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**MERCURY AUDIT AT
ROCKY MOUNTAIN ARSENAL**

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M. K. Jensen
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ROCKY MOUNTAIN ARSENAL**

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DATE PUBLISHED - FEBRUARY 1994

Prepared for the
HAZWRAP SUPPORT CONTRACTOR OFFICE
Oak Ridge, Tennessee
Prepared by
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managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract DE-AC05-84OR21400



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EXECUTIVE SUMMARY

This report presents the results of an environmental compliance audit to identify potential mercury-containing equipment in 261 buildings and 197 tanks at the Rocky Mountain Arsenal (RMA). The RMA, located near Denver, Colorado, is undergoing clean up and decommissioning by the Department of the Army. Part of the decommissioning procedure is to ensure that all hazardous wastes are properly identified and disposed of. The purpose of the audit was to identify any mercury spills and mercury-containing instrumentation.

The audits were conducted from April 7, 1992, through July 16, 1992, by a two-person team. The team interviewed personnel with knowledge of past uses of the buildings and tanks. Information concerning past mercury spills and the locations and types of instrumentation that contain mercury proved to be invaluable for an accurate survey of the arsenal. The team used a Jerome® 431-X™ Mercury Vapor Analyzer to detect spills and confirm locations of mercury vapor. Twelve detections were recorded during the audit and varied from visible mercury spills to slightly elevated readings in the corners of rooms with past spills. The audit also identified instrumentation that contained mercury. All data have been incorporated into a computerized data base that is compatible with the RMA data base.

1. INTRODUCTION

1.1 BACKGROUND

The Rocky Mountain Arsenal (RMA), which has been used for the production of a wide variety of chemical compounds for both military and commercial applications, is under the control of the Department of the Army. The Department of the Army is in the process of cleaning up and decommissioning the RMA, and as part of that deactivation procedure, all hazardous wastes are to be properly identified and disposed of. Interim remedial actions are presently underway, and the installation is listed on the Environmental Protection Agency's (EPA) National Priority List (NPL).

To obtain assistance for environmental compliance and decommissioning activities, the Program Manager Rocky Mountain Arsenal (PMRMA) entered into an interagency agreement with the Department of Energy (DOE). The Hazardous Waste Remedial Actions Program (HAZWRAP), a division of Martin Marietta Energy Systems, Inc., a DOE contractor, was tasked to provide that assistance. HAZWRAP's support to PMRMA is defined in the program management plan (HAZWRAP 1991). HAZWRAP assigned the task of auditing for mercury to Oak Ridge National Laboratory (ORNL), to be performed by ORNL's Grand Junction, Colo., office. A work plan was prepared to accomplish this task (ORNL 1992).

1.2 TASK DESCRIPTION

The audit was conducted during three trips to the RMA during April, May, and July 1992. The list of buildings and tanks audited was supplied by PMRMA with the objective to locate any mercury spills and to identify instrumentation containing mercury. Locations of mercury, detection of spills, readings, and

comments were recorded on field sheets during a walk-through survey of each building and around each tank. Analyzer readings were taken in every room of each building and at all instrumentation; comments were entered on the field sheets if a building or tank could not be surveyed. This information was to be made available in electronic format to the RMA data base for review before any remedial action took place. A description of the ORNL data base appears in Appendix A.

1.3 APPROACH

The Jerome® 431-X™ Mercury Vapor Analyzer was selected for this audit because it is portable and the gold film sensor is inherently stable and selective to mercury, thus eliminating interferences (such as water vapor and hydrocarbons) that are common to ultraviolet analyzers. The instrument's detection range is 0.003 to 0.999 mg/m³, with a precision of 5% relative standard deviation at 0.100 mg/m³ of mercury.

Because of its low vapor pressure (0.0012 mm), mercury is not easily detected when left undisturbed. Since mercury tends to settle in cracks and corners, it becomes more difficult to detect over a period of time both visually and with a mercury vapor analyzer due to dust and oxidation.

Given these characteristics of mercury, the audit team began its investigation by meeting with PMRMA personnel familiar with plant activities. During these interviews, the team gathered information about past and present mercury spills, equipment, laboratory uses, and locations where mercury may have been used. Health and safety concerns were also discussed. Information obtained during these interviews made locating mercury spills much easier.

2. RESULTS

The results of the audit are presented in two categories: (1) the results of the comprehensive audit that was structured to identify the presence of all mercury in and around the buildings and tanks, and (2) the detection of all spilled or unconfined mercury in any of these areas. The first category is referred to as the mercury audit results and the second as detections.

2.1 MERCURY AUDIT RESULTS

2.1.1 Results from Buildings and Tanks Audited

Audit results for buildings and tanks are presented in Table 2.1, with building numbers and tank numbers listed alphanumerically. Detection numbers, analyzer readings, and locations identify all detections. The comments section lists the known mercury-containing or possibly mercury-containing instruments and their locations. Any building not audited or locations where only partial audits were performed are also noted in the comments section.

2.1.2 Other Buildings and Tanks

Twenty-five buildings from the original list were not audited for one of three reasons: 1) the building no longer exists or could not be located; 2) access to the building was denied due to physical barriers, for example locked doors, boarded up buildings, and fenced off areas; or 3) unsafe conditions prevented auditing. A list of unaudited buildings is presented in Table 2.2.

Table 2.1. Mercury audit results

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
111		0			
112		0			
112A		0			
135		0			
143		0			
145		0			
211		0			
213		0			
241		1	0.128	Old laboratory room	Elevated readings inside the center lab bench and the northernmost bottom cabinet, west side. The cabinet is marked asbestos (no visible mercury).
242		0			
243		1	0.010	East wall/switchroom/2nd floor	Elevated readings in the switchroom (2nd room from west end) from an in-line pressure gauge (manometer) containing mercury. A pot that may contain mercury was also found.
244		0			Building no longer exists.
245		0			
251		0			Stairs to upper floor boarded off. Checked ground floor only.
307		0			
309		0			
311		0			
312		0			
313		0			Laboratory building; one lab was used to store mercury in the past, but no elevated readings were measured during the audit.
314		0			
315		0			
315A		0			
319		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
321		1	0.764	North wall/ 2nd floor	1) Behind the instrument panel, visible spills of mercury were detected on the floor. The instruments still in use have pots containing mercury. 2) Throughout the building are Mercoïd switches still in use containing small amounts of mercury.
321A	321A	0			
321B	321B	0			
321C		0			
321D		0			
321E	321E	0			
322		0			
322A		0			
325		1	0.040	North wall/ 1st floor	Elevated readings of mercury were detected on the floor behind the control panel. Instruments on the panel have pots containing mercury.
325		2	0.006	2nd floor/ southeast corner	Instrument assembly room was used to drain mercury from old meters. Slightly elevated readings were recorded in the corner of the room.
326		0			
328		0			Mercoïd switches found on 1st floor, northeast corner of switch gear room, on vertical piping.
328A		0			
329		0			
331		0			
332		0			
333		0			
334		0			
335		0			
336		0			
337		0			
341		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
341A		0			
341B		0			
342		0			
343		0			
343A		0			Boarded up; could not access.
343B		0			
344		0			
345		0			
346		1	0.860	Southeast wall	A mercury spill was found in the meter storage area. Small pools of mercury are visible below an old instrument. Additional mercury-containing meters are stored in this area.
346		2	0.342	North wall/ westernmost door	Two 5-gal buckets containing approximately 3 gal of mercury in separate plastic containers were located near the northwest door.
351		0			
352A		0			
354		0			
355		0			
356		0			
361		0			
362		0			
364		0			
365		0			2 Mercoid switches on east wall. One is attached to the wall, and one is on a table.
368		0			The tank room of the swimming pool has a level gauge that used mercury. Also, bottles of mercury were stored there in the past. No elevated readings were detected during the audit.
371		0			2 Mercoid switches on the west wall, 1st floor. 2 more Mercoid switches on the west wall, basement pump room.
372A		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
373		0			
373B		0			
378		0			The old Building 378 on airport property has been removed, and a new Building 378 is now located southeast of Building 615.
379		0			
382		0			
383		0			
383A		0			Building has been removed.
385		0			
386		0			
387		0			
391		0			
392		0			
393		0			
409		0			
411		0			
411A		1	0.480	Northeast corner under instrument	Visible mercury spill from a mercury pot in a recorder.
411B		0			
412		0			Several Mercoid switches in the storage room, northeast corner of the building.
413		0			Tank on the west side of the building has a mercury thermometer on the north end.
425	T0032	0			
426	R0019	0			
428		0			
429		0			
431		0			
433		1	0.024	South corridor, south side of building	2 chart recorders are in the south corridor, south side of building; no visible mercury.
459C		0			
462A	462A	0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
463A	463A	0			
463B	463B	0			
463C	463C	0			
463E	463E	0			
463F	463F	0			
463G	463G	0			
463H	463H	0			
464		0			
464A	464A	0			
464B	464B	0			
471	T0130	0			
471	T0131	0			
471	T0132	0			
471	T0133	0			
471	T0273	0			
472	T0208	0			
473	T1048	0			
473	T1142	0			
473	V1061	0			
473	V1064	0			
512	T1390	0			
512	T1391	0			
512	T1392	0			
515	R0038	0			
515	V1214	0			
515	V1220	0			
522		0			2 Mercoid switches on the east end of loading dock.
522B		0			
523		0			
527		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
536		0			Located: 1) 9 Mercoid meters in rear of control panel in control room. 2) 1 Mercoid switch on top of vent line next to salt storage tank. 3) Foxboro™ pneumatic transmitter next to salt storage tank with a pot on back that may contain mercury. 4) 2 Mercoid switches on 2nd level on natural gas line in rear of dryer tank.
537		0			Located: 1) Manometer containing mercury in storage pen in shipping W.T. room. 2) Thermostat on cooling unit inside middle door next to caustic tank. 3) Thermostat on cooling unit behind mustard gas containment unit inside middle door on north wall. 4) Mercoid switch on compressor behind middle mustard gas containment unit inside middle doors.
538		0			Located: 1) 4 Honeywell™ temperature control meters with mercury bulbs on the south side of north-central wall. 2) Honeywell™ temperature control meter that may contain mercury on control panel for furnace. 3) 4 Mercoid switches on control panel in southeast corner, east of furnace. 4) Thermometer (400° F) above and right of furnace control panel. 5) 2 Mercoid switches behind and right of furnace control panel.
538A		0			7 Mercoid switches on quench and scrubber control panel.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
539		0			
540		0			Mercoid switch on a Moyno™ pump near southeast corner.
541		0			In bay "K" on north side of building, a Honeywell™ "Pressuretrol™" meter containing mercury was found on the floor. It is attached to a pot that may contain mercury.
541A		0			
542		0			Located: 1) Mercury float switch and three Honeywell™ pressure switches with mercury bulbs in pipe fitting area on shelf #7. 2) Located multiple Honeywell™ thermostats containing mercury in metal cabinet #D.
543		0			Honeywell™ chart recorder on the north wall that may contain mercury.
543A		1	0.039	North wall/floor/west end	Several elevated readings along crack where wall and floor meet. A mercury spill occurred in this building in the past and was cleaned up.
543B		0			Located: 1) 2 mercury standard cells in a metal cabinet on the north wall of the B.G.&U. shop. 2) 2 mercury standard cells were located in cabinet #3 on the south wall of the janitor's supply room.
544		0			
545		0			
546		0			
548		0			The building consists of a basement that is flooded; could not access. Meters that may contain mercury are visible from the hatch in the roof.
549		0			
550		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
552		0			
553		0			
555		0			
605		0			
607		0			
608		0			
611		0			Large vault was locked and could not be accessed.
612		0			
613		0			
614		0			
615		0			
616		0			
617		0			
618		0			Found a glass pressure meter (CARM 12743) containing mercury and a 1-oz. bottle of high grade mercury. Both items were located in row 30, section G.
619		0			1) 55-gal drum (25420), label indicated mercury content. The drum is located in grid 2, aisle I, row 43. 2) 55-gal drum (40858), label indicated mercury contents. The drum is located in row 32, section E.
621		0			
621A		0			
622		0			
623		0			
624		0			
625		0			
627		0			
627B		0			
629		0			
629E		0			
630		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
631		0			
631A		0			
632		0			There are numerous Mercoïd and Honeywell™ switches containing mercury on boiler system.
633		0			Thermostat containing 2 mercury bulbs on east wall.
633A		0			
633B		0			
634		0			
635		0			
639		0			
643		0			
647A		0			
647B		0			
647C		0			
647D		0			
648		0			
673		0			
725		0			
726		0			Could not access south side of building due to bees.
728		0			
731		0			
732		0			
735		0			
741		0			Labor building, possible past spills, but no elevated readings detected during audit.
742		1	0.027	South section, north side, row T	Flow meter with a mercury pot attached; no visible mercury.
742A		0			
743		0			Laboratory building, possible past spills; no elevated readings detected during audit. A Mercoïd switch was detected on sump pump level control system. Sump is located outside on north side of building.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
743A		0			
744		0			
745		0			
745A	745A	0			
745B	745B	0			
745C	745C	0			
748		0			
751		0			
752		0			
752A		0			
753		0			
754		0			
785		0			
786		0			
787		0			
788		0			
791		0			
792		0			
793		0			
794		0			
795		0			
796		0			
797		0			
798		0			
801		0			
808		0			
831		0			
831A		0			
833		0			
834		0			
836		0			
841		0			
846		0			Building has been removed.
851		0			
863		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
864		0			
865		0			
866		0			
867A		0			
867B		0			
868C		0			Building has been removed.
1501		0			<p>Located:</p> <ol style="list-style-type: none"> 1) 2 Honeywell™ static pressure regulators with mercury bulbs on 3rd floor, south hall. 2) 2 Honeywell™ static pressure regulators with mercury bulbs on 3rd floor, north hall. 3) Ashcroft® mercury switch on 2nd floor, center bay. 4) Manometer in lab on 2nd floor, center bay. 5) Honeywell™ mercury switch in center bay mezzanine lab, west wall on overhead plumbing. 6) 2 manometers, one with visible mercury and one without, in south mezzanine lab. 7) Very old gas analyzer in south mezzanine lab that may have contained mercury. 8) 11 Honeywell™ chart recorders with 2 to 4 bulbs of mercury each in the control room on the northeast wall. 9) 35+ Panalarm™ meters in control panel.
1503A		0			Mercoid switch on a pipe next to the pump.
1503B		0			Mercoid switch on a pipe next to the pump.
1503C		0			Mercoid switch on a pipe next to the pump.
1504		0			
1504A		0			
1505A		0			
1506		0			2 Honeywell™ mercury switches on control panel in the northeast corner of control room.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
1509		0			
1510A		0			
1512		0			
1601		0			<p>Located:</p> <ol style="list-style-type: none"> 1) 2 Pressuretrol™ switches and one Mercoid switch in boiler room, 2nd floor, south end. 2) Honeywell™ chart recorder on west wall, center room of south bay. 3) 2 Pressuretrol™ switches in room B7 on panel in south end. 4) 5 Pressuretrol™ switches from north to south on east wall of room B7. 5) 1 Mercoid thermostat on west wall of Room B7. 6) 5 mercury-containing switches in M-125 bomb fill machine. 7) 1 mercury thermometer on east side, south end of 155 mm shell fill machine. 8) 2 Mercoid switches on west side, south end of 155 mm shell fill machine; also, a Mercoid switch with a pot attached that may contain mercury. 9) 1 Mercoid switch on west side, north end of 155 mm shell fill machine; also a Mercoid switch with a pot attached that may contain mercury. 10) 5 mercury-containing switches on west side, north end of 105 mm shell fill machine. 11) 2 Mercoid switches on round filling machines at southwest end of filling room. 12) Honeywell™ chart recorder on west wall, south end of filling room. 13) 1 Panalarm™ meter in storage shelf with other miscellaneous parts near north end of building. Could not access far north end of this building.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
1601A		0			2 manometers containing mercury in northeast room.
1602		0			
1603A		0			Mercoid switch on a pipe next to the pump.
1603B		0			Mercoid switch on a pipe next to the pump.
1606		0			<p>Located:</p> <ol style="list-style-type: none"> 1) Thermometer on control box. 2) 2 Honeywell™ chart recorders with 4 mercury bulbs each in assembly room on east wall, north bay. 3) 1 Honeywell™ chart recorder with 4 mercury bulbs in center of north bay on west wall. 4) 1 chart recorder with 8 mercury bulbs in assembly room on west wall. 5) 3 Mercoid switches located on top of round filling machine in the assembly room. 6) 3 mercury thermostats in boiler room. 7) 1 Honeywell™ chart recorder with 2 mercury bulbs on north wall of center room of assembly area. 8) Numerous chart recorders that may contain mercury on control panel covered with black plastic in control room. 9) Mercoid thermostat on wall opposite containment room. 10) 3 thermostats containing mercury in boiler room at south end of building. 11) 2 thermostats that may contain mercury located on overhead pipe in boiler room. 12) 1 Honeywell™ mercury-containing temperature recorder outside on the east side of the building.
1607		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
1611		0			Located: 1) 3 Honeywell™ gas pressure switches in room 11 on workbench. 2) 6 Mercoïd switches in room 11 on workbench. 3) Honeywell™ gas pressure switches in room 26 in supply crib on aisle 800-810, shelf E. 4) 1 Mercoïd switch in room 26 in supply crib, aisle 800-810, shelf D. 5) Mercoïd switch in south corner of disassembly room next to suit-removal room number 2. 6) Honeywell™ thermostat in 2nd floor control room on south wall. 7) Multiple Honeywell™ gas pressure switches and Mercoïd switches in a pile behind control panel on 2nd floor. 8) 3 Mercoïd control switches on southwest roof.
1611A		0			
1613		0			
1614		0			3 Mercoïd switches on top of round filling machine in the southeast end of the building.
1615		0			
1616		0			
1618		0			
1619		0			
1622		0			
1701		0			Located: 1) 4 Mercoïd thermostats evenly spaced along east wall. 2) 4 Mercoïd thermostats evenly spaced along west wall. 3) Mercoïd switch on pallet in row D east.
1702		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
1703		0			<p>Located:</p> <ol style="list-style-type: none"> 1) 2 Mercoïd switches on the west wall in the east bay. 2) Mercoïd thermostat on south wall near middle door in east bay. 3) Mercoïd switch in assembly room on south side of bay. <p>As advised by TVA, did not enter west end of building due to storage of unknown substances.</p>
1704		0			<p>Located:</p> <ol style="list-style-type: none"> 1) Mercoïd thermostat on south wall at east end next to phone cabinet lighting panel L-B. 2) 1 Mercoïd and 1 Honeywell™ thermostat on wall in generator room next to lighting panel L-E. 3) Mercoïd thermostat in generator room on north wall, west end. 4) Mercoïd thermostat in compressor room on south wall, west end. 5) 2 Mercoïd thermostats in compressor room on north wall. 6) Honeywell™ thermostat in compressor room on north wall. 7) 2 Mercoïd thermostats in boiler room on south wall. 8) 2 Mercoïd thermostats in boiler room on north wall. 9) 4 Honeywell™ Pressuretrol™ gauges, 1 on each of the boilers facing the center aisle.
1705		0			
1706		1	0.118	North end of center wall	Mercoïd thermostat with a broken mercury bulb. Traces of mercury were found under the switch.
1707		0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
1710		0			Located: 1) 3 bottles containing mercury-contaminated water in room 11. 2) Honeywell™ thermostat in room 36 on north wall.
1711		0			
1712		0			Located: 1) 2 Honeywell™ Pressuretrol™ gauges, 1 on northeast side of east furnace and 1 on northeast side of west furnace. 2) 2 Honeywell™ Pressuretrol™ gauges, 1 on west side of east furnace and 1 on west side of west furnace.
1713		0			
1717		0			
1718		0			
1719		0			
1727		0			
1730		0			Inaccessible due to bees.
1734		0			
1735		0			
NN0104		0			Broken temperature gauge that may contain mercury (no visible mercury).
NN0105		0			
NN0106		0			
NN0111		0			
NN0112		0			
NN0115		0			
NN0116		0			
NN0601		0			Building no longer exists.
NN0602		0			
NN0603		0			
NN0903		0			Access not controlled by PMRMA.
NN1201		0			Building has been removed.
NN1213		0			Building has been removed.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
NN2301		0			
NN2403		0			
NN2502		0			
NN2503		0			
T0026	T0026	0			
T0064	T0064	0			
T1040	T1040	0			Temperature probe (500° F).
T1606	T1606	0			Tank could not be located.
TF0101	T1219	0			
TF0101	T1220	0			
TF0101	T1267	0			
TF0101	T1296	0			
TF0101	T1307	0			
TF0101	T1394	0			High temperature thermometer on south side of tank.
TF0102	T1010	0			
TF0102	T1216	0			
TF0102	T1340	0			Tank had been removed.
TF0102	V1230	0			Tank had been removed.
TF0102A	T0014	0			
TF0102A	T0015	0			
TF0102A	T0160	0			
TF0102A	T0161	0			
TF0102A	T0164	0			
TF0102A	T0165	0			
TF0103	T0065	0			Temperature controller (250° F), west side of tank.
TF0103	T0066	0			Tank has been removed.
TF0103	T0075	0			Temperature gauge (<160° F).
TF0103	T0076	0			
TF0103	T0077	0			
TF0103	T0078	0			
TF0103	T0079	0			
TF0103	T0080	0			
TF0103	T0081	0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
TF0103	T0082	0			
TF0103	T0178	0			Instrumentation on catwalk not checked.
TF0103	T0197	0			Instrumentation on catwalk not checked.
TF0103	T1124	0			Instrumentation on east and west side of tank.
TF0103	T1202	0			
TF0103	T1203	0			
TF0103	T1204	0			Thermostat on south end of tank (300° F).
TF0103	T1272	0			
TF0103	T1273	0			
TF0103	T1324	0			
TF0103	T1377	0			
TF0103	T1446	0			Recorder on west side of tank, instrumentation above.
TF0103	V1147	0			
TF0104	T0019	0			High temperature probe on south end of tank.
TF0104	T1128	0			Tank has been removed.
TF0104	T1129	0			Tank has been removed
TF0104	T1132	0			Tank has been removed.
TF0104	T1133	0			Tank has been removed.
TF0104	T1135	0			
TF0104	T1139	0			
TF0104	T1140	0			Tank has been removed.
TF0104	T1148	0			Possible mercury-containing instrument on top of tank. High temperature thermometer and flow meter on sides of tank.
TF0104	T1149	0			Possible mercury-containing instrument on top of tank. High temperature thermometer and flow meter on sides of tank.
TF0104	T1150	0			
TF0104	T1151	0			
TF0104	T1222	0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
TF0104	T1246	0			Possible mercury-containing instrument on top of tank. High temperature thermometer and flow meter on sides of tank.
TF0104	T1247	0			Possible mercury-containing instrument on top of tank. High temperature thermometer and flow meter on sides of tank.
TF0104	T1322	0			
TF0104	T1323	0			
TF0104	T1463	0			
TF0104	V1250	0			
TF0104	V1254A	0			
TF0104	V1254B	0			
TF0105	V1500	0			
TF0105	T1501	0			
TF0105	T1502	0			
TF0105	T1503	0			
TF0105	T1504	0			Several instruments and a 1-gal pot that may contain mercury are on top of tank.
TF0105	T1505	0			
TF0105	T1506	0			
TF0105	T1507	0			
TF0105	T1508	0			
TF0105	T1509	0			
TF0105	T1510	0			
TF0105	T1511	0			High temperature probes on east and west sides of tank.
TF0105	T1512	0			
TF0105	T1513	0			
TF0105	T1514	0			
TF0105	T1515	0			
TF0105	T1516	0			
TF0105	T1566	0			
TF0105	T1569	0			
TF0105	T1570	0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
TF0105A	V1255	0			
TF0105A	V1259	0			
TF0105A	V1264	0			Tank has been removed.
TF0105A	V1265	0			Tank has been removed.
TF0105A	V1267	0			Could not locate tank.
TF0105A	V1270	0			
TF0105A	V1313	0			
TF0106	T0058	0			
TF0106	T0257	0			
TF0106	T1027	0			
TF0106	T1315	0			
TF0106	V1156	0			
TF0106	V1187	0			
TF0107	T0026	0			
TF0107	T0027	0			
TF0107	T0139	0			
TF0107	T0190	0			
TF0108	T1235	0			
TF0108	T1253	0			Temperature probe (300° F), on south end of tank.
TF0108	T1279	0			
TF0108	T1288	0			
TF0108	T1289	0			
TF0108	T1290	0			
TF0108	T1291	0			
TF0108	T1305	0			
TF0108	T1433	0			
TF0108	V1186	0			
TF0108	V1253	0			Possible mercury-containing instrumentation.
TF0108	T1307	0			
TF0110	T1127	0			
TF0110	T1134	0			
TF0110	T1146	0			Could not access tank; fenced off by Shell.

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
TF0110	T1147	0			Could not access tank; fenced off by Shell.
TF0110	T1171	0			
TF0110	T1173	0			
TF0110	T1215	0			
TF0512	V1001	0			
TF0512	V1002	0			
TF0628	T0628A	0			
TF0628	T0629A	0			
TF0628	T0629B	0			
TF0628	T0629C	0			
TF0628	T0629D	0			
TF0628	T0648A	0			
TF0628	T0648B	0			
TF1402	T41104	0			
TF1402	T41115	0			
TF1402	T49368	0			
TF1402	T49369	0			
TF1402	T49370	0			
TF1402	T49371	0			
TF1402	T49372	0			
TF1402	T49373	0			
TF1403	T0001	0			
TF1403	T0002	0			
TF1403	T0003	0			
TF1403	T0004	0			
TF1403	T0005	0			
TF1404	1404	0			
TF1405	T0001	0			
TF1405	T0002	0			
TF1502	F5109	0			
TF1502	F5110	0			
TF1502	F5111	0			
TF1502	F5112	0			
TF1502	F5601	0			

Table 2.1. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
TF1502	F5602	0			
TF1505	F05102	0			
TF1505	F05103	0			
TF1505	F05104	0			
TF1505	F05105	0			
TF1505	F05106	0			
TF1505	F05107	0			
TF1505	F05108	0			
TF1505	F50097	0			
TF1505	F50098	0			
TF1505	F50099	0			
TF1508	T0001	0			
TF2501	F40007	0			
TF2501	F50117	0			
TF2501	F50120	0			
TF2501	F50123	0			
TF2501	F50393	0			
TF2501	F50394	0			
TF2501	F50670	0			
TF2501	F50967	0			
TF2501	G50830	0			
TF2501	G50831	0			

Table 2.2. Tanks and buildings not audited

TANKS		
Tank Farm	Tank number	Reason for not surveying
TF0102	V1230	Tank has been removed
TF0102	T1340	Tank has been removed
TF0103	T0066	Tank has been removed
TF0104	T1128	Tank has been removed
TF0104	T1129	Tank has been removed
TF0104	T1132	Tank has been removed
TF0104	T1133	Tank has been removed
TF0104	T1140	Tank has been removed
TF0105A	V1264	Tank has been removed
TF0105A	V1265	Tank has been removed
TF0105A	V1267	Could not locate tank
T1606	T1606	Could not locate tank
TF0110	T1146	Could not access, fenced off by Shell
TF0110	T1147	Could not access, fenced off by Shell

Table 2.2. (continued)

BUILDINGS		
Building No.	Description	Reason for not surveying
244	3 liquid chlorine tank saddles	Building has been removed
343A	Flammable material storehouse	Boarded up, no access
383A	Officer's Club storage	Building has been removed
548	Process water pumping station (underground)	Flooded
NN0601	Loading dock	Building has been removed
846	Recreation building	Building has been removed
868C	Office/ton container storage shed	Building has been removed
NN0903	VORTAC station	Locked, not under PMRMA control
NN1201	Long metal shed	Building has been removed
NN1213	Maintenance shop	Building has been removed
1730	Sentry station/gate house	Inaccessible due to bees

In addition, the team was unable to access portions of some buildings. The locations and reasons for partial surveys are listed in the comments section of Table 2.1.

2.2 DETECTIONS

Detections during the audit are defined as above-zero readings on the Jerome® 431-X™ Mercury Vapor Analyzer. The twelve detections located are presented in Table 2.3. Visible mercury spills were the most critical of these, with the remaining detections attributed to mercury-containing instrumentation and residual mercury from past spills. There were no visible mercury spills in these remaining detections. Detections in five buildings (241, 321, 346, 411A, and 1706) exceed the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (PEL) of 0.100 mg/m³ for mercury.

2.2.1 Visible Mercury Spills

Visible mercury spills were found in Buildings 321, 346, 411a, and 1706. The spills in Buildings 321, 346, and 411a were from instruments with leaking mercury pots. Figure 1 top shows a typical instrument control panel utilizing mercury pots; Fig. 1 bottom shows a back view of a portion of the same instrument panel with the mercury pot attached to the back of a round chart recorder. The spill detected in Building 1706 was the result of a broken thermostat. In addition to these four mercury spills, there were two buckets in Building 346 containing bottles of mercury drained from old mercury pots. Mercury vapors were leaking from these containers.

Table 2.3. Mercury detections

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
241		1	0.128 ^a	Old laboratory room	Elevated readings inside the center lab bench and the northern-most bottom cabinet, west side. The cabinet is marked asbestos (no visible mercury).
243		1	0.010	East wall/switchroom/ 2nd floor	Elevated readings in the switchroom (2nd room from west end) on an in-line pressure gauge (manometer) containing mercury. A pot that may contain mercury was also found.
321		1	0.764 ^a	North wall/ 2nd floor	1) Behind an instrument panel, visible spills of mercury were detected on the floor. Most instruments have pots containing mercury. These instruments are still in use. 2) Throughout the building are Mercoid switches containing small amounts of mercury. These switches are still in use.
325		1	0.040	North wall/ 1st floor	Elevated readings of mercury were detected on the floor behind the control panel. Instruments in the panel have pots containing mercury.
325		2	0.006	2nd floor/ southeast corner	The instrument assembly room was used to drain mercury from old meters. Slightly elevated readings were detected in the corners of the room.
346		1	0.860 ^a	Southeast wall	A mercury spill was found in the meter storage area. Small pools of mercury are visible below an old instrument. Additional mercury-containing meters are stored in this area.
346		2	0.342 ^a	North wall/ westernmost door	Two 5-gal buckets containing approximately 3 gal of mercury in separate plastic containers were found near the northwest door.
411A		1	0.480 ^a	Northeast corner under instrument	Visible mercury spill from a mercury pot in a recorder.

Table 2.3. (continued)

Building No.	Tank No.	Detection No.	Analyzer Reading, mg/m ³ Hg	Location of Detection	Comments
433		1	0.024	South corridor/south side of bldg.	2 chart recorders in south corridor, south side of building. No visible mercury.
543A		1	0.039	North wall/floor/west end	Several elevated readings along crack where wall and floor meet. A mercury spill occurred in this building in the past and was cleaned up.
742		1	0.027	South section/north side/row T	Flow meter with a mercury pot attached; no visible mercury.
1706		1	0.118 ^a	North end of center wall	Mercoid thermostat with a broken mercury bulb. Traces of mercury were found under the switch.

^a Readings exceed the OSHA PEL of 0.100 mg/m³ for an 8-hour period.

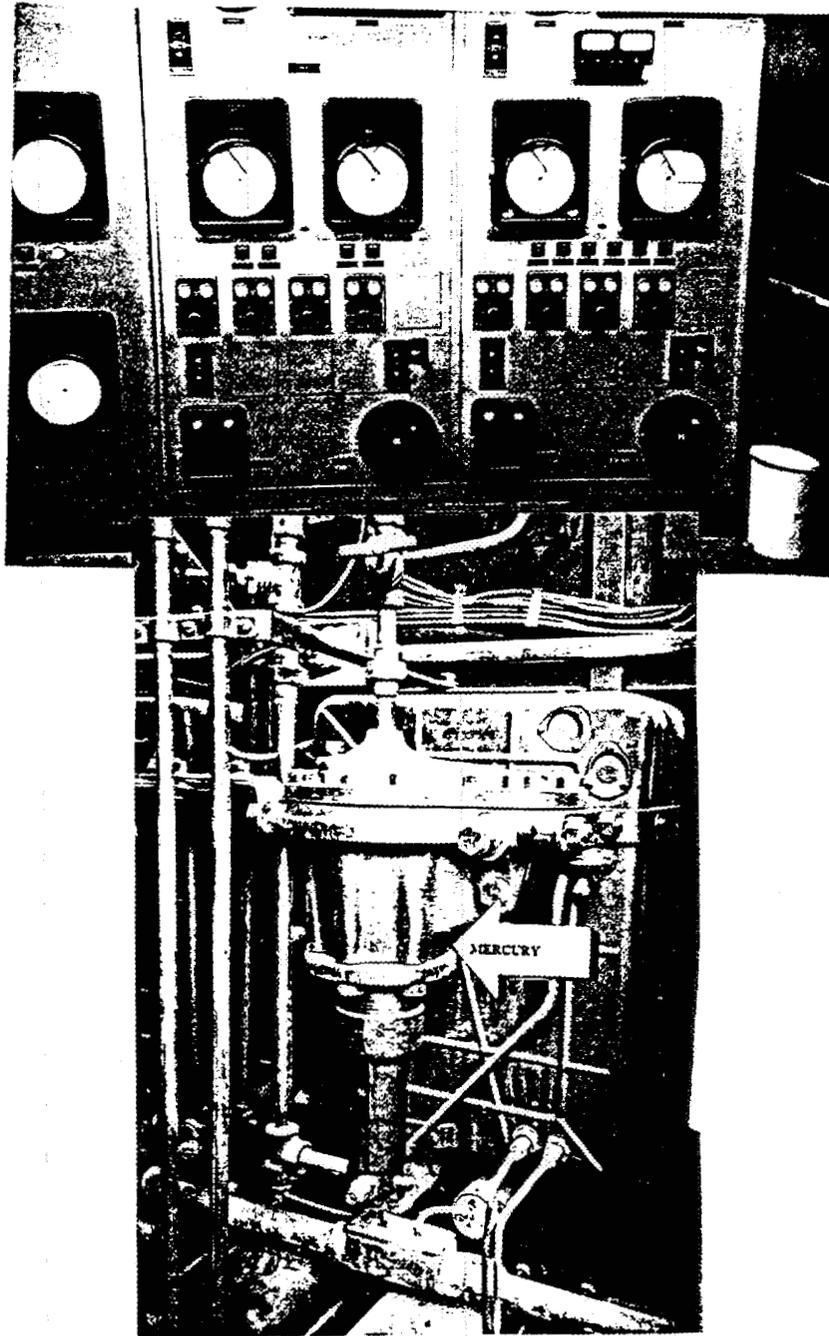


Fig. 1. Front view of instrument control panel and rear view showing mercury pot.

2.2.2 Other Detections

Buildings 325 and 742 each had mercury pots emitting detectable mercury vapors. Neither of these buildings had visible mercury spills.

Reported past mercury spills were closely investigated, and three of these areas in Buildings 241, 325, and 543A showed detectable mercury vapor with no visible mercury. The detection location in Building 325 was an area used to drain old mercury pots.

Building 433 contains two chart recorders. Mercury vapor was detected inside the recorders through a small hole; however, since the doors of both recorders were rusted shut, the presence of mercury bulbs could not be confirmed.

The remaining detection was at an old manometer located in Building 243. A similar mercury-containing manometer is shown in Fig. 2.

2.3 INSTRUMENTATION

In addition to the mercury-containing instruments shown in Figs. 1 and 2, several other commonly found instruments containing mercury bulbs were photographed to aid with any remedial action that may follow. Figure 3 shows two Mercoid controls and a Mercoid thermostat, both commonly found on machinery at the RMA. The color of the controls varies from black to green. All are round, with mercury bulbs visible through a glass window. A Mercoid thermostat was found in Building 1706 with a broken mercury bulb. Another common mercury-containing thermostat is the round Honeywell™ thermostat (no picture available). Not all of the thermostats used at RMA contain mercury.

Figure 4 shows the front and back of a Honeywell™ chart recorder and the locations of the mercury bulbs. These recorders typically had two to four mercury bulbs.

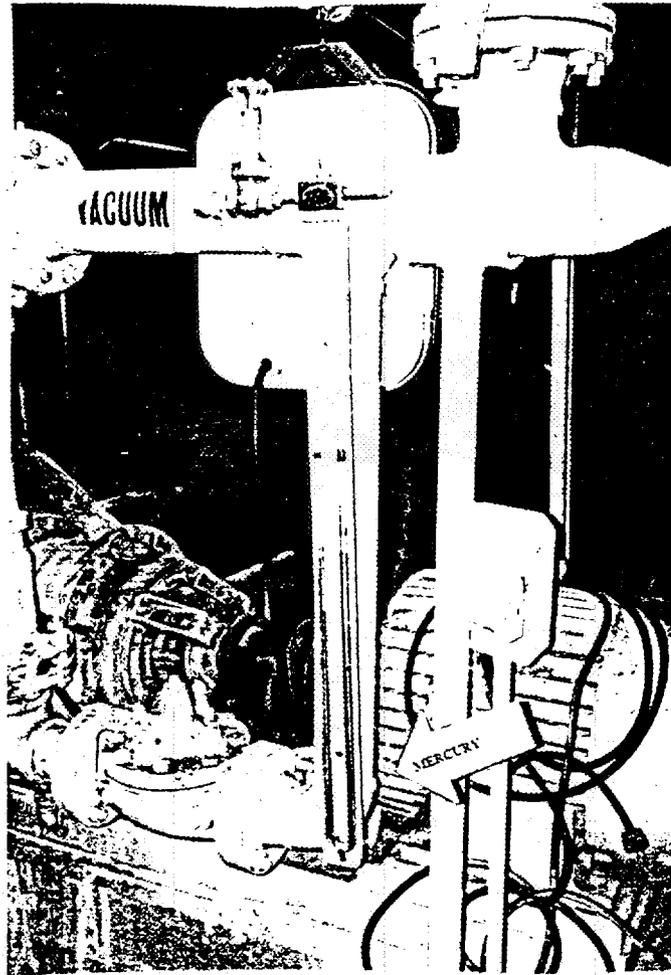


Fig. 2. Mercury-containing manometer.

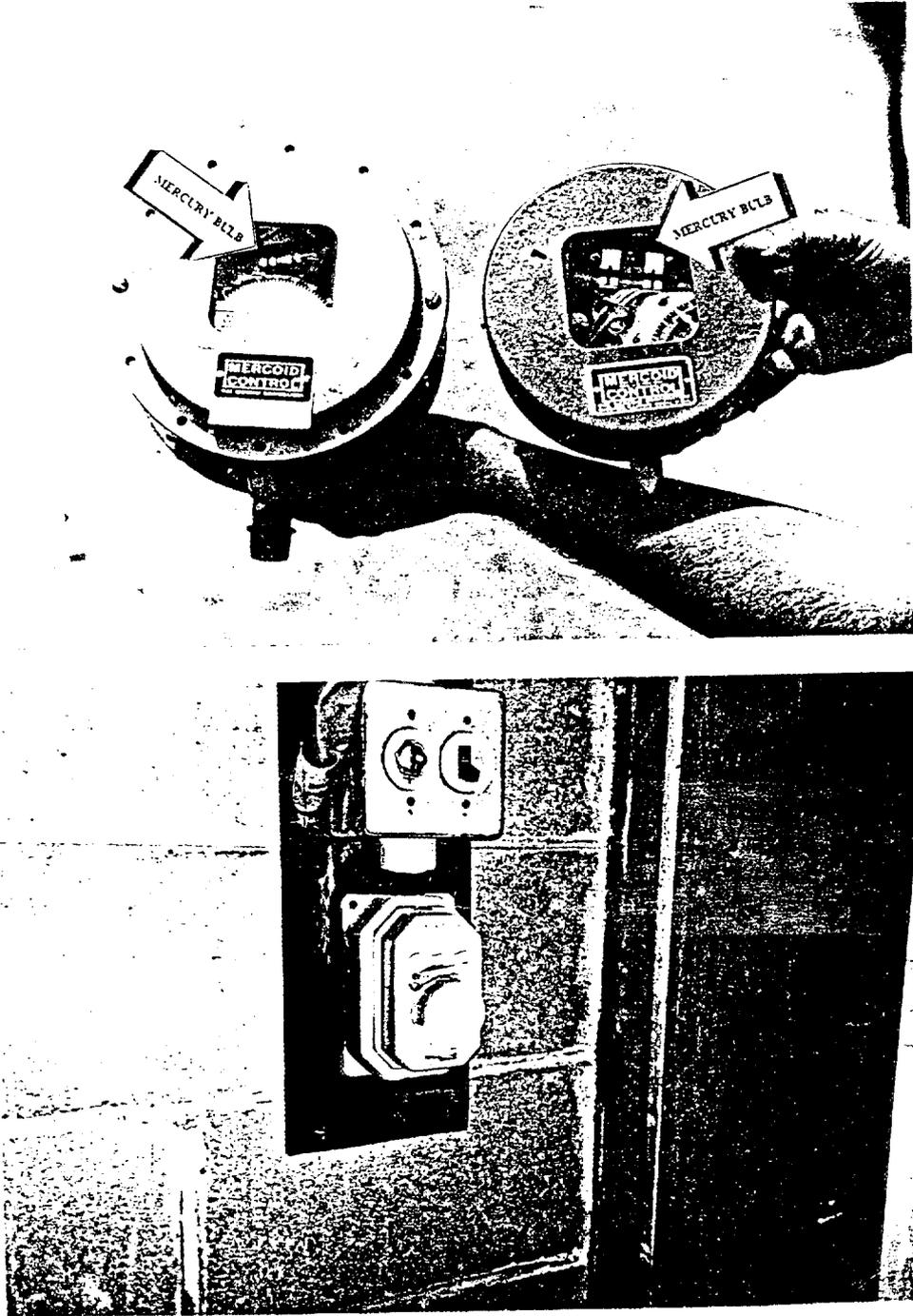


Fig. 3. Mercoid controls and Mercoid thermostat.

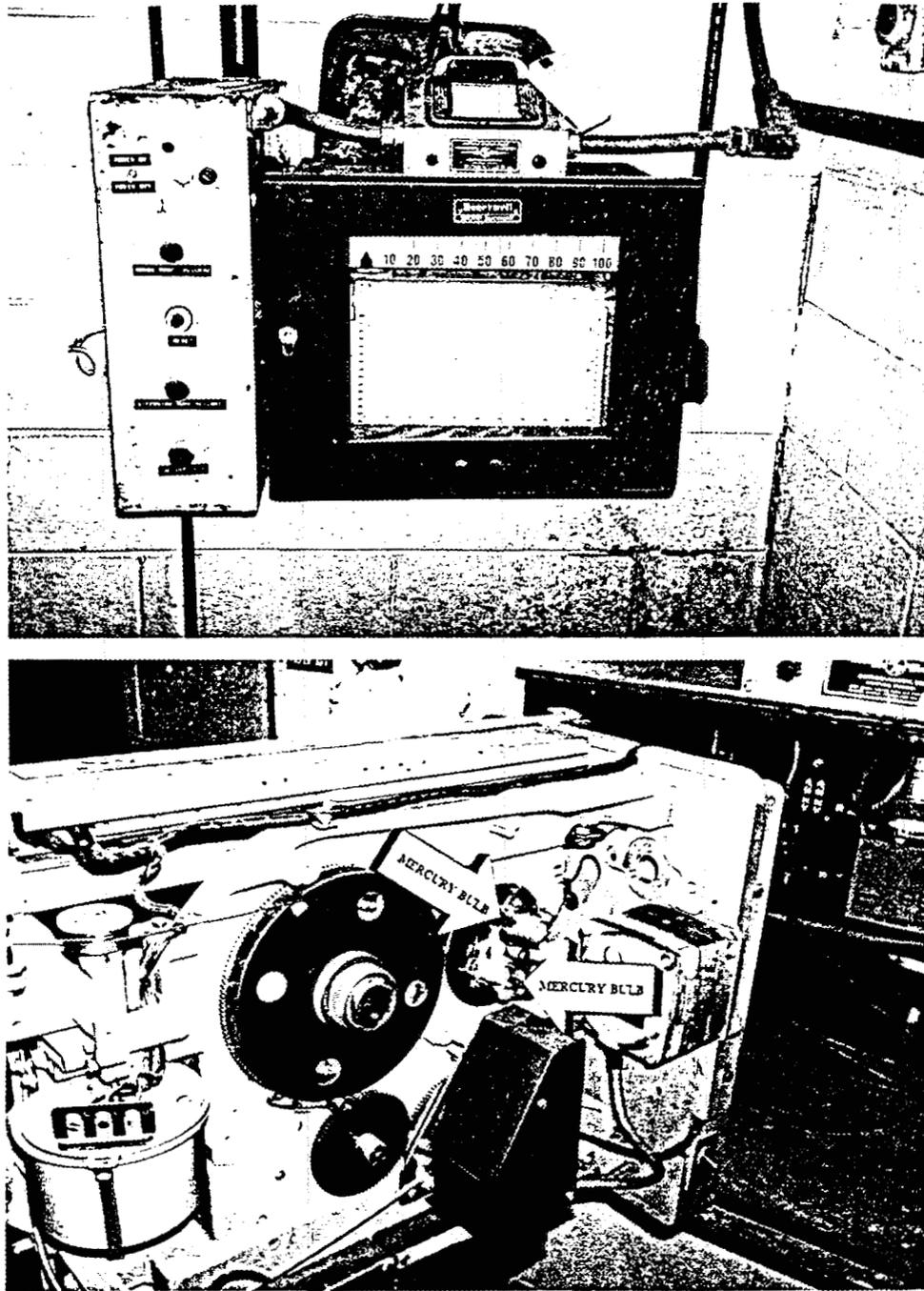


Fig. 4. Honeywell™ chart recorder with inside view of mercury bulbs.

Figure 5 shows a control panel with 10 Panalarm™ controls. Also shown are an individual Panalarm™ detached from the control panel and a side view of the instrument.

Figure 6 and the top of Fig. 7 are pictures of Pressuretrol™ instruments. Several different types of these instruments were located at the RMA, some appearing to be newer than others. Mercury bulbs are indicated.

A Honeywell™ gas pressure switch appears as the bottom picture in Fig. 7. Many of these switches are located in boxes in storage areas and supply cabinets; however, none were located on machinery.

In addition to those shown in the figures, many other instruments were found and are listed in Table 2.1 with brief descriptions of locations. It should be noted that instruments suspected of containing mercury are also on this list. The placement or condition of the instrument prevented confirmation of mercury content.

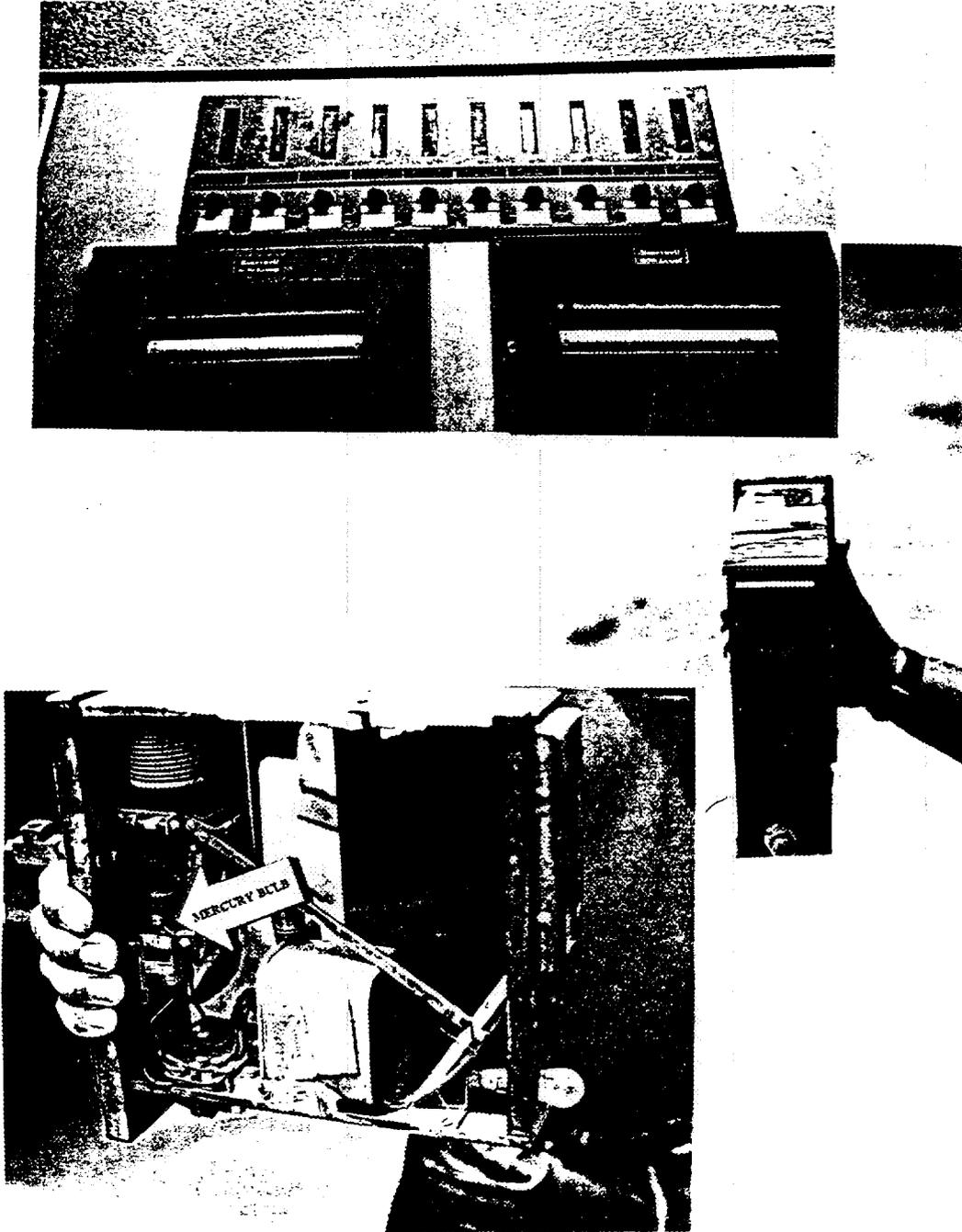


Fig. 5. Panalarm™ gauge, front and rear view.

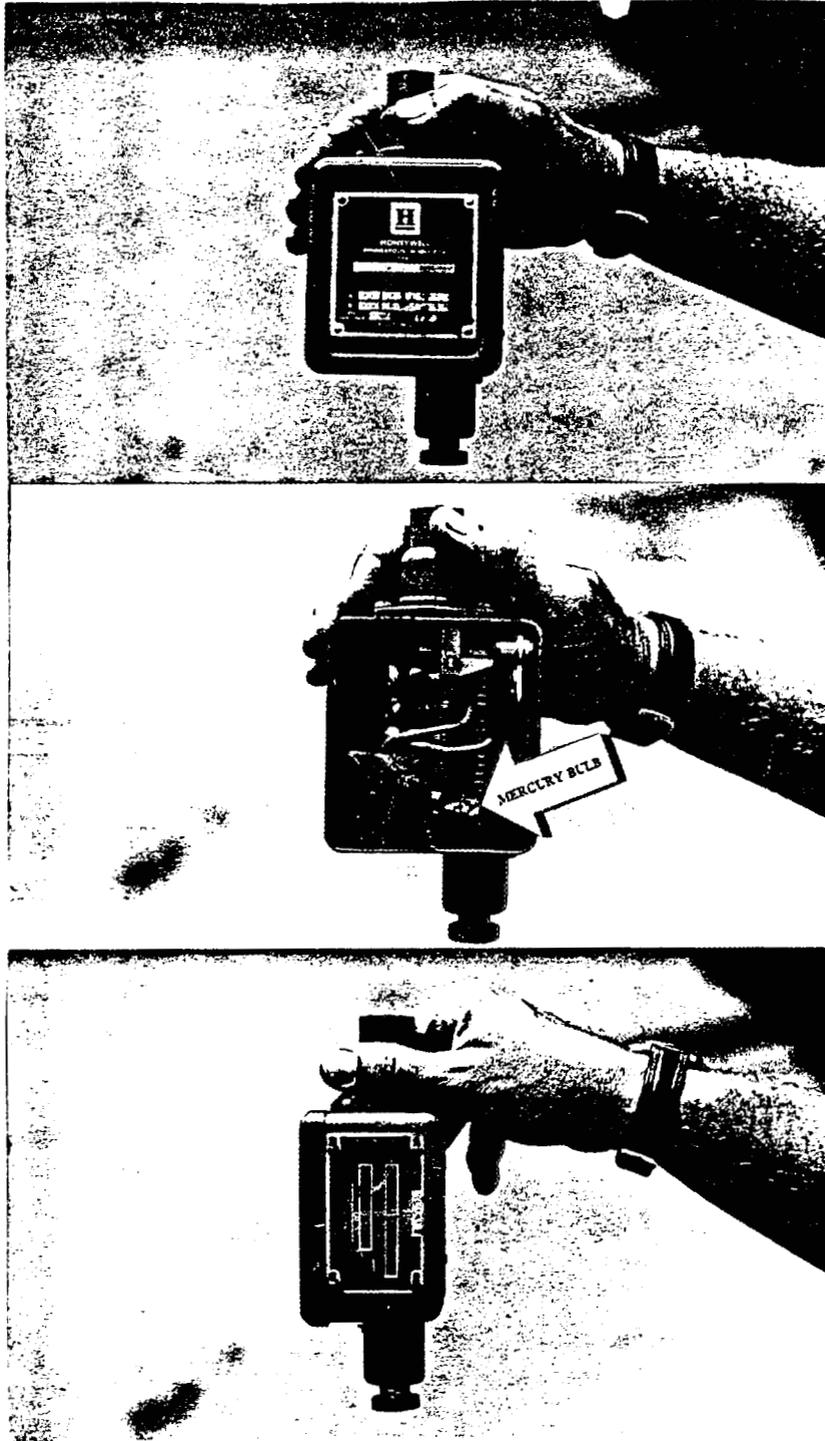


Fig. 6. Honeywell™ Pressuretrol™ switch with mercury bulb.

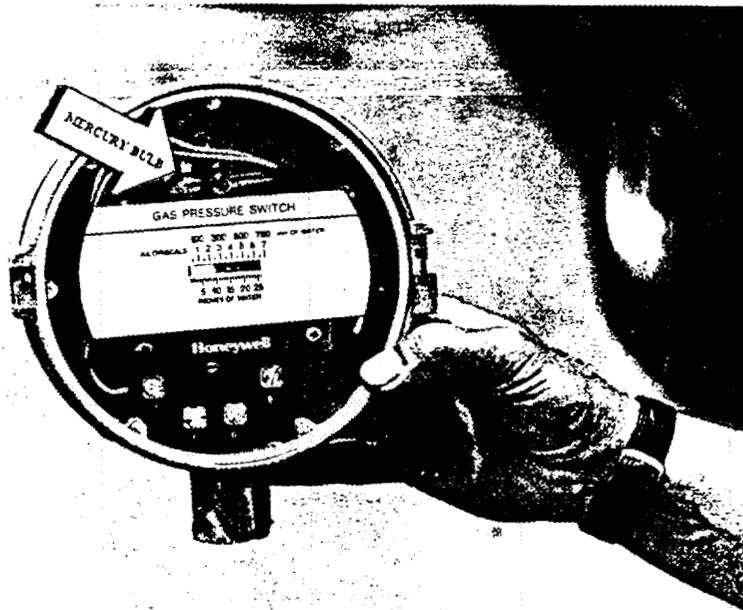
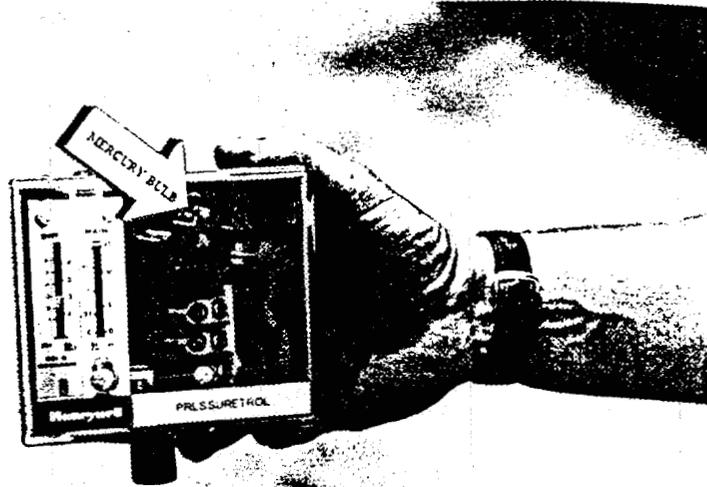


Fig. 7. Honeywell™ Pressuretrol™ switch and Honeywell™ gas pressure switch.

3. HEALTH AND SAFETY ISSUES

The primary health risks associated with mercury are skin absorption and inhalation of the vapor. Prolonged exposure to mercury vapor adversely affects the nervous system. Symptoms may include irritability, depression, vivid dreams, inflammation of the gums, insomnia, loss of memory and concentration, and constricted visual fields.

The OSHA PEL for mercury is 0.100 mg/m³ and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) is 0.05 mg/m³. Both of these standards are based on an eight hour day (NIOSH 1985).

A site-specific and job-specific health and safety plan for the audit was prepared following the requirements of the PMRMA and the HAZWRAP health and safety plan (HAZWRAP 1990) and in accordance with OSHA requirements for hazardous waste site operations described in Title 29 of the Code of Federal Regulations, Part 1910.120. The health and safety plan established personal protection standards and mandatory safety practices for the mercury audit.

In order to mitigate the risk of exposure to chemical agents, the audit team gathered as much information as was available on the history of each building and interviewed PMRMA staff and subcontractors who had worked in the areas of concern. In most of the buildings, there was evidence that personnel had worked in or inspected the areas within a sufficiently recent period of time to conclude that risk to the audit team was minimal. Contact with surfaces suspected to be contaminated and walking through puddles and mud and on discolored surfaces were avoided.

Both audit team members were fit tested for RMA-issued gas masks; these accompanied each member throughout the surveys. A two-way radio obtained from the RMA Fire Prevention and Protection Branch accompanied the audit team in all survey areas except in the North Plants. A two-way radio obtained

from a subcontractor, the Tennessee Valley Authority (TVA), was used in the North Plants. This provided the audit team with both information on TVA activities and a nearby emergency contact.

The audit team found RMA personnel and subcontractors to be extremely helpful with health and safety issues. Stearns and Rogers, another subcontractor, sent a representative to accompany the audit team in all buildings under their control. This proved to be quite useful, both in identifying health and safety concerns and locating mercury.

Access to buildings controlled by Weston, another subcontractor, required both reading and signing the Weston site-specific health and safety plan and a brief safety training. A representative of Weston accompanied the audit team and monitored the ambient air in buildings.

All access to the North Plant buildings was coordinated with the TVA. The list of buildings to be accessed was reviewed with TVA personnel, and special safety concerns were discussed. A representative from the TVA accompanied the audit team in Building 1501. Asbestos removal by Dominion, Inc., and dismantling of equipment by the TVA made this building a special safety concern. The TVA also was concerned about entry into Building 1611. An employee of the TVA had developed eye problems after entering this building the prior week. It was only after further investigation by TVA's industrial hygienist that the building was cleared for survey. The audit team exercised extreme caution in this building, wearing Tyvek™ suits, Sol-Vex® gloves, boot covers, hard hats, and safety glasses.

All buildings that were part of the mercury audit were surveyed without incident.

REFERENCES

- HAZWRAP. 1990. *Health and Safety Plan: HAZWRAP Support to the PMRMA at Rocky Mountain Arsenal*. Hazardous Waste Remedial Actions Program, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.
- HAZWRAP. 1991. *Program Management Plan for Environmental Support at Rocky Mountain Arsenal, Colorado*. Revision 3. Hazardous Waste Remedial Actions Program, Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.
- NIOSH. 1985. *National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards*. U. S. Department of Health and Human Services, Washington, D. C.
- ORNL. 1992. *Mercury Audit at Rocky Mountain Arsenal: Work Plan*. Oak Ridge National Laboratory, Oak Ridge, Tenn.

ACRONYMS AND INITIALS

ACGIH	-	American Conference of Governmental Industrial Hygienists
DOE	-	Department of Energy
EPA	-	Environmental Protection Agency
HAZWRAP	-	Hazardous Waste Remedial Actions Program
NPL	-	National Priorities List
ORNL	-	Oak Ridge National Laboratory
OSHA	-	Occupational Safety and Health Administration
PEL	-	permissible exposure limit
PMRMA	-	Project Manager Rocky Mountain Arsenal
RMA	-	Rocky Mountain Arsenal
TLV	-	threshold limit value
TVA	-	Tennessee Valley Authority

APPENDIX A

MERCURY AUDIT DATA BASE

APPENDIX A
MERCURY AUDIT DATA BASE

The data collected during the April-July 1992 mercury audit at the Rocky Mountain Arsenal was organized for display and transmission into a data base using KMan™, a product of Micro Data Base Systems, Inc. The following is a description of the data base fields.

Field No.	Name	Type	Length	Picture
1	Building or tank farm number	string	10	
2	Tank group	string	10	
3	Mercury survey date	string	8	nn/nn/nn
4	Team members	string	36	
5	Detection number	number	2	nn.
6	Mercury reading	number	5	n.nnn
7	Location of detection	string	30	
8	Comments (memo field)	string	variable length	

All building and tank numbers (field No. 1) are sorted alphabetically. If no alphabetic characters exist at the beginning of these numbers, they are sorted numerically. A final alphabetic sort is conducted for numbers that end with alphabetic characters. Tank group numbers (field No. 2) are sorted alphabetically.

Table 2.1, a listing of everything surveyed, is sorted as described above. Table 2.3, a listing of detections, is a subgroup of the data in Table 2.1 and is sorted similarly. Table 2.3 is created by the appearance of a number greater than zero in fields 5 and 6.

For the ASCII file sent to PMRMA, the database was sorted in report order. Each line of data contained the eight fields shown above, with no delimiters separating fields. Each line was up to 255 characters. When a record exceeded this length, the excess data was wrapped around the following line.

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