON CARBIDE (40%)

HIGHEST THIRD

GENERIC IRON CARBIDE (100%)
REDSMELT
COLD PIG IRON (30%)/ SCRAP (70%)
SL/RN ROTARY KILN
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$120/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
BLAST FURNACE H.M. - N.R. COKE
CIRCORED
MAUMEE BRIQUETTE RHF
FINMET
MINI BLAST FURNACE H.M. (30%)

MIDDLE THIRD

CIRCOFER
MIDREX SHAFT FCE. DRI (30%)
HISMELT
BLAST FURNACE H.M. - C.P. COKE
ITMK3
TECNORED H.M. - W/O COGEN
GENERIC IRON CARBIDE (100%)

HIGHEST THIRD

REDSMELT
GENERIC IRON CARBIDE (100%)
SL/RN ROTARY KILN
COLD PIG IRON (30%)/ SCRAP (70%)
HYLSA IVM (100%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

IRONMAKING PROCESSES SORTED BY RANKING SUM - ALL VARIABLES SUMMED 1-7

$140/mt STEEL SCRAP COST

RANKING VARIABLES

1 = INSTALLED CAPITAL COST
2 = OPERATING COST PER IRON UNIT
3 = OPERATING COST PER MT LIQUID STEEL
4 = SIMPLE INTERNAL RATE OF RETURN
5 = CUMULATIVE ELECTRICAL POWER
6 = CUMULATIVE PROCESS C02 EMISSIONS
7 = TOTAL CUMULATIVE CO2 EMISSIONS

LOWEST THIRD

100% STEEL SCRAP
TECNORED H.M. WITH COGEN
CIRCORED
BLAST FURNACE H.M. - N.R. COKE
MAUMEE BRIQUETTE RHF
FINMET
CIRCOFER

MIDDLE THIRD

ITMK3
MINI BLAST FURNACE H.M. (30%)
MIDREX SHAFT FCE. DRI (30%)
GENERIC IRON CARBIDE (100%)
BLAST FURNACE H.M. - C.P. COKE
HISMELT
REDSMELT

HIGHEST THIRD

TECNORED H.M. - W/O COGEN
SL/RN ROTARY KILN
GENERIC IRON CARBIDE (100%)
HYLSA IVM (100%)
COLD PIG IRON (30%)/ SCRAP (70%)
MIDREX SHAFT FCE. DRI (100%)
COREX/MIDREX

*NOTE: THROUGH PRODUCTION OF EAF/LRF LIQUID STEEL

APPENDIX G

RANKING OF PROCESSES

G-1: TABULATIONS:

VARIABLE 1: BY CAPITAL COSTS/ANNUAL MT L.S.

VARIABLE 2: BY IRON UNIT COSTS/MT I.U.

VARIABLE 3: BY OPERATING COST/MT L.S.

VARIABLE 4: BY INTERNAL RATE OF RETURN

VARIABLE 5: BY TOTAL ELECTRICAL POWER REQUIRED

VARIABLE 6: BY TOTAL CUMULATIVE CO_2 EMISSIONS - PROCESS ONLY

VARIABLE7: BY TOTAL CUMULATIVE CO_2 EMISSIONS - TOTAL INCLUDING ELECTRICAL POWER GENERATION

G-2: VISUAL GROUPINGS OF SORTED AND RANKED VARIABLES

Appendix G: Rankings Of Processes

G-1 Ranking by Variables

The Sorted Variable tables in Appendix F were used for a Ranking procedure for the various Alternative Ironmaking Processes. The procedures followed for this Ranking Analysis were as followed:

- Each of the sequenced lists by the index variables above for each of the Alternative Ironmaking Processes were represented by the sorted sequence rankings (i.e. from 1 to 21).
- These sequence ratings (i.e. from 1 to 21) were summed in the following manner.
- The variable rankings based on costs (i.e. variables 1-4 of CAPEX, OPEX I.U., OPEX L.S. and I.R.R.) were summed.
- Similarly, the energy and emissions variable rankings (i.e. variables 5-7 of Electric Power, Process CO_2 and Total CO_2) were summed by process.
- In addition all of the ranking variables were summed (i.e. variables 1-7).
- Based on these summation totals, additional sorts of these grouping totals (1-4, 5-7 and 1-7) were done. That is, the lowest sum of the grouped ranking variables was first, the highest last, etc.
- Again, the sorted Ranking Variable Groups for the processes were arranged into a Lowest Group, A Middle Group and a Highest Group.
- It should be noted that the Ranking Exercise was done for each of the Steel Scrap Price values, i.e. $100, $120 and $140 respectively.

These sorted Ranking Variable Groupings, thus, provide some additional insights into the most attractive Ironmaking Process Alternatives and those that are less attractive. With the added dimension of the independent Steel Scrap Price variable and the impacts on the ultimate Refined Liquid Steel costs, some of the significant impacts of this key variable can be seen more clearly in evaluating the various Ironmaking Processes.

The tables of the Ranked Variables and summation groupings discussed are also provided in this section.

G-2 Sorted and Ranked Process Groupings

As an alternative way of visualizing the Sorted Variable and Ranked Process Groupings, visual representations of each are provided in this section with the members of each process summarized in highlighted bullets.

RANKING OF IRONMAKING PROCESSES - RESEQUENCED ORDER

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
1	100% DRI, 1.0% C, MIDREX	20	14	20	20	21	9	17	74	121	47	20	20	18
2	100% STEEL SCRAP	1	1	1	1	8	1	1	4	14	10	1	1	1
3	30% DRI, 1.0% C/70% SCRAP	5	15	13	8	18	2	2	41	63	22	11	5	7
4	HYLSA IVM	19	12	18	19	20	7	14	68	109	41	19	19	14
5	30% BF H.M./70% SCRAP CP COKE	9	18	14	11	6	4	6	52	68	16	15	9	3
6	30% MINI-BF H.M.	4	17	15	4	7	5	7	40	59	19	10	3	6
7	30% BF H.M./70% SCRAP NR COKE	8	11	5	5	2	8	4	29	43	14	18	4	2
8	30% COLD PIG IRON/70% SCRAP	10	19	19	15	17	6	9	63	95	32	4	17	9
9	30% TECNORED H.M. W COGEN	3	13	3	2	1	13	3	21	38	17	2	2	4
10	30% TECNORED H.M. W/O COGEN	2	21	17	3	3	12	8	43	66	23	21	21	8
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	13	7	20
12	HISMELT 32.7% H.M.	12	16	16	14	10	3	5	58	76	18	17	11	5
13	REDSMELT	16	10	11	18	4	17	11	55	87	32	16	16	11
14	MAUMEE BRIQUETTE DRI/EAF	14	3	2	10	14	11	13	29	67	38	5	8	13
15	ITMK3 DR SHOT TO EAF	15	4	6	13	9	18	18	38	83	45	3	13	16
16	CIRCORED/HBI/EAF	6	6	10	6	11	14	12	28	65	37	8	6	12
17	CIRCOFER/HBI/SAF/EAF	7	8	12	9	5	19	19	36	79	43	7	12	15
18	FINMET/HBI/EAF	13	7	9	12	12	10	10	41	73	32	12	10	10
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	4	16	15	15	16	40	86	46	9	15	17
20	GENERIC I.C. (40%)/SAF/EAF	11	9	7	7	19	16	15	34	84	50	6	14	19
21	SL/RN ROTARY KILN	17	5	8	17	16	20	20	47	103	56	14	18	21

RANKING OF IRONMAKING PROCESSES - RESEQUENCED ORDER

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO_2 RANKING (6)	TOTAL CO_2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
1	100% DRI, 1.0% C, MIDREX	20	14	18	20	21	9	17	72	119	47	20	20	18
2	100% STEEL SCRAP	1	1	13	1	8	1	1	16	26	10	1	1	1
3	30% DRI, 1.0% C/70% SCRAP	5	15	15	13	18	2	2	48	70	22	13	9	7
4	HYLSA IVM	19	12	12	19	20	7	14	62	103	41	18	19	14
5	30% BF H.M./70% SCRAP CP COKE	9	18	16	16	6	4	6	59	75	16	17	11	3
6	30% MINI-BF H.M.	4	17	17	9	7	5	7	47	66	19	12	7	6
7	30% BF H.M./70% SCRAP NR COKE	8	11	11	7	2	8	4	37	51	14	9	3	2
8	30% COLD PIG IRON/70% SCRAP	10	19	20	18	17	6	9	67	99	32	19	18	9
9	30% TECNORED H.M. W COGEN	3	13	9	2	1	13	3	27	44	17	5	2	4
10	30% TECNORED H.M. W/O COGEN	2	21	19	11	3	12	8	53	76	23	15	13	8
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20
12	HISMELT 32.7% H.M.	12	16	14	14	10	3	5	56	74	18	16	10	5
13	REDSMELT	16	10	8	17	4	17	11	51	83	32	14	15	11
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	5	14	11	13	23	61	38	3	5	13
15	ITMK3 DR SHOT TO EAF	15	4	3	8	9	18	18	30	75	45	6	12	16
16	CIRCORED/HBI/EAF	6	6	6	3	11	14	12	21	58	37	2	4	12
17	CIRCOFER/HBI/SAF/EAF	7	8	7	4	5	19	19	26	69	43	4	8	15
18	FINMET/HBI/EAF	13	7	5	6	12	10	10	31	63	32	7	6	10
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	12	15	15	16	34	80	46	8	14	17
20	GENERIC I.C. (40%)/SAF/EAF	11	9	10	10	19	16	15	40	90	50	10	16	19
21	SL/RN ROTARY KILN	17	5	4	15	16	20	20	41	97	56	11	17	21

RANKING OF IRONMAKING PROCESSES - RESEQUENCED ORDER

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
1	100% DRI, 1.0% C, MIDREX	20	14	10	19	21	9	17	63	110	47	19	20	18
2	100% STEEL SCRAP	1	1	15	9	8	1	1	26	36	10	4	1	1
3	30% DRI, 1.0% C/70% SCRAP	5	15	16	17	18	2	2	53	75	22	13	10	7
4	HYLSA IVM	19	12	9	18	20	7	14	58	99	41	17	18	14
5	30% BF H.M./70% SCRAP CP COKE	9	18	19	14	6	4	6	60	76	16	18	12	3
6	30% MINI-BF H.M.	4	17	18	15	7	5	7	54	73	19	14	9	6
7	30% BF H.M./70% SCRAP NR COKE	8	11	13	10	2	8	4	42	56	14	11	4	2
8	30% COLD PIG IRON/70% SCRAP	10	19	21	20	17	6	9	70	102	32	20	19	9
9	30% TECNORED H.M. W COGEN	3	13	12	6	1	13	3	34	51	17	8	2	4
10	30% TECNORED H.M. W/O COGEN	2	21	20	13	3	12	8	56	79	23	15	15	8
11	COREX/MIDREX WITH 60% H.M.	21	20	17	21	13	21	21	79	134	55	21	21	20
12	HISMELT 32.7% H.M.	12	16	14	16	10	3	5	58	76	18	16	13	5
13	REDSMELT	16	10	8	12	4	17	11	46	78	32	12	14	11
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	3	14	11	13	21	59	38	2	5	13
15	ITMK3 DR SHOT TO EAF	15	4	3	5	9	18	18	27	72	45	5	8	16
16	CIRCORED/HBI/EAF	6	6	5	1	11	14	12	18	55	37	1	3	12
17	CIRCOFER/HBI/SAF/EAF	7	8	7	2	5	19	19	24	67	43	3	7	15
18	FINMET/HBI/EAF	13	7	4	4	12	10	10	28	60	32	6	6	10
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	7	15	15	16	29	75	46	7	11	17
20	GENERIC I.C. (40%)/SAF/EAF	11	9	11	11	19	16	15	42	92	50	10	17	19
21	SL/RN ROTARY KILN	17	5	6	8	16	20	20	36	92	56	9	16	21

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM (5-7)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	13	1	8	1	1	16	26	10	1	1	1
7	30% BF H.M./70% SCRAP NR COKE	8	11	11	7	2	8	4	37	51	14	9	3	2
5	30% BF H.M./70% SCRAP CP COKE	9	18	16	16	6	4	6	59	75	16	17	11	3
9	30% TECNORED H.M. W COGEN	3	13	9	2	1	13	3	27	44	17	5	2	4
12	HISMELT 32.7% H.M.	12	16	14	14	10	3	5	56	74	18	16	10	5
6	30% MINI-BF H.M.	4	17	17	9	7	5	7	47	66	19	12	7	6
3	30% DRI, 1.0% C/70% SCRAP	5	15	15	13	18	2	2	48	70	22	13	9	7
MIDDLE THIRD														
10	30% TECNORED H.M. W/O COGEN	2	21	19	11	3	12	8	53	76	23	15	13	8
8	30% COLD PIG IRON/70% SCRAP	10	19	20	18	17	6	9	67	99	32	19	18	9
18	FINMET/HBI/EAF	13	7	5	6	12	10	10	31	63	32	7	6	10
13	REDSMELT	16	10	8	17	4	17	11	51	83	32	14	15	11
16	CIRCORED/HBI/EAF	6	6	6	3	11	14	12	21	58	37	2	4	12
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	5	14	11	13	23	61	38	3	5	13
4	HYLSA IVM	19	12	12	19	20	7	14	62	103	41	18	19	14
HIGHEST THIRD														
17	CIRCOFER/HBI/SAF/EAF	7	8	7	4	5	19	19	26	69	43	4	8	15
15	ITMK3 DR SHOT TO EAF	15	4	3	8	9	18	18	30	75	45	6	12	16
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	12	15	15	16	34	80	46	8	14	17
1	100% DRI, 1.0% C, MIDREX	20	14	18	20	21	9	17	72	119	47	20	20	18
20	GENERIC I.C. (40%)/SAF/EAF	11	9	10	10	19	16	15	40	90	50	10	16	19
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20
21	SL/RN ROTARY KILN	17	5	4	15	16	20	20	41	97	56	11	17	21

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM(1-4)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	1	1	8	1	1	4	14	10	1	1	1
9	30% TECNORED H.M. W COGEN	3	13	3	2	1	13	3	21	38	17	2	2	4
16	CIRCORED/HBI/EAF	6	6	10	6	11	14	12	28	65	37	3	6	12
7	30% BF H.M./70% SCRAP NR COKE	8	11	5	5	2	8	4	29	43	14	4	3	2
14	MAUMEE BRIQUETTE DRI/EAF	14	3	2	10	14	11	13	29	67	38	5	8	13
20	GENERIC I.C. (40%)/SAF/EAF	11	9	7	7	19	16	15	34	84	50	6	14	14
17	CIRCOFER/HBI/SAF/EAF	7	8	12	9	5	19	19	36	79	43	7	12	15
MIDDLE THIRD														
15	ITMK3 DR SHOT TO EAF	15	4	6	13	9	18	18	38	83	45	8	13	16
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	4	16	15	15	16	40	86	46	9	15	17
6	30% MINI-BF H.M.	4	17	15	4	7	5	7	40	59	19	10	4	6
3	30% DRI, 1.0% C/70% SCRAP	5	15	13	8	18	2	2	41	63	22	11	5	7
18	FINMET/HBI/EAF	13	7	9	12	12	10	10	41	73	32	12	10	10
10	30% TECNORED H.M. W/O COGEN	2	21	17	3	3	12	8	43	66	23	13	7	8
21	SL/RN ROTARY KILN	17	5	8	17	16	20	20	47	103	56	14	18	21
HIGHEST THIRD														
5	30% BF H.M./70% SCRAP CP COKE	9	18	14	11	6	4	6	52	68	16	15	9	3
13	REDSMELT	16	10	11	18	4	17	11	55	87	32	16	16	11
12	HISMELT 32.7% H.M.	12	16	16	14	10	3	5	58	76	18	17	11	5
8	30% COLD PIG IRON/70% SCRAP	10	19	19	15	17	6	9	63	95	32	18	17	9
4	HYLSA IVM	19	12	18	19	20	7	14	68	109	41	19	19	14
1	100% DRI, 1.0% C, MIDREX	20	14	20	20	21	9	17	74	121	47	20	20	18
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM (1-4)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	13	1	8	1	1	16	26	10	1	1	1
16	CIRCORED/HBI/EAF	6	6	6	3	11	14	12	21	58	37	2	4	12
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	5	14	11	13	23	61	38	3	5	13
17	CIRCOFER/HBI/SAF/EAF	7	8	7	4	5	19	19	26	69	43	4	8	15
9	30% TECNORED H.M. W COGEN	3	13	9	2	1	13	3	27	44	17	5	2	4
15	ITMK3 DR SHOT TO EAF	15	4	3	8	9	18	18	30	75	45	6	12	16
18	FINMET/HBI/EAF	13	7	5	6	12	10	10	31	63	32	7	6	10
MIDDLE THIRD														
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	12	15	15	16	34	80	46	8	14	27
7	30% BF H.M./70% SCRAP NR COKE	8	11	11	7	2	8	4	37	51	14	9	3	2
20	GENERIC I.C. (40%)/SAF/EAF	11	9	10	10	19	16	15	40	90	50	10	16	19
21	SL/RN ROTARY KILN	17	5	4	15	16	20	20	41	97	56	11	17	21
6	30% MINI-BF H.M.	4	17	17	9	7	5	7	47	66	19	12	7	6
3	30% DRI, 1.0% C/70% SCRAP	5	15	15	13	18	2	2	48	70	22	13	9	7
13	REDSMELT	16	10	8	17	4	17	11	51	83	32	14	15	11
HIGHEST THIRD														
10	30% TECNORED H.M. W/O COGEN	2	21	19	11	3	12	8	53	76	23	15	13	8
12	HISMELT 32.7% H.M.	12	16	14	14	10	3	5	56	74	18	16	10	5
5	30% BF H.M./70% SCRAP CP COKE	9	18	16	16	6	4	6	59	75	16	17	11	3
4	HYLSA IVM	19	12	12	19	20	7	14	62	103	41	18	19	14
8	30% COLD PIG IRON/70% SCRAP	10	19	20	18	17	6	9	67	99	32	19	18	9
1	100% DRI, 1.0% C, MIDREX	20	14	18	20	21	9	17	72	119	47	20	20	18
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM(1-4)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
16	CIRCORED/HBI/EAF	6	6	5	1	11	14	12	18	55	37	1	3	12
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	3	14	11	13	21	59	38	2	5	13
17	CIRCOFER/HBI/SAF/EAF	7	8	7	2	5	19	19	24	67	43	3	7	15
2	100% STEEL SCRAP	1	1	15	9	8	1	1	26	36	10	4	1	1
15	ITMK3 DR SHOT TO EAF	15	4	3	5	9	18	18	27	72	45	5	8	16
18	FINMET/HBI/EAF	13	7	4	4	12	10	10	28	60	32	6	6	10
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	7	15	15	16	29	75	46	7	11	17
MIDDLE THIRD														
9	30% TECNORED H.M. W COGEN	3	13	12	6	1	13	3	34	51	17	8	2	4
21	SL/RN ROTARY KILN	17	5	6	8	16	20	20	36	92	56	9	16	21
20	GENERIC I.C. (40%)/SAF/EAF	11	9	11	11	19	16	15	42	92	50	10	17	19
7	30% BF H.M./70% SCRAP NR COKE	8	11	13	10	2	8	4	42	56	14	11	4	2
13	REDSMELT	16	10	8	12	4	17	11	46	78	32	12	14	11
3	30% DRI, 1.0% C/70% SCRAP	5	15	16	17	18	2	2	53	75	22	13	10	7
6	30% MINI-BF H.M.	4	17	18	15	7	5	7	54	73	19	14	9	6
HIGHEST THIRD														
10	30% TECNORED H.M. W/O COGEN	2	21	20	13	3	12	8	56	79	23	15	15	8
12	HISMELT 32.7% H.M.	12	16	14	16	10	3	5	58	76	18	16	13	5
4	HYLSA IVM	19	12	9	18	20	7	14	58	99	41	17	18	14
5	30% BF H.M./70% SCRAP CP COKE	9	18	19	14	6	4	6	60	76	16	18	12	3
1	100% DRI, 1.0% C, MIDREX	20	14	10	19	21	9	17	63	110	47	19	20	18
8	30% COLD PIG IRON/70% SCRAP	10	19	21	20	17	6	9	70	102	32	20	29	9
11	COREX/MIDREX WITH 60% H.M.	21	20	17	21	13	21	21	79	134	55	21	21	20

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM(1-7)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $100/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	1	1	8	1	1	4	14	10	1	1	1
9	30% TECNORED H.M. W COGEN	3	13	3	2	1	13	3	21	38	17	2	2	4
7	30% BF H.M./70% SCRAP NR COKE	8	11	5	5	2	8	4	29	43	14	4	3	2
6	30% MINI-BF H.M.	4	17	15	4	7	5	7	40	59	19	10	4	6
3	30% DRI, 1.0% C/70% SCRAP	5	15	13	8	18	2	2	41	63	22	11	5	7
16	CIRCORED/HBI/EAF	6	6	10	6	11	14	12	28	65	37	3	6	12
10	30% TECNORED H.M. W/O COGEN	2	21	17	3	3	12	8	43	66	23	13	7	8
MIDDLE THIRD														
14	MAUMEE BRIQUETTE DRI/EAF	14	3	2	10	14	11	13	29	67	38	5	8	13
5	30% BF H.M./70% SCRAP CP COKE	9	18	14	11	6	4	6	52	68	16	15	9	3
18	FINMET/HBI/EAF	13	7	9	12	12	10	10	41	73	32	12	10	10
12	HISMELT 32.7% H.M.	12	16	16	14	10	3	5	58	76	18	17	11	5
17	CIRCOFER/HBI/SAF/EAF	7	8	12	9	5	19	19	36	79	43	7	12	15
15	ITMK3 DR SHOT TO EAF	15	4	6	13	9	18	18	38	83	45	8	13	16
20	GENERIC I.C. (40%)/SAF/EAF	11	9	7	7	19	16	15	34	84	50	6	14	19
HIGHEST THIRD														
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	4	16	15	15	16	40	86	46	9	15	17
13	REDSMELT	16	10	11	18	4	17	11	55	87	32	16	16	11
8	30% COLD PIG IRON/70% SCRAP	10	19	19	15	17	6	9	63	95	32	18	17	9
21	SL/RN ROTARY KILN	17	5	8	17	16	20	20	47	103	56	14	18	21
4	HYLSA IVM	19	12	18	19	20	7	14	68	109	41	19	19	14
1	100% DRI, 1.0% C, MIDREX	20	14	20	20	21	9	17	74	121	47	20	20	18
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20

RANKING OF IRONMAKING PROCESSES - SORTED ON RANKING SUM (1-7)

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $120/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	13	1	8	1	1	16	26	10	1	1	1
9	30% TECNORED H.M. W COGEN	3	13	9	2	1	13	3	27	44	17	5	2	4
7	30% BF H.M./70% SCRAP NR COKE	8	11	11	7	2	8	4	37	51	14	9	3	2
16	CIRCORED/HBI/EAF	6	6	6	3	11	14	12	21	58	37	2	4	12
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	5	14	11	13	23	61	38	3	5	13
18	FINMET/HBI/EAF	13	7	5	6	12	10	10	31	63	32	7	6	10
6	30% MINI-BF H.M.	4	17	17	9	7	5	7	47	66	19	12	7	6
MIDDLE THIRD														
17	CIRCOFER/HBI/SAF/EAF	7	8	7	4	5	19	19	26	69	43	4	8	15
3	30% DRI, 1.0% C/70% SCRAP	5	15	15	13	18	2	2	48	70	22	13	9	7
12	HISMELT 32.7% H.M.	12	16	14	14	10	3	5	56	74	18	16	10	5
5	30% BF H.M./70% SCRAP CP COKE	9	18	16	16	6	4	6	59	75	16	17	11	3
15	ITMK3 DR SHOT TO EAF	15	4	3	8	9	18	18	30	75	45	6	12	16
10	30% TECNORED H.M. W/O COGEN	2	21	19	11	3	12	8	53	76	23	15	13	8
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	12	15	15	16	34	80	46	8	14	17
HIGHEST THIRD														
13	REDSMELT	16	10	8	17	4	17	11	51	83	32	14	15	11
20	GENERIC I.C. (40%)/SAF/EAF	11	9	10	10	19	16	15	40	90	50	10	16	19
21	SL/RN ROTARY KILN	17	5	4	15	16	20	20	41	97	56	11	17	21
8	30% COLD PIG IRON/70% SCRAP	10	19	20	18	17	6	9	67	99	32	19	18	9
4	HYLSA IVM	19	12	12	19	20	7	14	62	103	41	18	19	14
1	100% DRI, 1.0% C, MIDREX	20	14	18	20	21	9	17	72	119	47	20	20	18
11	COREX/MIDREX WITH 60% H.M.	21	20	21	21	13	21	21	83	138	55	21	21	20

RANKING OF IRONMAKING PROCESSES - RESEQUENCED ORDER

(BASIS: 1.00 MM mt LIQUID STEEL PER YEAR, $140/mt STEEL SCRAP COST)

SEQ. NO.	PROCESS	CAPEX RANKING (1)	OPEX I.U. RANKING (2)	OPEX L.S. RANKING (3)	I.R.R. RANKING (4)	ELEC. RANKING (5)	PROC. CO2 RANKING (6)	TOTAL CO2 RANKING (7)	TOTALS (1-4)	TOTALS (1-7)	TOTALS (5-7)	T.S.RANK (1-4)	T.S.RANK (1-7)	T.S.RANK (5-7)
LOWEST THIRD														
2	100% STEEL SCRAP	1	1	15	9	8	1	1	26	36	10	4	1	1
9	30% TECNORED H.M. W COGEN	3	13	12	6	1	13	3	34	51	17	8	2	4
16	CIRCORED/HBI/EAF	6	6	5	1	11	14	12	18	55	37	1	3	12
7	30% BF H.M./70% SCRAP NR COKE	8	11	13	10	2	8	4	42	56	14	11	4	2
14	MAUMEE BRIQUETTE DRI/EAF	14	3	1	3	14	11	13	21	59	38	2	5	13
18	FINMET/HBI/EAF	13	7	4	4	12	10	10	28	60	32	6	6	10
17	CIRCOFER/HBI/SAF/EAF	7	8	7	2	5	19	19	24	67	43	3	7	15
MIDDLE THIRD														
15	ITMK3 DR SHOT TO EAF	15	4	3	5	9	18	18	27	72	45	5	8	16
6	30% MINI-BF H.M.	4	17	18	15	7	5	7	54	73	19	14	9	6
3	30% DRI, 1.0% C/70% SCRAP	5	15	16	17	18	2	2	53	75	22	13	10	7
19	GENERIC IRON CARBIDE (100%)/EAF	18	2	2	7	15	15	16	29	75	46	7	11	17
5	30% BF H.M./70% SCRAP CP COKE	9	18	19	14	6	4	6	60	76	16	18	12	3
12	HISMELT 32.7% H.M.	12	16	14	16	10	3	5	58	76	18	16	13	5
13	REDSMELT	16	10	8	12	4	17	11	46	78	32	12	14	11
HIGHEST THIRD														
10	30% TECNORED H.M. W/O COGEN	2	21	20	13	3	12	8	56	79	23	15	15	8
21	SL/RN ROTARY KILN	17	5	6	8	16	20	20	36	92	56	9	16	21
20	GENERIC I.C. (40%)/SAF/EAF	11	9	11	11	19	16	15	42	92	50	10	17	19
4	HYLSA IVM	19	12	9	18	20	7	14	58	99	41	17	18	14
8	30% COLD PIG IRON/70% SCRAP	10	19	21	20	17	6	9	70	102	32	20	19	9
1	100% DRI, 1.0% C, MIDREX	20	14	10	19	21	9	17	63	110	47	19	20	18
11	COREX/MIDREX WITH 60% H.M.	21	20	17	21	13	21	21	79	134	55	21	21	20

APPENDIX H

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Appendix H: Bibliography and References

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