ORNL HEAT PUMP DESIGN MODEL

Description of Heat Pump Specification Data

Mark V
Version 95d

May 1996

In the following pages, the input parameters for the heat pump specification data file are described. This file has the default name HPDATA.DAT.

To provide a comparison to earlier versions, changes from the Mark III version of the ORNL Heat Pump Design Model (HPDM) are identified by vertical change bars in the extreme leftmost column. Changes from the ORNL Mark IV (MODCON) version are denoted by forward slashes in the extreme leftmost column.

The new data file is free format and was designed to minimize changes necessary to update existing Mark III or Mark IV data sets. **The one new line, Line 4, enables the user to specify the desired cooling or heating capacity**. The remaining new input requirements are appended to existing lines. **The options available to the compressor map, flow control, and line loss sections have been expanded.** In the case of flow controls, if optional values are left blank or set to zero, default values will be used.

More details of the model changes since Mark III are described in the Mark IV (June 1991) and Mark V (July 1994) reports that accompany this description.

The compressor simulation can now use the standardized ARI ten-coefficient format described in *ARI 540-91*, *Method For Presentation Of Compressor Performance Data*. As these coefficients should be generally available from the compressor manufacturers, this is now the easiest—and usually the most accurate—method of representing compressors in the model.

If an ARI standardized ten-coefficient representation is not available or feasible (such as when the user has less than 10 compressor data points), six-coefficient curve-fit representations for the HPDATA file can be generated as an output file from the provided ORNL compressor map-fitting program. This output file can be imported into an existing heat pump model data set with minimal editing as given in the map-fitting program description sheets.

The user can now specify the diameter, length, and number of capillary tubes and short-tube orifices. TXV distributor nozzle and tube sizes and lengths are also user-selectable. Extra line pressure drop for ancillary components based on a nominal refrigerant flow rate is another new option.

In the present Mark V version, eight HFCs, three HCFCs, and one natural refrigerant are available using Downing or Martin-Hou equation-of-state representations**.** These include leading HFC azeotropic and near-azeotropic R-22 and R-502 alternatives—R-410A, R-507, and R404A. A variety of refrigerant naming conventions are allowed.

Description of HPDATA Input to ORNL Mark V HPDM, Version 95d

TITLE and OUTPUT DATA:

<u>First Line</u>

HTITLE	Descriptive title for heat pump system defined by this data set (maximum of 80 characters)	SAMPLE

<u>New Line</u>

LPRINT	Output switch to control the type and amount of printed results =-2, for minimum output from contour data generation front end, no heat pump model output =-1, for diagnostic output from contour data generation front end, no heat pump model output =0, for minimum heat pump model output with only an energy input and output summary =1, for a summary of the system operating conditions and component performance calculations as well as the energy summary =2, for output *after* each intermediate iteration converges =3, for continuous output *during* intermediate iterations	1

MODE and REFRIGERANT DATA:

<u>New Line</u>

NCORH	Switch to specify cooling or heating mode =1, for cooling mode =2, for heating mode =3, for dual mode (used in conjunction with contour data generation)	1
NR	Refrigerant -- 12, 22, 114, 502, 134a, 32, 123, 124, 125, 143a, 152a, 290, 404A, 410A, and 507 (If NR is omitted, the default is R-22; see following page for currently accepted input formats for refrigerant names: either the refrigerant ID, the refrigerant number, or the listed alternative names, except for those in parentheses, may be specified.)	22

FIXED CAPACITY OPTION:

<u>New Line</u>

ICAPFLAG	Option for capacity scaling =0, for no capacity scaling =1, for capacity scaling	0
CAPACITY	Desired output capacity (Btu/h), cooling or heating, to be obtained by adjusting compressor displacement.	36000.
EPSILON	Acceptable tolerance on capacity (Btu/h).	50.

REFRIGERANT ID SPECIFICATIONS IN MARK V DATA FILE

The Mark V version of the ORNL HPDM includes thirteen chlorine-free refrigerants --eight pure refrigerants and five near-azeotropic mixtures. Different mixture versions (constituting the preliminary and official compositions) of the two-component refrigerant near-azeotropes, R- 410A and R-507 (AZ-20 and AZ-50) are included. Representations for the chlorine-free, pure and the two-component near-azeotropic refrigerants were provided by Allied-Signal. Dupont provided property representations for R- 404A (HP-62)--the near-azeotrope ternary that is an R-502 alternative.

The desired refrigerant can be identified in the input data in a variety of ways.The refrigerant ID specification is relatively free format. The "R" or "R-" preceding a refrigerant number is optional. For refrigerants R-134a, R-143a and R-152a, the "a" is optional. For C-318, the "C-" is optional. For binary mixtures, the official composition percentages are assumed if omitted. R- 410A and AZ-20 may be used instead of R-32/R-125. R-507 and AZ-50 may be substituted for R-143a/R-125. (The full names with composition percentages typed as shown below can be included in the input data if desired.)

For example, AZ-50 can be specified in the input line as AZ-50, AZ50, 50, R-507, 507, R-143a/R-125(50/50), 143/125(50/50), 143/125 or 143125.

The following refrigerants are represented, in full (thermodynamically and thermophysically) or in part (transport properties only) in the Mark V model:

Version	Refrigerant ID	Ref. No.	Alternative Names	Candidate Replacement For
3	R-12	12		
3	R-22	22		
3	R-114	114		
3	R-502	502		
4	R-134a	134		R-12, R-22
5	R-32	32		R-22
5	R-123	123		R-11
5	R-124	124		R-114
5	R-125	125		R-502
5	R-143a	143		R-502
5	R-152a	152		R-12
5	R-290	290	(propane)	R-22
5	R-32/R-125(50/50)	410	R- 410A, AZ-20	R-22
5	R-32/R-125(60/40)	3212560	(prelim. AZ-20)	R-22
5	R-143a/R-125(50/50)	507	R-507, AZ-50	R-502
5	R-143a/R-125(55/45)	14312555	(prelim. AZ-50)	R-502
5	R-143a/R-125/R-134a (52/44/4)	404	R- 404A, HP-62	R-502
*	(R-11)	(11)		
*	(R-13)	(13)		
*	(R-14)	(14)		
*	(R-21)	(21)		
*	(R-23)	(23)		
*	(R-113)	(113)		
*	(C-318)	(318)		
*	(R-500)	(500)		
*	(R-729)	(729)	(air)	

3 refrigerants included in the Mark III and earlier versions of the ORNL HPDM

version number of the ORNL HPDM where newer refrigerants first appeared—4 refers to the Mark IV (MODCON) version and 5 to the Mark V (PUREZ) version. **References:Allied-Signal, Dupont.**

* denotes refrigerants ( ) for which only thermophysical (transport) properties are built into the model. The thermodynamic (equation-of-state) properties for these can be modeled by adding published "Downing" coefficients to the TABLES subroutine. **Reference: R. L. Downing, "Refrigerant Equations", ASHRAE Transactions, Vol. 80, Part 2, 1974.**

CHARGE INVENTORY / SUPERHEAT DATA:

New Line

ICHRGE	Indicator for specifying charge inventory balance choice =0, *no* charge balance -- low- and high-side determined, refrigerant charge can be calculated; *specify* compressor inlet superheat, *specify* condenser exit subcooling or flow control requirements. =1, charge balance -- high-side determined; *specify* refrigerant charge, *estimate* compressor inlet superheat, *specify* condenser exit subcooling or flow control requirements. * =2, charge balance -- low-side determined; *specify* refrigerant charge, *specify* compressor inlet superheat, *estimate* condenser exit subcooling, *determine* flow control requirements.	0
SUPER	*Specified* (if ICHRGE=0,2) or *estimated* (if ICHRGE=1) refrigerant superheat (or quality) at the compressor shell inlet (F° or negative of the desired quality fraction)	20.0
REFCHG	*Specified* system refrigerant charge (lbm) (not needed if ICHRGE=0)	(5.882)
MVOID	Switch to specify heat exchanger void fraction (slip) method for charge inventory calculations =0, default method -- Zivi void fraction model with analytical solution for a *constant* heat flux approximation >0, various user-selected void fraction models with *variable* heat flux effects (which require slower numerical solutions) --mass-flow independent methods =1, Homogeneous (no slip) =2, Zivi =3, Lockhart-Martinelli =4, Thom =5, Baroczy -- mass-flow dependent methods =6, Hughmark =7, Premoli* =8, Tandon	0

*Straight bars in left-hand margins indicate changes in input or definitions from Mark III single-speed version. Forward slashes indicate changes from Mark IV version.

*Presently configured only with R-22 surface tension properties.

CHARGE INVENTORY CALCULATIONAL DATA:

New Line

IMASS	Switch for option to omit refrigerant charge calculations, only active for ICHRGE=0 case =0, if charge calculations are to be omitted =1, if charge calculations are to be made	1

Compressor and Accumulator Geometry Values for Refrigerant Charge Calculations:
(not required if IMASS = 0 and ICHRGE = 0)
(if an accumulator is not used, set accumulator height ACCHGT to 0.0)

VOLCMP	Internal void space volume of compressor (cu. in.)	395.0
ACCHGT	Height of accumulator (in.)	10.0
ACCDIA	Internal diameter of accumulator (in.)	4.834
OILDIA	Inner diameter of oil return hole J-tube (in.)	0.035
UPPDIA	Inner diameter of upper hole in J-tube (in.)	0.040
HOLDIS	Vertical distance between holes (in.)	2.50
ATBDIA	Inner diameter of J-tube (in.)	0.680

FLOW CONTROL DEVICE DATA: (the variables on this line depend on the type of flow control device selected)

New Line

Specified or Estimated Condenser Subcooling:

IREFC	=0, for specified or estimated refrigerant subcooling at the condenser exit	0
DTROC	*Specified* (if ICHRGE=0,1) or *estimated* (if ICHRGE=2) refrigerant subcooling (or quality) at the condenser exit (F°or negative of the desired quality fraction)	15.0

Optional Italicized Entries To Override Default Flow Control Specifications Used For Autosizing At Specified Subcooling

Optional entries must follow DTROC on the same line, be separated by spaces or commas and be entered as follows until all desired changes are made,
i.e., capillary tube input, short-tube-orifice input, TXV input, as needed

Capillary Tube
NCAP, CAPL, default values of 1, 80.

Short-Tube-Orifice
NORF, ORIFL, ORIFCD, default values of 1, 0.5, and 0.0, respectively

Thermostatic Expansion Valve
STATIC, SUPRAT, SUPMAX, BLEEDF, NZTBOP, IDNZ, IDTB, XLTUBE
default values of 6.0, 11.0, 13.0, 1.15, 0.0, 4, 3, 30, respectively

Thermostatic Expansion Valve:
(italicized entries are optional)

IREFC	=1, for a thermostatic expansion valve (TXV)	1
TXVRAT	Rated capacity of the TXV (tons)	1.688
STATIC	*Static superheat setting for the TXV (F˚)*	*6.0*
SUPRAT	*TXV superheat at rating conditions (F˚)*	*11.0*
SUPMAX	*Maximum effective operating superheat (F˚)*	*13.0*
BLEEDF	*TXV bypass or bleed factor*	*1.15*
NZTBOP	*Switch to omit TXV nozzle and tube pressure drop calculations* *=0.0, to include distributor nozzle and tube pressure drops* *=1.0, to omit nozzle and tube pressure drop calculations*	*0.0*

Thermostatic Expansion Valve (continued):
/ *(italicized entries are optional)*

/ *IDNZ* *ID number (1–10) of the TXV distributor nozzle size (approx. tons* *4*
/ *of evaporator capacity) based on Sporlan Bulletin 20-10 (1975)*

IDNZ	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Nozzle Size (tons)	*1*	*1.5*	*2*	*2.5*	*3*	*4*	*5*	*6*	*8*	*10*

/ *IDTB* *ID number (1–5) selecting TXV distributor tube size (inch OD)* *3*

IDTB	*1*	*2*	*3*	*4*	*5*
Tube OD (in)	*5/32*	*3/16*	*1/4*	*5/16*	*3/8*

/ *XLTUBE* *length of each distributor tube (inches)* *30.*
/ *(There are as many distributor tubes as there are circuits in the evaporator.)*

Capillary Tube(s):
/ *(italicized entries are optional)*

IREFC =2, for capillary tube(s) 2

/ CAPD capillary tube inside diameter (in.) 0.1148

NCAP *Number of capillary tubes in parallel* *1*

/ *CAPL* *Capillary tube length (in.)* *80.*

Short Tube Orifice(s):
/ *(italicized entries are optional)*

IREFC =3, for short tube orifice(s) 3
/ refrigerant-specific correlations from Kim and O'Neal (1994)
/ used for R-22, R-134a, and R-12; for other refrigerants,
/ the R-22 correlations are assumed

ORIFD Diameter of the short-tube orifice (in.) 0.0715
/ 0.043 < ORIFD < 0.0676, within correlation range of model

/ *NORF* *Number of short-tube-orifices in parallel* *1*

/ *ORIFL* *Length of short-tube-orifice (in.)* *0.5*
/ *0.375< ORIFL ≤ 1.0, within correlation range of model*

/ *ORIFCD* *Chamfer depth of inlet to short-tube-orifice (in.)* *0.0*
/ *= 0.0, for a sharp-edged inlet*
/ *0.0 < ORIFCD ≤ 0.02, for a chamfered inlet within correlation range of model*

ESTIMATES of the LOW- and HIGH-SIDE REFRIGERANT SATURATION TEMPERATURES:

<u>New Line</u>

TSICMP	Estimate of the refrigerant saturation temperature at the compressor shell inlet (˚F)	45.0
TSOCMP	Estimate of the refrigerant saturation temperature at the compressor shell outlet (˚F)	110.0

GENERAL COMPRESSOR DATA:

<u>New Line</u>

ICOMP	Switch to specify which compressor submodel is to be used, =1, for the efficiency-and-loss model (*single-speed only*) =2, for the map-based model (*single- or variable-speed*)	2
DISPL	Total piston displacement for *selected* compressor (cu. in.)	3.024
CMPSPD	Speed/frequency-determining-parameter for *selected* compressor --	
	Operating frequency ratio (relative to nominal frequency on Line 9.2), if value ≤ 5 and ICOMP= 2;	1.0
	Operating drive frequency (Hz), if value > 5 and ICOMP= 2,	(60.0)
	Synchronous compressor motor speed (rpm) if ICOMP=1 and FLMOT is specified on LINE #9;	(3600.)
	Rated compressor motor speed (rpm) if ICOMP=1 and FLMOT is to be calculated	(3450.)
QCAN	Compressor shell heat loss rate (Btu/h), used if CANFAC is 0.0	0.0
CANFAC	Switch to control the method of specifying compressor shell heat loss rate, QCAN =0.0, to specify QCAN explicitly <1.0, to calculate QCAN as a fraction of compressor input power, POW, (i.e., QCAN = CANFAC * POW) =1.0, QCAN is based on map submodel of CANFAC (Map-based model only, Line 9.8) >1.0, to calculate QCAN from the relationship : QCAN = 0.90 * [1 - {motor η * mechanical η}] * POW, (only if ICOMP = 1)	0.1

COMPRESSOR DATA FOR EFFICIENCY-AND-LOSS MODEL:
(ICOMP=1)

New Line

VR	Compressor actual clearance volume ratio	0.06
EFFMMX	Maximum efficiency of the compressor motor	0.82
ETAISN	Isentropic efficiency of the compressor	0.70
ETAMEC	Mechanical efficiency of the compressor	0.80

New Line

MTRCLC	Switch to determine whether to calculate the full load motor power (FLMOT) or to use the input value =0, to calculate FLMOT =1, to use the input value of FLMOT	0
FLMOT	Compressor motor output at full load (kW) (not used if MTRCLC = 0)	( )
QHILO	Heat transfer rate from the compressor inlet line to the inlet gas (Btu/h), used if HILOFC=0.0	300.0
HILOFC	Switch to determine internal heat transfer from the high side to the low side, QHILO = 0.0, to specify QHILO explicitly < 1.0, to calculate QHILO = HILOFC * POW ≥ 1.0, to calculate QHILO = 0.03 * POW	0.0

OR

MAP-BASED COMPRESSOR MODEL INPUT DATA :
(ICOMP=2, Preferred Alternative To Efficiency-Based Compressor Input,
Alternative input described on following pages)

MAP-BASED COMPRESSOR MODEL INPUT DATA:

General Input Data (Frequency-Independent):

New Line

CTITLE	Descriptive title for map-based compressor data	MAP DATA

New Line

MODEDT	Switch indicating type of compressor data representation =1, six-coefficient biquadratic curve fits to compressor input power and refrigerant mass flow rate =2, six-coefficient biquadratic curve fits to compressor shell isentropic and volumetric efficiencies =3, ten-coefficient ARI 540-91 curve fits to compressor input power and refrigerant mass flow rate	3
ICMPDT	Switch *identifying* drive efficiency level of *base* compressor data =0, first-generation inverter-driven induction-motor (IDIM) efficiency =1, state-of-the-art IDIM efficiency =2, ideal sine-wave-driven, induction motor (SWDIM) efficiency =3, electronically-commutated motor (ECM) efficiency	2
ICDVCH	Switch *choosing selected* drive efficiency level (to convert *base* compressor data) =0, first-generation IDIM efficiency =1, state-of-the-art IDIM efficiency =2, ideal SWDIM efficiency =3, ECM efficiency	2
CSIZMT	If > 0.0, *nominal* motor size for *selected* compressor (hp), used to determine relative motor loading and resultant motor efficiency	(2.25)
	If < 0.0, (negative of) *specified percentage of nominal loading* at which the motor efficiency of the *selected* compressor is to be evaluated, also (if CMPFRQ = CFRQNM) the required motor size will be calculated (auto-sizing)	-130.0
CFRQNM	*Nominal* frequency for *selected* motor rating (Hz)	60.0
CVLTNM	*Nominal* voltage for *selected* motor rating (Volts) -- induction motors only	230.0
CVLHZM	*Selected* operating volts/Hertz ratio multiplier (range of 0.85 to 1.15) -- induction motors only	1.0

General Input Data (Frequency-Independent) Continued:

New Line

NHZ	Number of frequencies for which compressor-data curve-fits are available,	1
DISPLB	*Base* compressor displacement for compressor map (cubic inches)	3.024
SUPERB	*Base* 'superheat' value for compressor map, If ≥ 0, base superheat entering compressor (F˚), If < 0, negative of return gas temperature into compressor (˚F)	 20.0 (-65.0)
CSIZMB	Motor size for *base* compressor (hp)	2.25
CFRQNB	*Nominal* frequency for *base* motor rating (Hz)	60.0
CVLTNB	*Nominal* voltage for *base* motor rating (volts) -- induction motors only	230.0

MAP DATA AT SPECIFIED COMPRESSOR FREQUENCY (HZVAL):

New Line

HZVAL	Compressor frequency value (Hz) for which map data follow	60.0
RPMVAL	*Nominal* compressor speed *at given frequency* (rpm) (used to determine nominal compressor motor torque)	3450.0
VLTVAL	Compressor motor voltage (volts) *at given frequency* for which map data apply -- induction motors only	230.0

/ **(If MODEDT = 1 or 3)**

POWADJ	Adjustment factor to curve-fit for power *at given frequency* (set to 1.0 if value is omitted)	1.0
XMRADJ	Adjustment factor to curve-fit for mass flow rate *at given frequency* (set to 1.0 if value is omitted)	1.0

(If MODEDT = 2)

ETIADJ	Adjustment factor to curve-fit for isentropic efficiency *at given frequency* (set to 1.0 if value is omitted)	1.0
ETVADJ	Adjustment factor to curve-fit for volumetric efficiency *at given frequency* (set to 1.0 if value is omitted)	1.0

(If MODEDT = 1, Read The Following Two Lines)

New Line

CPOWER — Coefficients for bi-quadratic fit to *compressor power* (kW) as a function of compressor suction and discharge saturation temperatures (˚F), TSICMP and TSOCMP, of the form --

POWER(IHZ) =

CPOWER (1,IHZ) * $TSOCMP^2$	+	(	)
CPOWER (2,IHZ) * TSOCMP	+	(	)
CPOWER (3,IHZ) * $TSICMP^2$	+	(	)
CPOWER (4,IHZ) * TSICMP	+	(	)
CPOWER (5,IHZ) * TSOCMP * TSICMP	+	(	)
CPOWER (6,IHZ)		(	)

<u>New Line</u>

CMASSF Coefficients for bi-quadratic fit
to *compressor mass flow rate* (lbm/hr)
as a function of compressor suction and discharge
saturation temperatures (˚F),TSICMP and TSOCMP,
of the form --

XMR(IHZ) =

CMASSF (1,IHZ) * $TSOCMP^2$	+	(	)
CMASSF (2,IHZ) * TSOCMP	+	(	)
CMASSF (3,IHZ) * $TSICMP^2$	+	(	)
CMASSF (4,IHZ) * TSICMP	+	(	)
CMASSF (5,IHZ) * TSOCMP * TSICMP	+	(	)
CMASSF (6,IHZ)		(	)

(If MODEDT = 2, Read The Following Two Lines)

<u>New Line</u>

CETAIS Coefficients for bi-quadratic fit
to *compressor shell isentropic efficiency*
as a function of compressor suction and discharge
saturation temperatures (˚F), TSICMP and TSOCMP,
of the form --

ETAISN(IHZ) =

CETAIS (1,IHZ) * $TSOCMP^2$	+	(	)
CETAIS (2,IHZ) * TSOCMP	+	(	)
CETAIS (3,IHZ) * $TSICMP^2$	+	(	)
CETAIS (4,IHZ) * TSICMP	+	(	)
CETAIS (5,IHZ) * TSOCMP * TSICMP	+	(	)
CETAIS (6,IHZ)		(	)

<u>New Line</u>

CETAVL Coefficients for curve fit
to *compressor shell volumetric efficiency*
as a function of pressure ratio P_R and discharge pressure P_D (psia)
of the form --

ETAVOL(IHZ) =

CETAVL (1,IHZ) * $(P_R - 1.)$	+	(	)
CETAVL (2,IHZ) * $(P_R - 1.) * P_D$	+	(	)
CETAVL (3,IHZ) * $(P_R - 1.) * P_D * P_D$	+	(	)
CETAVL (4,IHZ)		(	)

/ **(If MODEDT = 3, Read The Following Two Lines)**
/
/ New Line
/
/ CPOWER Coefficients for ten-coefficient ARI 540-91 representation
/ of *compressor power* (Watts)
/ as a function of compressor suction and discharge saturation temperatures (˚F),
/ TSICMP and TSOCMP,
/ of the form --
/
/ POWER(IHZ) =

CPOWERA (1,IHZ)	+	275.57071
CPOWERA (2,IHZ) * TSICMP	+	-21.546331
CPOWERA (3,IHZ) * TSOCMP	+	25.208069
CPOWERA (4,IHZ) * TSICMP**2	+	-0.29343623
CPOWERA (5,IHZ) * TSOCMP * TSICMP	+	0.48438260
CPOWERA (6,IHZ) * TSOCMP**2	+	-0.15513997
CPOWERA (7,IHZ) * TSICMP**3	+	-0.00033087510
CPOWERA (8,IHZ) * TSOCMP * TSICMP**2	+	0.00098385545
CPOWERA (9,IHZ) * TSICMP * TSOCMP**2	+	-0.00036841937
CPOWERA(10,IHZ) * TSOCMP**3		0.00020905216

/
/ New Line
/
/ CMASSF Coefficients for ten-coefficient ARI 540-91 representation
/ of *compressor mass flow rate* (lbm/hr)
/ as a function of compressor suction and discharge
/ saturation temperatures (˚F),TSICMP and TSOCMP,
/ of the form --
/
/ XMR(IHZ) =

CMASSFA (1,IHZ)	+	29.000366
CMASSFA (2,IHZ) * TSICMP	+	3.4896154
CMASSFA (3,IHZ) * TSOCMP	+	5.5909472
CMASSFA (4,IHZ) * TSICMP**2	+	0.058079902
CMASSFA (5,IHZ) * TSOCMP * TSICMP	+	0.041391749
CMASSFA (6,IHZ) * TSOCMP**2	+	-0.066189520
CMASSFA (7,IHZ) * TSICMP**3	+	0.00019594388
CMASSFA (8,IHZ) * TSOCMP * TSICMP**2	+	-0.00016566363
CMASSFA (9,IHZ) * TSICMP * TSOCMP**2	+	-0.00021479024
CMASSFA(10,IHZ) * TSOCMP**3		0.00020337809

/
/

(Repeat The Preceding 3 Lines For Each Compressor Frequency, IHZ=1, NHZ*)*

Compressor Shell Heat Loss Correlation :

/ (This Line Is Only Included If QCAN = 1.0 Under General Compressor Data)

New Line

CQCAN Coefficients of quadratic fit to *compressor shell heat loss*
as a function of compressor dischargesaturation temperature (˚F)
of the form --

CANFAC =

CQCAN (1) * TSOCMP	+	-1.704E-02
CQCAN (2) * $TSOCMP^2$	+	5.610E-05
CQCAN (3)		1.314E+00

INDOOR UNIT DATA:

New Line

Indoor Operating Conditions:

TAIII	Air temperature entering the indoor unit (˚F)	80.0
RHII	Relative humidity of the air entering the indoor unit	0.50

New Line

Indoor Blower:

FRQIDF	*Operating* frequency parameter for indoor blower —		
	if ≤ 5, operating frequency *ratio* relative to nominal given by FRQNMI if > 5, operating frequency (Hz)		1.0 (60.0)
FRQNMI	*Nominal* indoor blower frequency (Hz)		60.0
QANMI	*Nominal* air flow rate (cfm)		1200.
SIZMTI	ECM blower motor sizing parameter — (SIZMTI is only used if ICHIDF=3)		
	> 0.0,	*nominal* blower motor size (hp), used to determine relative motor loading and resultant ECM efficiency	(0.33)
	< 0.0,	(negative of) *percentage of nominal loading* at which the ECM efficiency is to be evaluated, also -- if FRQIDF = FRQNMI -- the required motor size will be calculated (auto-sizing)	-75.0
FANEFI	Fan / fan-motor efficiency parameter —		
	≤ 1.0,	specified fixed value of separate or combined efficiencies of fan and/or drive: (those values not explicitly specified by FANEFI will be calculated based on ICHIDF selection)	
		If ICHIDF < 0, specified value of combined fan / fan-motor efficiency	(0.30)
		If ICHIDF ≥ 0, specified fan-only efficiency;	0.45

FANEFI... >1.0, directly-specified power (watts) of <u>reference</u> drive (293.0)
at nominal air flow rate (if available measured
power is not at selected nominal cfm, then ratio
the measured power by cube of cfm ratio),
at reference inlet air temperatures
of 70˚F heating and 80˚F cooling

IRFIDF Integer switch to identify <u>reference</u> drive type -1
if FANEFI is used to specify nominal fan power
(only used if FANEFI > 1.0)

< 0, No reference drive type to be used,
gives a constant implicit drive efficiency with speed

≥ 0, Nominal input power is referenced to choice of following drives --
(drive efficiency will vary with speed)
= 0, specifies a first-generation IDIM drive
= 1, specifies a state-of-the-art IDIM drive
= 2, specifies an ideal SWDIM drive
= 3, specifies an ECM drive

ICHIDF Integer switch for choosing <u>selected</u> drive type: -1
For use in combination with given FANEFI values
(If FANEFI ≤ 1.0)
or
For conversion from reference IRFIDF values
to selected ICHIDF drive type
(If FANEFI > 1.0)

< 0, drive efficiency assumed constant as explicitly
or implicitly given by FANEFI
(If IRFIDF < 0 and FANEFI > 1.0,
ICHIDF will be automatically set to -1)

≥ 0, drive efficiency computed using choice of following drives --
(drive efficiency will vary with speed)
= 0, specifies a first-generation IDIM drive
= 1, specifies a state-of-the-art IDIM drive
= 2, specifies an ideal SWDIM drive
= 3, specifies an ECM drive

DDUCT Indoor duct sizing parameter —

If > 0, equivalent diameter of each of 6 identical air ducts (in.) (6.0)
-- each with an equivalent length of 100 ft
If ≤ 0, (negative of) specified external pressure drop of duct system -0.15
-- independent of specified air flow rate or fan speed
(Note: DDUCT is not used in fan power calculations if FANEFI > 1.0)

FIXCAP House heating load (Btu/h), optional, used to calculate 0.0
the necessary backup resistance heat in the heating mode

New Line

Indoor Heat Exchanger Configuration:

AAFI	Frontal area of the coil (sq. ft.)	3.802
NTI	Number of refrigerant tube rows in the direction of air flow	4.0
NSECTI	Number of equivalent, parallel refrigerant circuits in heat exchanger	6.0
WTI	Spacing of the refrigerant tubes in the direction of air flow (in.)	0.625
STI	Spacing of the refrigerant tube passes perpendicular to the direction of air flow (in.)	1.00
RTBI	Total number of return bends in heat exchanger (all circuits)	104.0

New Line

Indoor Heat Exchanger Configuration (cont.):

FINTYI	Switch to specify the type of fin surface, = 1.0, for smooth fins = 2.0, for *general* wavy (sinusoidal) or zig-zag (corrugated) fins -- using multipliers to smooth fin equations = 3.0, for *general* louvered (simple-strip) fins -- using multipliers to smooth fin equations = 4.0, for *specific* zig-zag fin designs = 5.0, for *specific* louvered (simple-strip) fin designs	2.0
FPI	Fin pitch (fins/in.)	13.0
DELTAI	Fin thickness (in.)	0.010
DEAI	Outside diameter of the refrigerant tubes (in.)	0.3325
DERI	Inside diameter of the refrigerant tubes (in.)	0.3085
XKFI	Thermal conductivity of the fins (Btu/hr-ft-~F)	128.3
XKTI	Thermal conductivity of the tubes (Btu/hr-ft-~F)	225.0
HCONTI	Fraction of the default computed contact conductance between the fins and tubes	100.0

<u>New Line</u>

Fin Patternation Data for Indoor Coil:

If FINTYI < 4.0, input dummy parameters to skip line.

NDUM	Dummy integer	0
XDUM	Dummy real	0.0

If FINTYI = 4.0,

NFPZGI	Number of fin patterns per row of tubes in flow direction (integer)	2
FPDZGI	Fin pattern depth (in)	0.045

If FINTYI = 5.0,

NSLVI	Number of strips in an enhanced zone (integer)	(4)
XLSLVI	Length of enhanced louvered zone (mm)	(8.0)
XWSLVI	Width of single strip in flow direction (mm)	(2.0)

<u>New Line</u>

Heat Transfer and Pressure Drop Multipliers for Indoor Coil :

HTRMLI	Refrigerant-side heat transfer multiplier	1.0
PDRMLI	Refrigerant-side pressure-drop multiplier	1.0
HTAMLI	Air-side heat transfer multiplier	1.0
PDAMLI	Air-side *coil* pressure-drop multiplier	1.0
CABMLI	Air-side *system* pressure-drop multiplier	1.0

OUTDOOR UNIT DATA:

New Line

Outdoor Operating Conditions:

TAIIO	Air temperature entering the heat exchanger (F)	82.0
RHIO	Relative humidity of the air entering the heat exchanger	0.40

New Line

Outdoor Fan:

FRQODF	*Operating* frequency parameter for outdoor fan —	
	if ≤ 5, operating frequency *ratio* relative to nominal given by FRQNMO if > 5, operating frequency (Hz)	1.0 (60.0)
FRQNMO	*Nominal* outdoor fan frequency (Hz)	60.0
QANMO	*Nominal* air flow rate (cfm)	3000.0
SIZMTO	ECM blower motor sizing parameter — (SIZMTO is only used if ICHODF=3)	
	> 0.0, *nominal* blower motor size (hp), used to determine relative motor loading and resultant ECM efficiency	(0.25)
	< 0.0, (negative of) *percentage of nominal loading* at which the ECM efficiency is to be evaluated, also -- if FRQODF = FRQNMO -- the required motor size will be calculated (auto-sizing)	-75.0
FANEFO	Fan / fan motor efficiency parameter —	
	≤ 1.0, specified fixed value of separate or combined efficiencies of fan and/or drive: (those values not explicitly specified by FANEFO will be calculated based on MFANFT / ICHODF selections)	
	If MFANFT = 0 and ICHODF < 0, specified value of combined fan / fan motor efficiency	(0.21)
	If MFANFT = 0 and ICHODF ≥ 0, specified fan-only efficiency	(0.35)
	If MFANFT = 1 and ICHODF < 0, specified drive efficiency	(0.60)

FANEFO	Fan / fan motor efficiency parameter (continued) — ≤1.0 If MFANFT = 1 and ICHODF => 0, specified value is ignored, model calculates both fan and drive efficiencies	0.00
	>1.0, directly-specified power (watts) of *reference* drive *at nominal air flow rate (if available measured power is not at selected nominal cfm, then ratio the measured power by cube of cfm ratio)*, at reference inlet air temperatures of 47˚F heating or 95˚F cooling	220.0
IRFODF	Integer switch to identify *reference* drive type if FANEFO is used to specify nominal fan power (only used if FANEFO > 1.0) < 0, No reference drive type to be used, gives a constant implicit drive efficiency with speed ≥ 0, Nominal input power is referenced to choice of following drives -- (drive efficiency will vary with speed) = 0, specifies a first-generation IDIM drive = 1, specifies a state-of-the-art IDIM drive = 2, specifies an ideal SWDIM drive = 3, specifies an ECM drive	-1
ICHODF	Integer switch for choosing *selected* drive type: For use in combination with given FANEFO values (If FANEFO ≤ 1.0) or For conversion from reference IRFODF values to selected ICHODF drive type (If FANEFO > 1.0) < 0, drive efficiency assumed constant as explicitly or implicitly given by FANEFO (If IRFODF < 0 and FANEFO > 1.0, ICHODF will be automatically set to -1) ≥ 0, drive efficiency computed using choice of following drives -- (drive efficiency will vary with speed) = 0, specifies a first-generation IDIM drive = 1, specifies a state-of-the-art IDIM drive = 2, specifies an ideal SWDIM drive = 3, specifies an ECM drive	-1
MFANFT	Switch for using static efficiency vs specific speed for the efficiency of the outdoor fan — =0, specified value of FANEFO is used	0

MFANFT...	=1, curve fit for fan static efficiency is used -- with fan motor efficiency either specified by FANEFO or calculated internally (should not be chosen if FANEFO > 1.0)	

New Line

Outdoor Heat Exchanger Configuration:

AAFO	Frontal area of the coil (sq. ft.)	14.713
NTO	Number of refrigerant tube rows in the direction of air flow	1.0
NSECTO	Number of equivalent, parallel refrigerant circuits in heat exchanger	3.0
WTO	Spacing of the refrigerant tubes in the direction of air flow (in.)	0.866
STO	Spacing of the refrigerant tube passes perpendicular to the direction of the air flow (in.)	1.00
RTBO	Total number of return bends in heat exchanger (all circuits)	21.0

New Line

Outdoor Heat Exchanger Configuration (cont.):

FINTYO	Switch to specify the type of fin surface, = 1.0, for smooth fins = 2.0, for *general* wavy (sinusoidal) or zig-zag (corrugated) fins -- using multipliers to smooth fin equations = 3.0, for *general* louvered (simple-strip) fins -- using multipliers to smooth fin equations | = 4.0, for *specific* zig-zag fin designs | = 5.0, for *specific* louvered (simple-strip) fin designs	2.0
FPO	Fin pitch (fins/in.)	20.0
DELTAO	Fin thickness (in.)	0.005
DEAO	Outside diameter of the refrigerant tubes (in.)	0.395
DERO	Inside diameter of the refrigerant tubes (in.)	0.371
XKFO	Thermal conductivity of the fins (Btu/hr-ft-˚F)	128.3
XKTO	Thermal conductivity of the tubes (Btu/hr-ft-˚F)	225.0
HCONTO	Fraction of the default computed contact conductance between the fins and tubes	100.0

Fin Patternation Data for Outdoor Coil:

<u>New Line</u>

If FINTYO < 4.0, input dummy parameters NDUM and XDUM to skip line as for indoor coil.

If FINTYO = 4.0,

NFPZGO	Number of fin patterns per row of tubes in flow direction (integer)	2
FPDZGO	Fin pattern depth (in.)	0.045

If FINTYO = 5.0,

NSLVO	Number of strips in an enhanced zone (integer)	(4)
XLSLVO	Length of enhanced louvered zone (mm)	(8.0)
XWSLVO	Width of single strip in flow direction (mm)	(2.0)

<u>New Line</u>

Heat Transfer and Pressure Drop Multipliers for Outdoor Coil :

HTRMLO	Refrigerant-side heat transfer multiplier	1.0
PDRMLO	Refrigerant-side pressure-drop multiplier	1.0
HTAMLO	Air-side heat transfer multiplier	1.0
PDAMLO	Air--side *coil* pressure-drop multiplier	1.0
CABMLO	Air--side *system* pressure-drop multiplier	1.0

CONFIGURATION OPTIONS DATA:

<u>New Line</u>

MCMPOP	Switch for adding *compressor can* heat loss to air in the outdoor coil =0, heat loss not added to outdoor air =1, heat loss added to air *before* crossing the outdoor coil =2, heat loss added to air *after* crossing the outdoor coil	2
MFANIN	Switch for adding heat loss from the *indoor fan* to air stream, settings are similar to those for MCMPOP	2
MFANOU	Switch for adding heat loss from the *outdoor fan* to air stream, settings are similar to those for MCMPOP	2

REFRIGERANT LINES DATA:

New Line

/ **Heat Transfer And Additional Pressure Drop in Refrigerant Lines :**

QSUCLN	If > 0, rate of heat gain in the compressor suction line (Btu/h);	0.0
	If < 0, the negative of the desired temperature rise in the suction line (F˚)	(-10.)
QDISLN	Rate of heat loss in the compressor discharge line (Btu/h)	0.0
QLIQLN	Rate of heat loss in the liquid line (Btu/h)	0.0

/ The following are optional values that can be added to the previous line.
/

/ DPSLN	Additional suction line pressure drop at nominal mass flow (psia)	0.0
/ DPDLN	Additional discharge line pressure drop at nominal mass flow (psia)	0.0
/ DPLLN	Additional liquid line pressure drop at nominal mass flow (psia)	0.0
/ XMRNOM	Nominal mass flow rate for above pressure drops (lbm/hr) (at a given mass flow rate, these added pressure drops are proportional to $[\text{flow / nom. flow}]^{1.8}$)	0.0

New Line

Lines Between Coils and from Reversing Valve to Coils:

DLL	Inside diameter of the liquid line (in.)	0.2885
XLEQLL	Equivalent length of the liquid line (ft.)	30.0
DLRVIC	Inside diameter of the vapor line between the reversing valve and the indoor coil (in.)	0.7260
XLRVIC	Equivalent length of the vapor line between the reversing valve and the indoor coil (ft.)	30.0
DLRVOC	Inside diameter of the vapor line between the reversing valve and the outdoor coil (in.)	0.7260
XLRVOC	Equivalent length of the vapor line between the reversing valve and the outdoor coil (ft.)	2.0

New Line

Lines from the Reversing Valve to the Compressor:

DSLRV	Inside diameter of the suction line from the reversing valve to the compressor inlet (in.)	0.7260
XLEQLP	Equivalent length of the low-pressure line from the reversing valve to the compressor inlet (ft.)	5.0
DDLRV	Inside diameter of the discharge line from the compressor outlet to the reversing valve (in.)	0.4760
XLEQHP	Equivalent length of the high-pressure line from the compressor outlet to the reversing valve (ft.)	2.0

SOLUTION CONVERGENCE CRITERIA :

New Line

Iteration Convergence Parameters :
(if set to zero or a blank line, the following defaults will be used)

AMBCON	Convergence parameter for the iteration on evaporator inlet air temperature (°F)	0.20
CNDCON	Convergence parameter for the iteration on condenser exit subcooling (or on exit quality * 200) -- used when IREFC = 0 on Line 6 (F°); also the quantity {2 * CNDCON} is used as the convergence parameter for the charge balancing iteration when ICHRGE =2	0.20
FLOCON	Convergence parameter for iteration on refrigerant mass flow rate -- used when IREFC › 0 on Line 6 (equivalent F°), value is specified as if it were in degrees F and is scaled internally (by $1/20^{th}$) to give a mass flow convergence factor	0.20
EVPCON	Convergence parameter for iteration on evaporator exit superheat (F°), (or on exit quality * 500); Also the quantity {2 * EVPCON} is used as the convergence parameter for the charge balancing iteration when ICHRGE =1	0.50
CONMST	Convergence parameter for iterations on evaporator tube wall temperatures in subroutine EVAP and dew-point temperature in subroutine XMOIST (F°)	0.003
CMPCON	Convergence parameter for iteration on suction gas enthalpy in the efficiency-and-loss compressor model (Btu/lbm) -- only used when ICOMP = 1 on Line 8	0.05
TOLH	Tolerance parameter used by refrigerant routines in calculating properties of superheated vapor when converging on a known *enthalpy* value (Btu/lbm)	0.001
TOLS	Tolerance parameter used by refrigerant routines in calculating properties of superheated vapor when converging on a known *entropy* value (Btu/lbm/°R)	0.00005