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Report of the chromic acid incident investigation at Rocky Flats

REPORT OF THE CHROMIC ACID INCIDENT INVESTIGATION AT ROCKY FLATS

FEBRUARY 22, 1989

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AUGUST 1989

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REPORT OF THE CHROMIC ACID INCIDENT INVESTIGATION AT ROCKY FLATS

FEBRUARY 22, 1989

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TABLE OF CONTENTS

1.0 SCOPE 1

2.0 SUMMARY 3

2.1 Probable Cause 5
2.2 Contributing Factors 6
2.3 Additional Factors 7

3.0 FACTS 8

3.1 Background and Location 8

3.1.1 General - Rocky Flats Plant 8
3.1.2 Building 444 Complex 8
3.1.3 Sewage Treatment Plant, Spray Irrigation, and Detention Ponds 19

3.2 Environmental Regulations 25

3.3 Organization and Responsibilities 26

3.3.1 Albuquerque Operations - Rocky Flats Area Office 26
3.3.2 Rockwell International 30

3.4 Building 444 Plating and Related Waste Operations 38

3.4.1 Plating Operations 38
3.4.2 Plating Laboratory Equipment 40
3.4.3 Waste Operations 46

3.5 Chromic Acid Release Incident 55

3.5.1 Building 444 Activities 55
3.5.2 Sewage Treatment Plant 61
3.5.3 Discharge from Sewage Treatment Plant . . . 64
3.5.4 Environmental Sampling and Monitoring . . . 65
3.5.5 Discharge of Water from Plantsite 70

3.6 Safety Policy and Procedures 71

3.6.1 General Policy 71
3.6.2 Health and Safety Policy/Program and Procedures 73
3.6.3 Environmental Policy and Procedures 74
3.6.4 Building 444 Safety Policies and Procedures 75

TABLE OF CONTENTS (contd)

3.7 Training 78

3.7.1 General Training Including Safety 78
3.7.2 Training for Plating Laboratory Personnel . 80
3.7.3 Training for Security Personnel 80
3.7.4 Spill Reporting Training 80

3.8 Maintenance Activities 81

3.8.1 Plant Maintenance 81
3.8.2 Building 444 Maintenance 84
3.8.3 Plating Lab and Room 9A Maintenance 86

3.9 Notification Actions - Chromic Acid Release . . . 87

3.9.1 General Requirements 87
3.9.2 Rockwell International 87
3.9.3 Rocky Flats Area Office 89
3.9.4 Albuquerque Operations Office 91
3.9.5 Press Releases 92

3.10 Potential Exposures to Chromic Acid 92

4. ANALYSIS 94

4.1 Events and Causal Factors 94

4.1.1 Events and Causal Factors Chart 94
4.1.2 Energy Trace and Barrier Analysis 95
4.1.3 Management Oversight and Risk Tree (MORT) . 96

4.2 Building 444 and Related Operations 101

4.2.1 Plating Lab Equipment 101
4.2.2 Plating Lab Procedures 103
4.2.3 Waste Tank Equipment 104
4.2.4 Waste Tank Procedures 105
4.2.5 Sewage Treatment Plant Equipment 107

4.3 Organizational Responsibilities 109

4.3.1 Operations 109
4.3.2 MTD Operations 109
4.3.3 RCRA Inspection and Certification 110

TABLE OF CONTENTS (contd)

4.4 The Chromic Acid Release 111

4.5 Safety Policy and Procedures 115

4.5.1 General Policy 115
4.5.2 General Procedures 115
4.5.3 Building 444 ES&H Policy and Procedures . . 116

4.6 Training 118

4.7 Maintenance 119

4.8 Environmental Concerns 120

4.8.1 Sewage Treatment Plant 120
4.8.2 Spray Irrigation and Holding Ponds 120
4.8.3 NPDES 121
4.8.4 RCRA 122
4.8.5 CERCLA 123
4.8.6 Pond B-5 & C-2 Treatment/ Discharge Options 124
4.8.7 Summary Assessment 125

4.9 Corrective Actions 125

4.10 Notification 126

4.10.1 Rockwell International 126
4.10.2 DOE 127

5.0 CONCLUSIONS. 130

5.1 Findings 130
5.2 Probable Cause 143
5.3 Contributing Factors 143
5.4 Judgments of Need 145
5.5 Other Areas and Concerns 148

TABLE OF CONTENTS (contd)

6.0 SIGNATURES AND ACKNOWLEDGEMENTS 150

APPENDICES

A. Establishment of DOE Investigation Board
B. Press and Media Releases
C. Soil and Water Samples
D. Medical Report
E. Summary of Corrective Action Plan
F. Events and Causal Factors Chart
G. Energy Trace and Barrier Failure Analysis

ILLUSTRATIONS

Figure 1.	Location of the Rocky Flats Plant Within a 50-Mile Radius	9
Figure 2.	Location of the Rocky Flats Plant in Relation to Denver, Colorado	10
Figure 3.	Aerial View of the Rocky Flats Plant Showing B-Series of Impoundment Ponds, Looking West . . .	11
Figure 4.	Location of Building 444 on the Plant Site . . .	12
Figure 5.	Location of Building 444 in the 400 Complex . . .	14
Figure 6.	Floor Plan, First Floor, Building 444	15
Figure 7.	Floor Plans, Mezzanine and Basement, Building 444	16
Figure 8.	Removable Roof of Room 9A, Building 444	17
Figure 9.	Sewage Treatment Plant, Rocky Flats Plant	20
Figure 10.	Layout of Rocky Flats Drainage, Showing the Location of Retention Ponds and Reservoirs . . .	23
Figure 11.	South Spraying Field, Rocky Flats Plant	24
Figure 12.	Organization Chart, United States Department of Energy, Albuquerque Operations Office	28
Figure 13.	Organization Chart, United States Department of Energy, Rocky Flats Area Office	29
Figure 14.	Organization Chart, Rockwell International, Aerospace Operations, Rocky Flats Plant	31
Figure 15.	Automatic Control Valves (non-functioning) on Chromic Acid Plating Tank, Room 245	41
Figure 16.	Chromic Acid Plating Tank and Rinse Sink, Room 245	42
Figure 17.	Chromic Acid Planting Tank Heaters and Level Detectors	44

ILLUSTRATIONS (contd)

Figure 18. Acid Waste Tanks and Cement Berm, Room 9A, Basement, Building 444 50

Figure 19. 1400-Gallon Cement Berm, Room 9A, Basement, Building 444 51

Figure 20. Primary Pump Used to Transfer Contents of Acid Waste Tanks to the Process Waste Treatment Facility, Building 374 52

Figure 21. Acid Waste Tanks High Level Alarm Panel, Room 245 54

Figure 22. Foundation Sump Pump, Building 444 60

Figure 23. Clarifiers, Building 995 62

Figure 24. Soil Sampling Locations, Chromic Acid Release . . . 68

Figure 25. Historical Backlog Hours, Maintenance 83

Figure 26. Safety Related Work Orders, Maintenance 85

REPORT OF THE CHROMIC ACID INCIDENT INVESTIGATION AT ROCKY FLATS

February 22, 1989

1.0 SCOPE

The following is the report of the Accident Investigation Board concerning the chromic acid release incident that occurred on February 22, 1989, at the United States Department of Energy Rocky Flats Plant. The Rocky Flats Plant is located near Golden, Colorado, and is operated for the Department of Energy (DOE) by Rockwell International (RI). The Investigation Board was established March 10, 1989, by Bruce G. Twining, Manager of the Albuquerque Operations Office (Appendix A). The purpose of the Board was to: (1) investigate the incident; (2) review the Albuquerque system for notification of occurrences; (3) determine the causes or probable causes of the incident; and (4) recommend corrective actions.

Because of the unknown amount of chromic acid released to the environment, the magnitude of costs associated with potential cleanup and remedial actions, and also the breakdown of the management notification system procedures, the AL Manager determined a Type A incident investigation was warranted. Rockwell International had initiated an investigation on March 2, 1989, by the Safety Review Group. On March 10, Rockwell formed an Accident Investigation Team. To obtain the most thorough report possible without duplicating efforts, the Chairman of the DOE Accident Investigation Board requested that the Rockwell Accident Investigation Team serve as advisors to the Board.

The Accident Investigation Board conducted interviews; visited the incident scenes; obtained evidence; and reviewed numerous programs, procedures, previous reports, operating manuals, Operational Safety Analyses, policy and procedure documents, and a draft Safety Analysis Report. The Board used DOE accident investigation techniques, including a MORT analysis, a barrier analysis, and an events and causal factors chart, to perform the analyses and assure all pertinent aspects of the incident were addressed.

2.0 SUMMARY

About 1600 hours, February 22, 1989 (near the end of the day shift), an engineer returned to the Plating Laboratory in Room 245 of Building 444 and noticed a low fluid level in a chromic acid plating bath containing approximately 100 pounds of hexavalent chromium. The automatic, level-controlled makeup water system for the plating bath was inoperative and the engineer added water to the plating bath with a hose line connected to a water faucet in an adjacent sink. The engineer left shortly after 1600 hours with the makeup water still running. The chromic acid plating bath overflowed into an acid waste drain system serving the laboratory. The drain system emptied into a 400-gallon stainless steel acid waste collection tank located in Room 9A in the basement of the building. The collection tank, one of two, is located inside a 1400-gallon, 18-inch deep secondary containment berm. The collection tank filled, overflowed into the berm area, filling it to capacity. The secondary containment, in turn, overflowed onto the floor. Solution leaked from the floor and the secondary containment through cracks in the floor and into the building foundation drain system. It then collected in a sump where it was automatically pumped into the sanitary sewer system. The hose line makeup water was turned off by the engineer at 0730 hours, February 23, when he reported for work the next day.

A greenish-yellow water discoloration was noticed in the primary clarifier at the Sewage Treatment Plant (STP), Building 995, at 1030 hours, February 23. The Stationary Operating Engineer (SOE) notified Environmental Management and took samples. Queries failed to identify the contaminant or its source, which was assumed to be organic in nature because its coloration was similar in color to antifreeze. The contamination moved through the STP in approximately 24 hours and into retention pond B-3.

The chromic acid-contaminated B-3 pond water was pumped to spray fields in conformance with the Rocky Flats Plant National Pollution Discharge Emissions System (NPDES) permit issued by the Environmental Protection Agency (EPA). The cold weather conditions prevailing at this time had frozen the surfaces of the spray field and pond. Consequently, significant amounts of chromic acid-contaminated spray water ran off the hillsides adjacent to the spray fields. The runoff-contaminated water then collected in the site water impoundment ponds. No offsite release of the chromium contaminant occurred. An estimated 30 pounds of chromium were released to the Sanitary Sewer System and approximately 5 pounds passed through the STP and were distributed in the spray fields and ponds.

Chromium was identified as the contaminant late in the afternoon of February 28. The Rockwell Safety Group started an investigation on March 2 and Rockwell Management convened an Accident Investigation Team on March 10. The AL Manager convened a Type A Accident Investigation Board on March 10, after notification of the incident on March 8. Press releases relating to the incident are included in Appendix B.

After chromium was identified as the contaminant on February 28, soil samples taken at one- and six-inch depths in the spray fields showed chromium levels to be within site background levels. Daily water samples taken from the impoundment ponds after the ice thawed on the ponds, thus permitting representative sampling, indicated chromium levels below the Clean Water Act drinking water standard of 0.05 ppm.

Borehole samples indicated no chromium contamination above background levels in the gravels and soils adjacent to the Building 444 foundation drain system. Consequently, no direct cleanup costs are to be assessed against this incident as a result of a RCRA action. The Building 444 site has been previously identified as a future environmental cleanup site due to other contaminants in the area.

In summary, there were no significant injuries, no programmatic interruption, no costs of significance, and minor impact on the environment.

The Board has identified the following probable causes and contributing factors.

2.1 Probable Cause

The probable cause of the incident was an inoperable automatic solution level control system in the chromic acid plating bath, resulting in operators not using the level-controlled water makeup system for the tank. The operator added makeup water by a hose line connected to a faucet. The operator forgot to turn off the faucet at the end of the shift. The bath overflowed and drained into an acid waste tank which, in turn, overflowed into a secondary containment. The secondary containment leaked, allowing the chromic acid to enter the Sanitary Sewer System.

2.2 Contributing Factors

Listed below are factors which contributed to the incident in varying degrees.

1. The high-level acid waste tank alarms are not monitored off-shifts, holidays, and weekends.

2. The containment berm high-water level sensor with a 24-hour monitored alarm system had not been installed. Work Order for installation is circa 1987.

3. The secondary containment system for the acid waste tanks leaked and permitted the chromic acid overflow from the waste tanks to enter the foundation drain system and into the Sanitary Sewer System.

4. Poor definition of hazards in the Operating Safety Analysis for the plating operations. Inadequate operating safety requirements that provide limiting conditions for development and production operations in the laboratory.

5. Split management responsibility for development and production operations conducted in the laboratory contributed to lack of proper maintenance and operability of the plating laboratory.

6. Inadequate training of employees as to what constitutes a spill of a reportable nature.

7. Many minor spills and the leaking roof in Room 9A allowing puddles to collect resulted in complacency regarding solutions on the floor of the room and reporting such incidents.

2.2 Contributing Factors (continued)

8. The Plant Shift Superintendent, Area HS&E Engineer, and upper Rockwell management were not notified of the chromic acid spill.

9. The acid waste high level alarm was silenced (with a high degree of probability) by persons unknown in the Plating Laboratory with no one taking remedial action. Pipefitters were working in the room and a security guard made routine periodic watchman tours and noted no alarms.

10. Inadequate safety and design documentation and limiting operating conditions combined with a lack of operating procedures.

2.3 Additional Factors

The Board identified 67 Findings and 32 Judgments of Need that are included in Section 5 of this report.

3.0 FACTS

3.1 Background and Location

3.1.1 General - Rocky Flats Plant

The Rocky Flats Plant has been operational since early 1952. The primary mission of the plant is the support of the nation's nuclear weapons program. The functions performed at the plant include plutonium component fabrication; plutonium reclamation; and the manufacture of various stainless steel, beryllium, and uranium alloy components. The plant is situated on 6,550 acres of land approximately 25 miles northwest of downtown Denver, Colorado. (See Figures 1 and 2.) Figure 3 shows the plant in relation to natural landmarks and the B series of site water impoundment ponds. The plant has been operated for the DOE by Rockwell International since 1975.

The Rocky Flats Plant operates 24 hours a day, seven days a week, and functions much the same as a self-contained city. The plant has its own utilities, railroad, fire department, medical facility, and food service facilities. Approximately 5,100 people are employed at the plant by the operating contractor (Rockwell International).

3.1.2 Building 444 Complex

Building 444, where the chromic acid release incident occurred, is located in the southwest area of the plantsite, south of Cottonwood Avenue, west of 7th Street, and within a security zone. Figure 4 shows the location of Buildings 374, 444, and 995 in relation to other major structures on the plantsite.

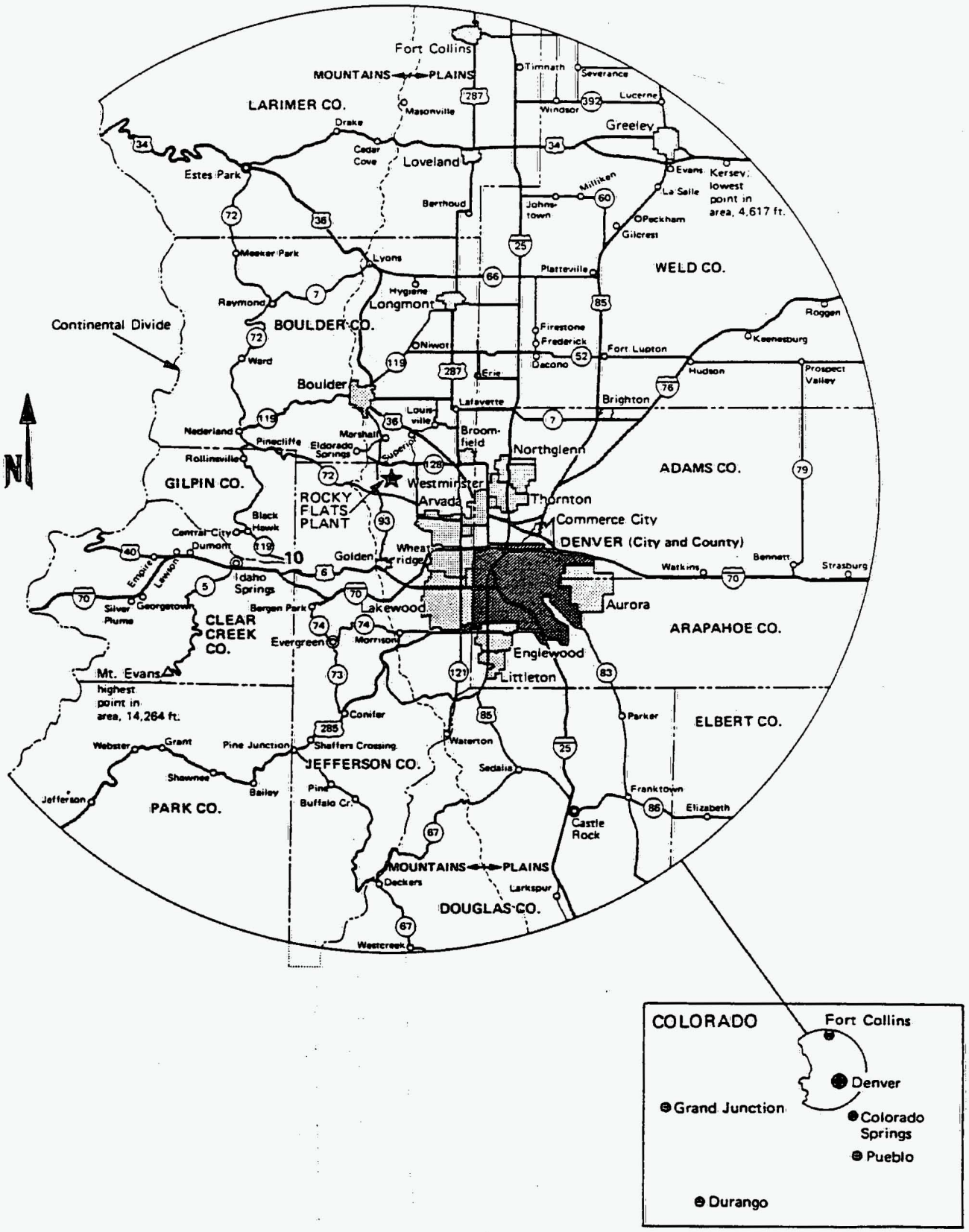


Figure 1. Location of the Rocky Flats Plant Within a 50-Mile Radius

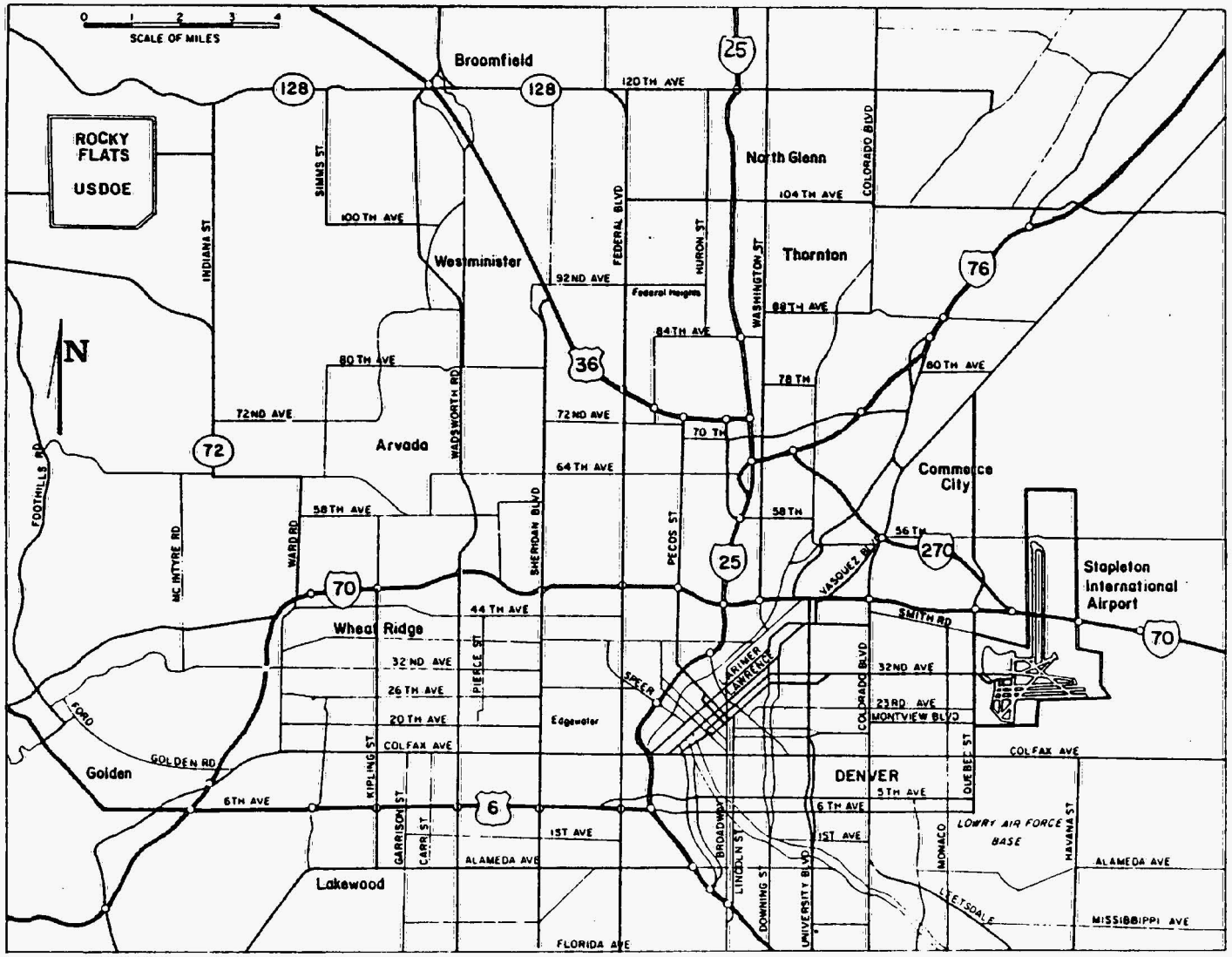


Figure 2. Location of the Rocky Flats Plant in Relation to Denver, Colorado

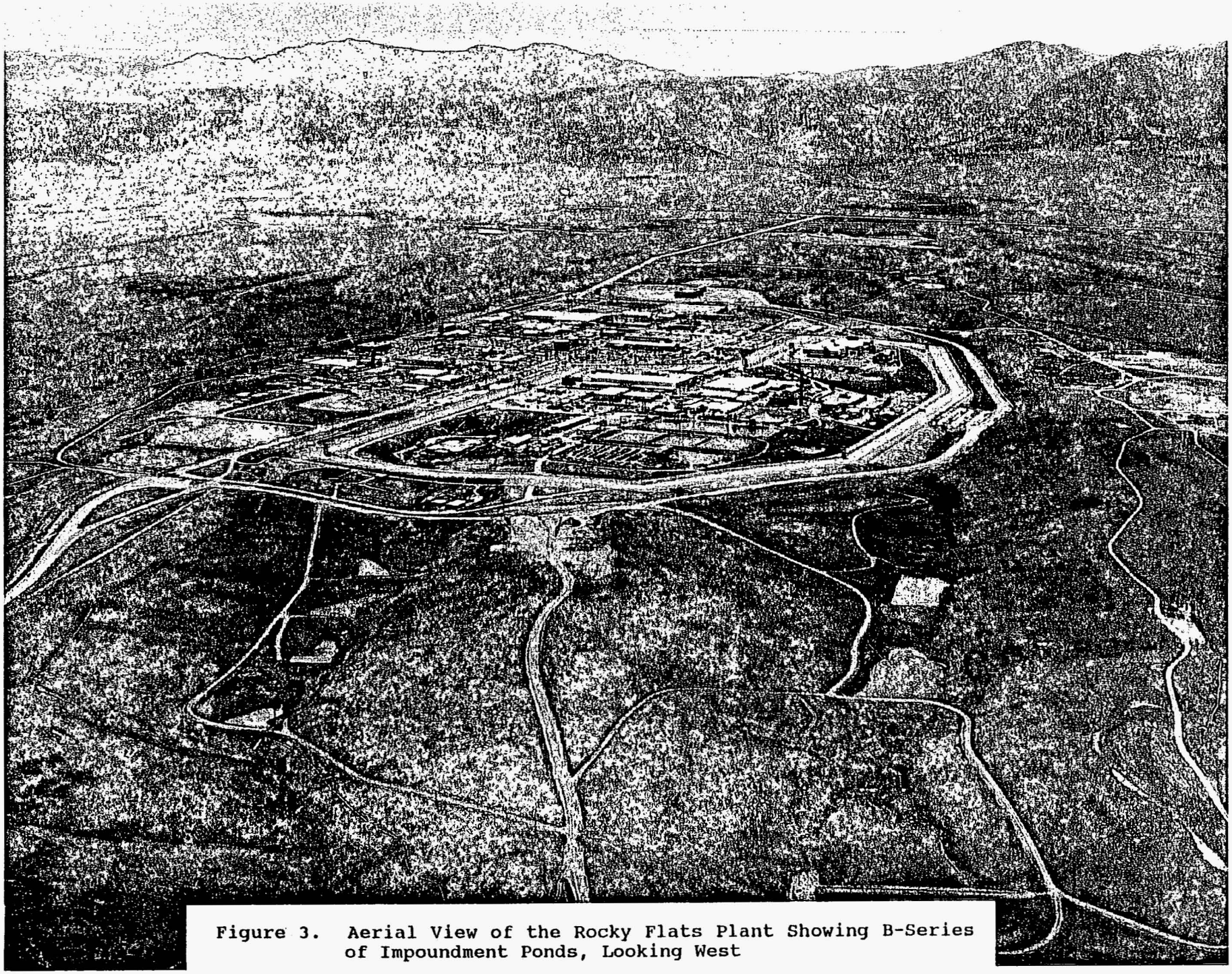


Figure 3. Aerial View of the Rocky Flats Plant Showing B-Series of Impoundment Ponds, Looking West

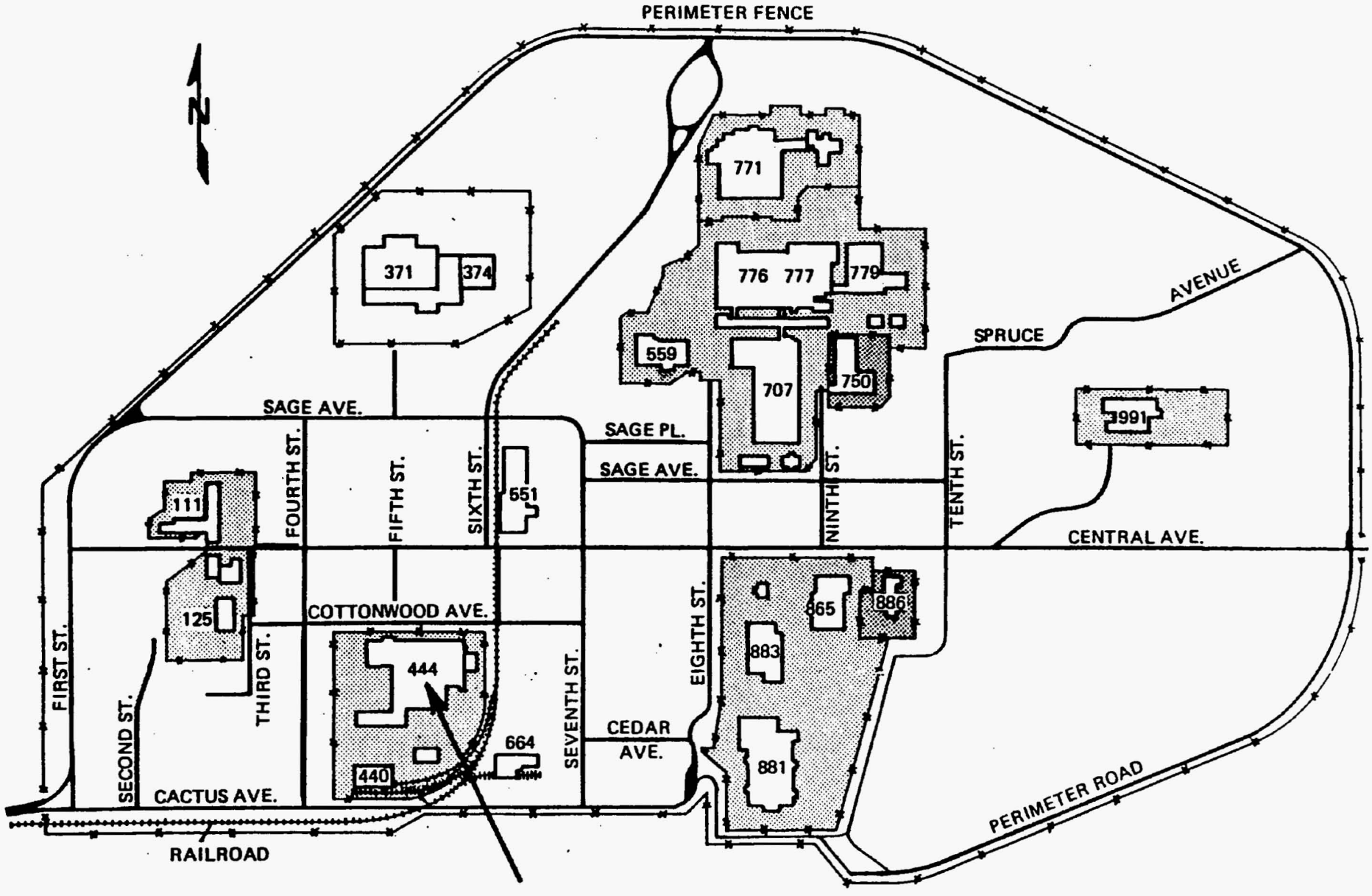


Figure 4. Location of Building 444 on the Plant Site

The Building 444 complex (Figure 5) is a highly sophisticated metal fabrication and machining facility, capable of producing parts to extremely close tolerances. General metal fabrication, beryllium foundry and fabrication, carbon shop, precision machine shops, tool engineering, production control, and nondestructive testing operations are housed in this building complex. Operational capabilities include electrochemical milling, plating, and cleaning among many others. Materials processed include depleted uranium (less than 0.7 U-235) and depleted uranium alloys, tool steels, special stainless steels, beryllium, aluminum, and graphite. Other less common materials such as titanium, tantalum, and silver also are occasionally used. No plutonium or enriched uranium (Oy - oralloy) is processed in this building complex.

Figures 6 and 7 show floor plans for portions of the Building 444 complex; first floor, mezzanine, and basement, respectively. The major portion of the Building 444 complex is a large structure consisting of four interconnected buildings (444, 445, 447, and 448). The type of construction varies as to wall, support structure, and roof materials and design; but, all have concrete foundations and concrete slab floors. The underfloor area is serviced by a foundation drain system because of soil and water conditions endemic to the Rocky Flats Site.

The Plating Laboratory (Room 245) where the incident occurred is located on the mezzanine of Building 444 (see Figure 7). The acid waste tanks which serve the Plating Laboratory are located in the basement area of the building in Room 9A (see Figure 7). The roof of Room 9A is removable to permit large pieces of equipment access to and from the basement area (see Figure 8). The construction of the roof and its periodic removal have led to its deterioration and leaks are prevalent during precipitation events. Access into Room 9A can also be made through a hatch in the roof and a ladder

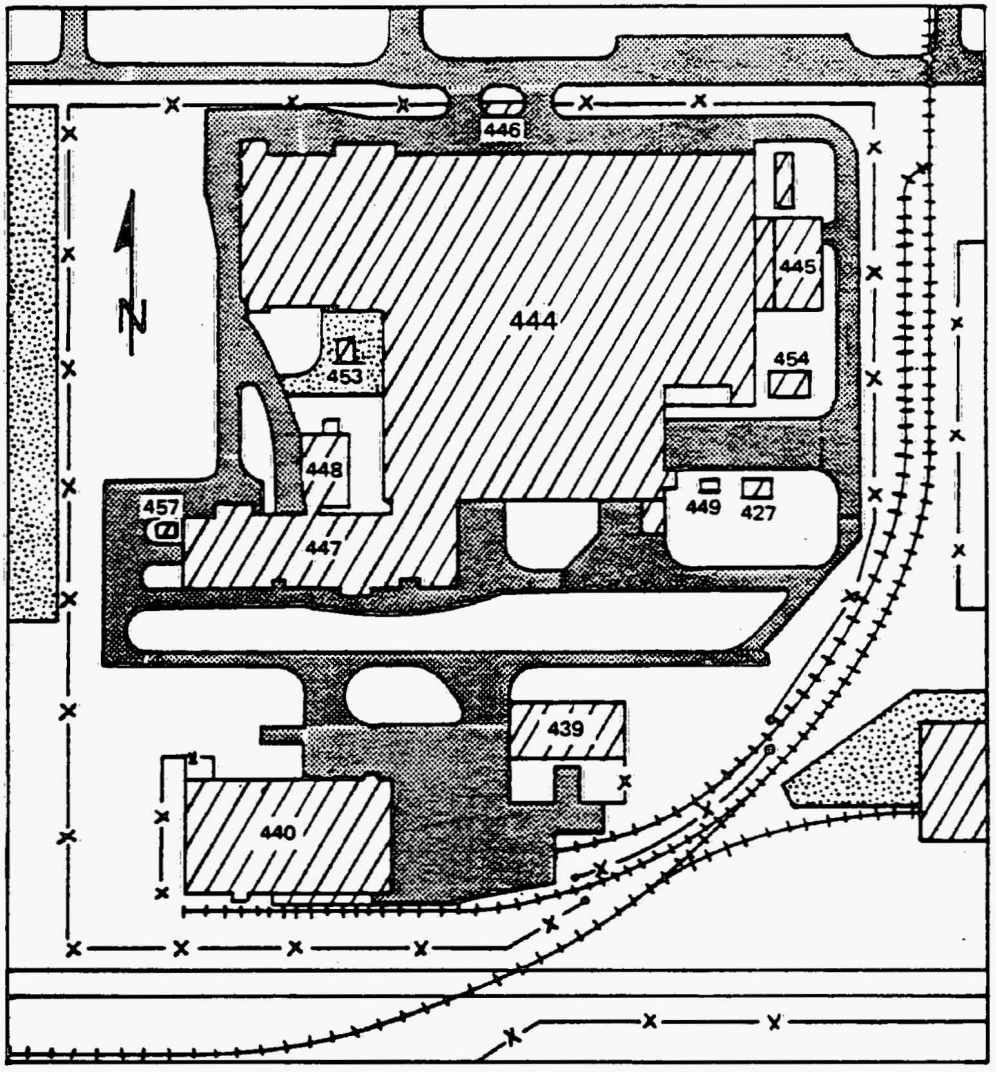


Figure 5. Location of Building 444 in the 400 Complex

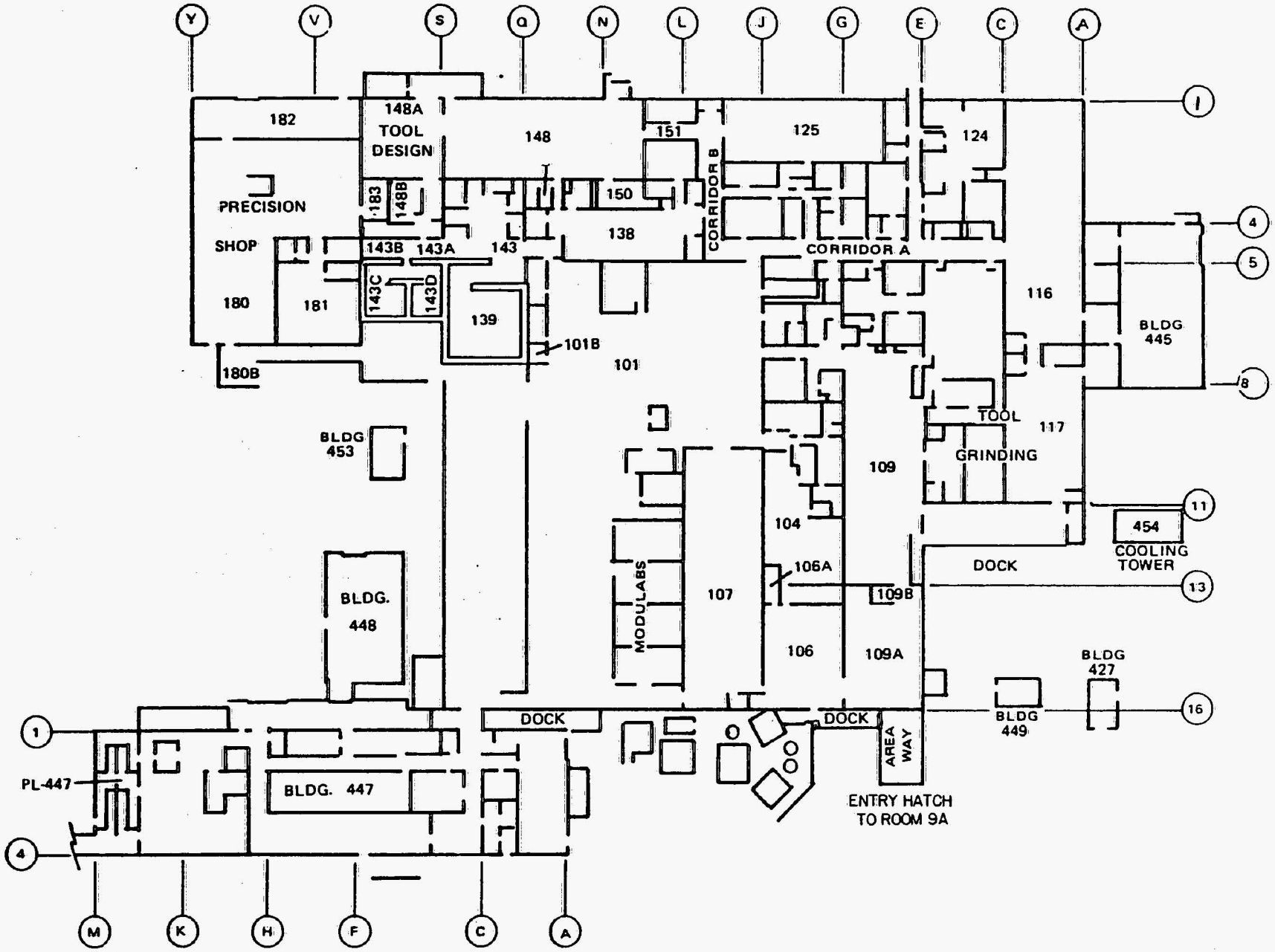


Figure 6. Floor Plan, First Floor, Building 444

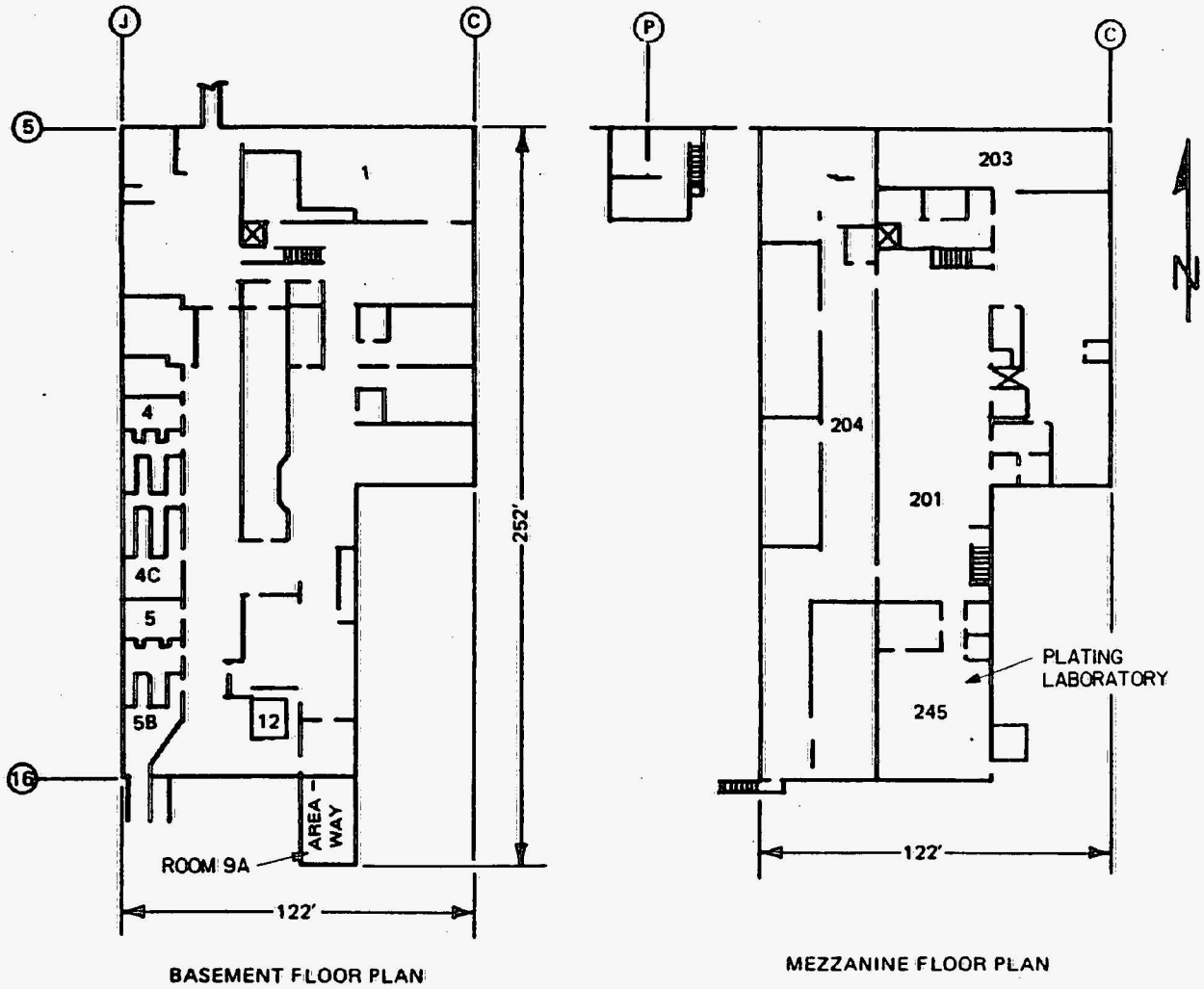


Figure 7. Floor Plans, Mezzanine and Basement, Building 444

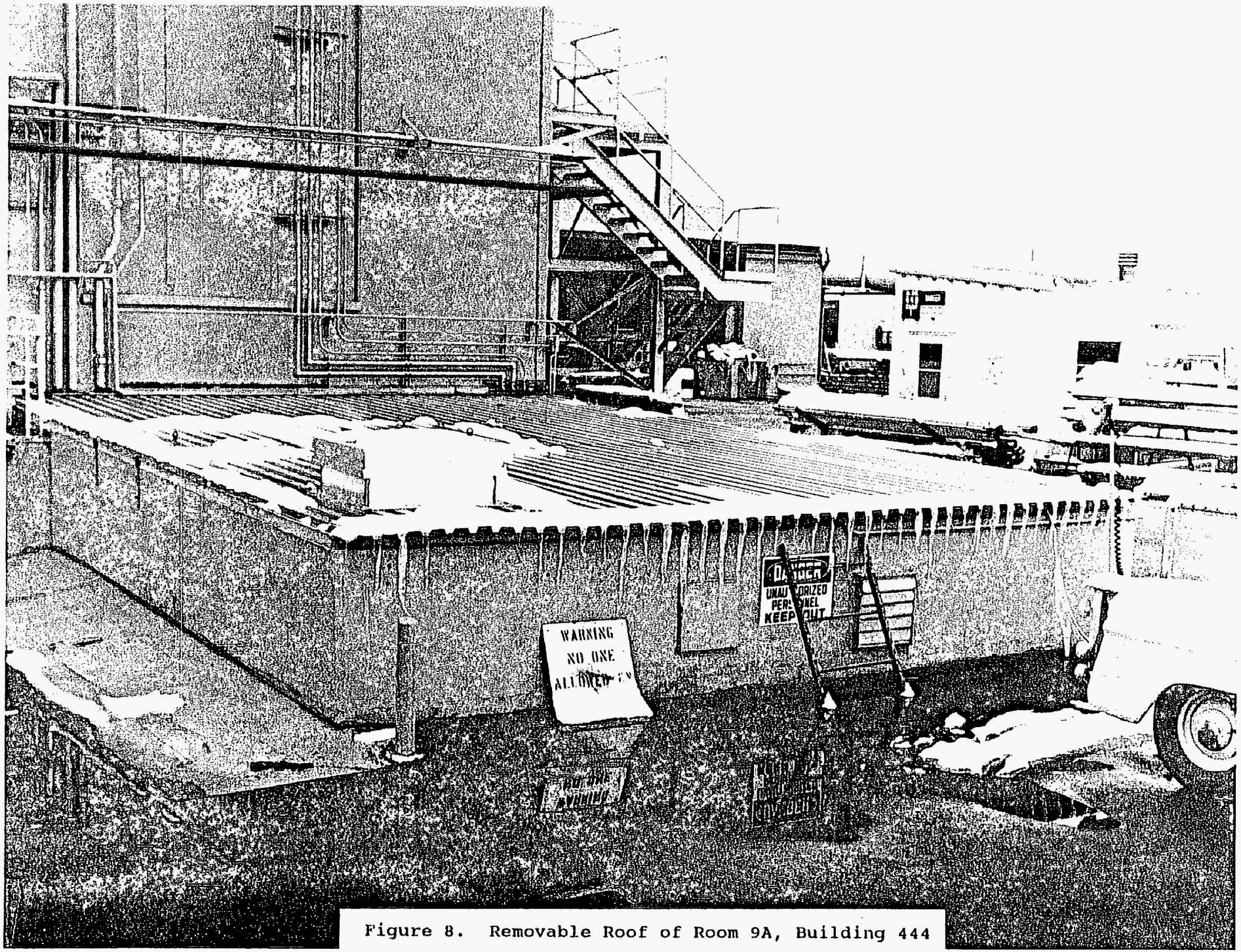


Figure 8. Removable Roof of Room 9A, Building 444

on the wall adjacent to the cyanide tanks. While the ladder and hatch serve as an exit from the building, it is not a designated emergency exit and is not marked as such.

3.1.2.1 Plating Laboratory

The Plating Laboratory, as previously stated, is located on the mezzanine in Room 245. The operations conducted there involve the development and application of many kinds of surface finishing techniques. Examples of these include electroplating, electropolishing, electroless plating, anodizing, oxide coating, cleaning, etching, passivating, chemical milling, sand blasting, buffing, sanding, grinding, drilling, and organic coating. The facilities include a plating laboratory, a metal preparation area, a chemical storage area, waste storage tanks and pumps, and an organic coating laboratory.

3.1.2.2 Waste Management

The Plating Laboratory and other operations in the Building 444 complex generate considerable quantities of liquid wastes. Liquid wastes are categorized as either nonradioactive or as containing radioactive materials. Each type of waste is carefully controlled and analyzed to assure that it is properly processed in accordance with its radioactive material content.

Nonradioactive liquid wastes typical of those produced by plating operations can be divided into three categories: hazardous wastes, sanitary waste, and machine oils.

Hazardous wastes are mainly chemicals from etching, plating, or cleaning operations that may contain beryllium, cyanide salts, or various acids. The more hazardous of these chemicals are placed in drums and sent to Waste Operations. Dilute solutions are

introduced into the liquid process waste drain system which empty into holding tanks located in the basement. Specific to the Plating Laboratory, the acid waste holding tanks are located in Room 9A. The contents of these tanks are sampled and periodically transferred to the Waste Treatment facility (Building 374) by Waste Operations personnel.

Sanitary waste from the office areas of the Building 444 complex is disposed of in the sanitary waste drains and is processed at the Sewage Treatment Plant (Building 995). The sanitary waste drains are collected in the basement for pumping to Building 995. There is also a sump for the collection of effluents from the footing drains.

Machine oil, after being determined nonradioactive, is sent in drums to Property Utilization and Disposal, Building 551, for disposal.

RCRA/CERCLA surveys in the vicinity of Building 444 have resulted in the area being designated as a site where environmental cleanup should be conducted. No imminent danger was deemed present.

3.1.3 Sewage Treatment Plant, Spray Irrigation, and Detention Ponds

3.1.3.1 Sewage Treatment Plant

The Sewage Treatment Plant is designed to accommodate a flow of 500,000 gallons per day. The facility (see Figure 9) consists of a bar screen primary settling tank, standard activated sludge secondary treatment, chemical clarification with alum, dual media filtration, and chlorination prior to discharge to pond B-3. Total residence time in the plant is approximately 24 hours.

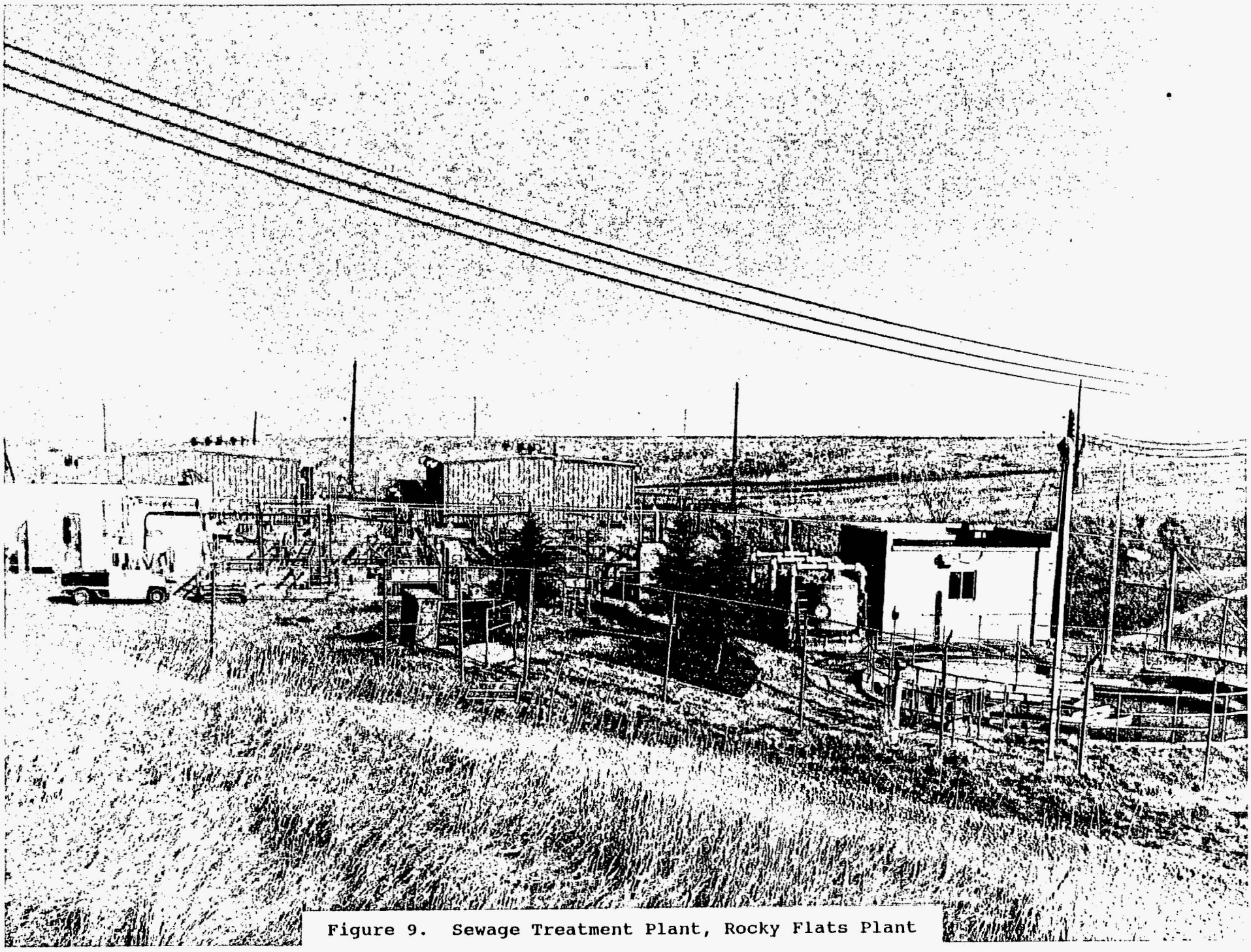


Figure 9. Sewage Treatment Plant, Rocky Flats Plant

As discussed earlier, the waste water management for the plant is complex because of hazardous liquids and liquids contaminated with beryllium and radioactive materials. The sanitary waste system and process wastes are separate systems and this separation is maintained within the buildings themselves. The discussion will be confined to the Sanitary Waste Collection System.

The Sanitary Waste Collection System consists of two major trunk systems. One collects sewage from the buildings in the plutonium manufacturing area and the other from non-plutonium areas. These two systems join at a valve pit just west of the Sewage Treatment Plant (Building 995). A bypass to one of two inlet tanks (total capacity 120,000 gallons) is possible before entry of the sewage into the plant. The present daily flows into the plant vary from 250,000 to 400,000 gallons per day.

Solids are gathered from primary and secondary clarifiers, digested, then dried in protected beds. Dried sludge, because of the potential of containing radioactive and hazardous materials, is layered with absorbants, boxed, and stored on site for future removal to a permanent disposal site. All backwashes and recycle flows are taken to the headworks of the facility. Approximately one million gallons per year of water are lost to atmosphere from evaporation and sludge drying or removal.

No real time monitoring capability exists at the treatment plant for either hazardous materials or environmental levels of radioactive material. Also, no diversion capability exists at the outflow of the sewage plant to collect any suspect discharges other than the detention ponds. A limited capacity (60,000 gallons) diversion exists for influent.

3.1.3.2 Spray Irrigation

Sewage effluent flows to pond B-3 via pipeline for storage and some evaporation (Figure 10). The normal capacity of pond B-3 is approximately one million gallons. As no discharge is allowed from this pond (see Section 3.1.3.3) unless severe precipitation causes capacity problems, other means for discharge are utilized under the Environmental Protection Agency NPDES permit for ultimate disposal.

Water is pumped from the pond and spray irrigated on adjacent or nearby hillsides (Figure 11). Gasoline-driven pumps and a series of laterals and spray nozzles distribute the water to the ground surface for evaporation and infiltration into the subsurface. It is estimated that up to 20 million gallons per year (MGY) of water are disposed of in this manner.

It should be noted that little control is maintained over the system and over-spraying and saturation often leads to overland flows: the effluent runs off the hillsides and back into the detention ponds (Figures 3 and 10). The water returning to the ponds is deteriorated in quality because of increased suspended solids and color. This treatment method has not been effective in wholly solving the problem of an overabundance of waste water.

3.1.3.3 Detention Ponds (Series A, B, and C)

A-series ponds in North Walnut Creek receive surface runoff and seeping groundwater from the plantsite (Figure 10). Water can be released from ponds A-3 and A-4 after satisfying EPA discharge limitations as well as quality and monitoring requirements.

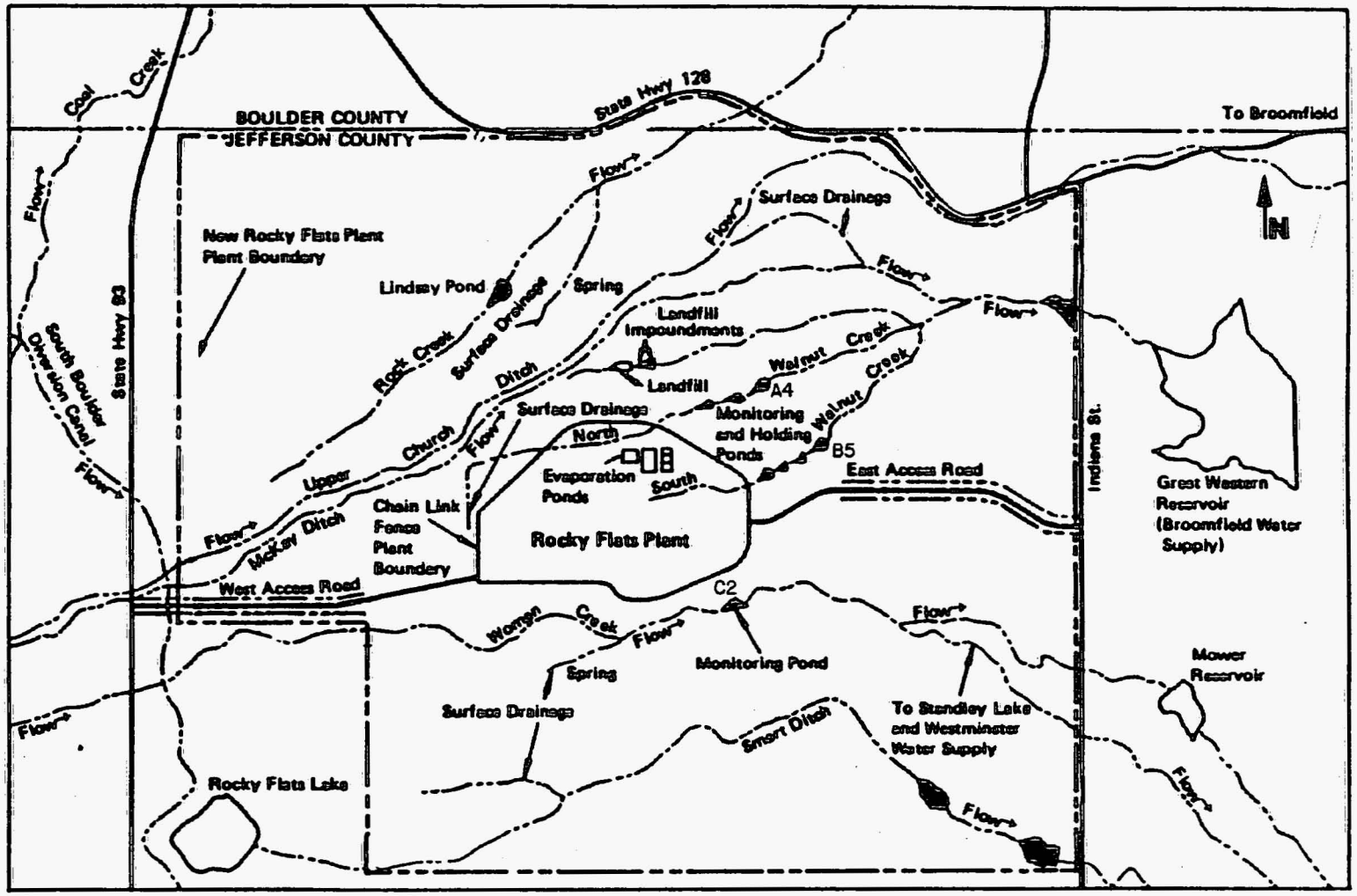


Figure 10. Layout of Rocky Flats Drainage, Showing the Location of Retention Ponds and Reservoirs

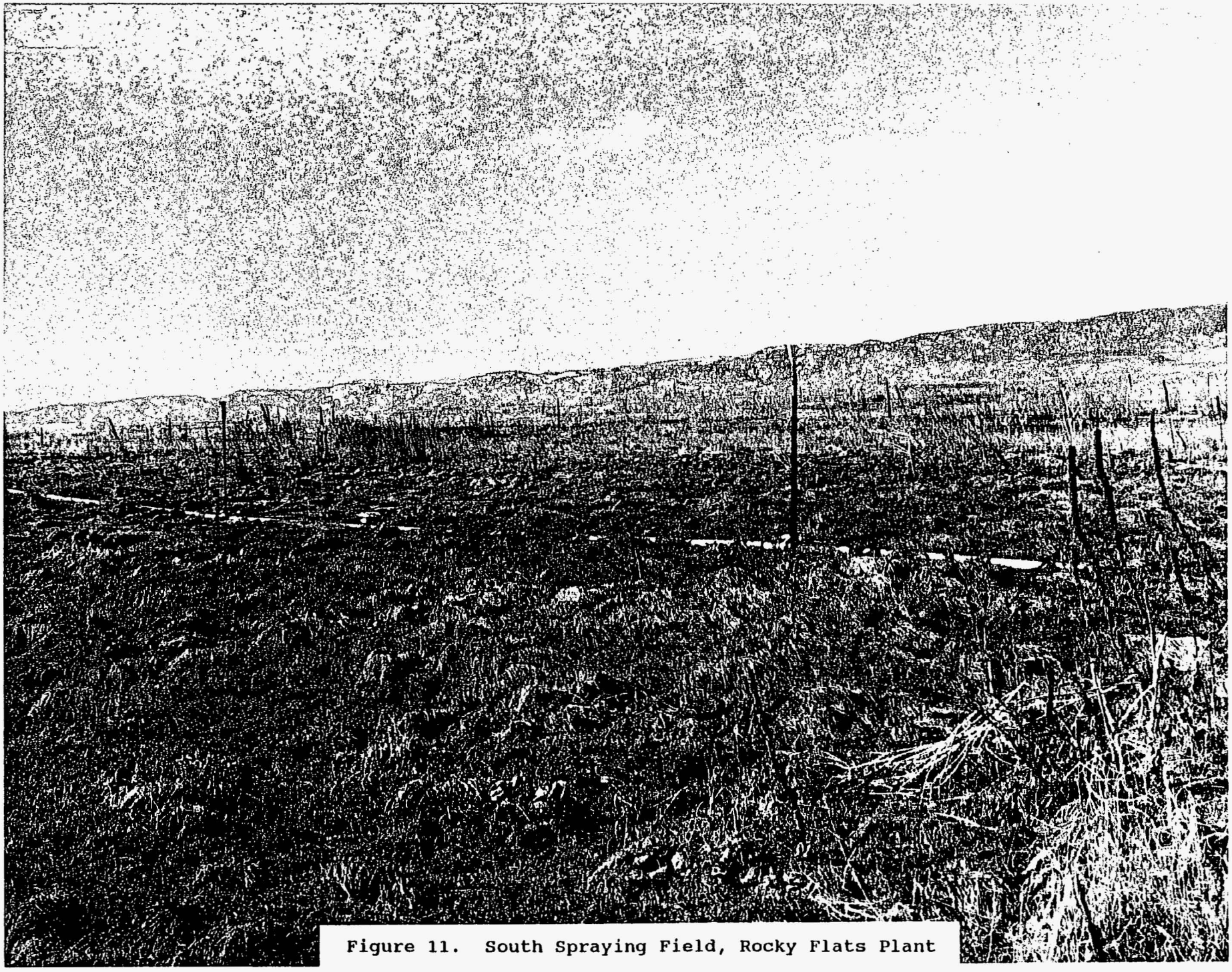


Figure 11. South Spraying Field, Rocky Flats Plant

B-series ponds in South Walnut Creek receive surface runoff, sewage effluent, and groundwater seepage. Water is released from ponds B-3 and B-5 after satisfying EPA discharge limitations as well as quality and monitoring requirements. Both ponds A-4 and B-5, per EPA requirements, can only be filled to 10 percent of capacity, thus providing additional storm runoff protection, but limiting holding capacity. These ponds can detain flows for short periods of times, but they are not designed for full capacity retention. Insufficient capacity exists in both series of ponds to handle storm flows as well as sewage effluents on a year round basis. Therefore, spray irrigation and land treatment are used to reduce the likelihood of an effluent discharge.

The C-series ponds provide for monitoring and storage of flows in Woman Creek south of the plantsite as well as detention of surface runoff and groundwater captured by interceptor trenches. Release of water from pond C-3 is allowed after EPA quality requirements are met. Another pond north of North Walnut Creek captures flow from the existing landfill. No discharge is evident from this retention pond and spray evaporation is utilized to dispose of the water.

3.2 Environmental Regulations

Three environmental regulations are pertinent to the incident which occurred. These are the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A quick summary of these laws is given below. The specific applications to the incident under investigation are given in Section 4.8.

CWA - Under CWA, all effluent discharges from a facility are required to have a National Pollution Discharge Elimination System (NPDES) permit regulating pollutant concentrations in discharges from the facility.

RCRA - The State of Colorado Department of Health (CDH) administers the RCRA regulations which apply to the storage, handling, and disposal of hazardous wastes, including cleanup and disposal of spills or releases to the environment.

CERCLA - Under CERCLA reporting requirements, a spill of a hazardous substance exceeding the reportable quantity (RQ) must be reported to the National Response Center within 24 hours after discovery of the spill.

3.3 Organization and Responsibilities

3.3.1 Albuquerque Operations - Rocky Flats Area Office

The Rocky Flats Plant is one of several area offices in the nuclear weapons production complex under the cognizance of Albuquerque Operations (see Figure 12). The responsibility for Rocky Flats operations and site management is delegated from the Manager, Albuquerque Operations (AL) to the Area Manager, Rocky Flats Area Office. The Rocky Flats Area Office organization is shown in Figure 13. The Operations Branch within the Area Office is responsible for interface of day-to-day activities in the operations of the plant with Rockwell International in an overview capacity. Overview of the site ES&H program is a responsibility assigned to the Safety and Environmental Programs Branch. Facilities Management Branch has the overview responsibilities for facilities, including maintenance activities.

Functional assistance and guidance for the Environmental Programs Branch and the Safety Officer are provided by the Safety Programs Division and the Environment and Health Division under the AL Assistant Manager for Environment Safety and Health (see Figure 12). Periodic appraisals of the site's ES&H program are conducted by these two AL organizations. Functional assistance for the Facilities Management Branch in the area of maintenance is provided by the AL Facilities and Project Management Division who also conducts periodic appraisals of the site maintenance program.

The Assistant Secretary for Environment, Safety and Health (ESH) is responsible for DOE ESH policy and Headquarters oversight in this area. In addition to performing Technical Safety Appraisals, and Environmental Assessments, EH presently has two persons located onsite and designated as DOE/HQ-EH Onsite Representatives. It is the responsibility of these personnel to report to EH on a daily basis any significant observations of a safety related nature. Weekly and monthly summary reports are also filed. A weekly report received in EH Headquarters prior to March 8 was the vehicle by which DOE headquarters and the AL Manager became aware of the chromic acid incident.

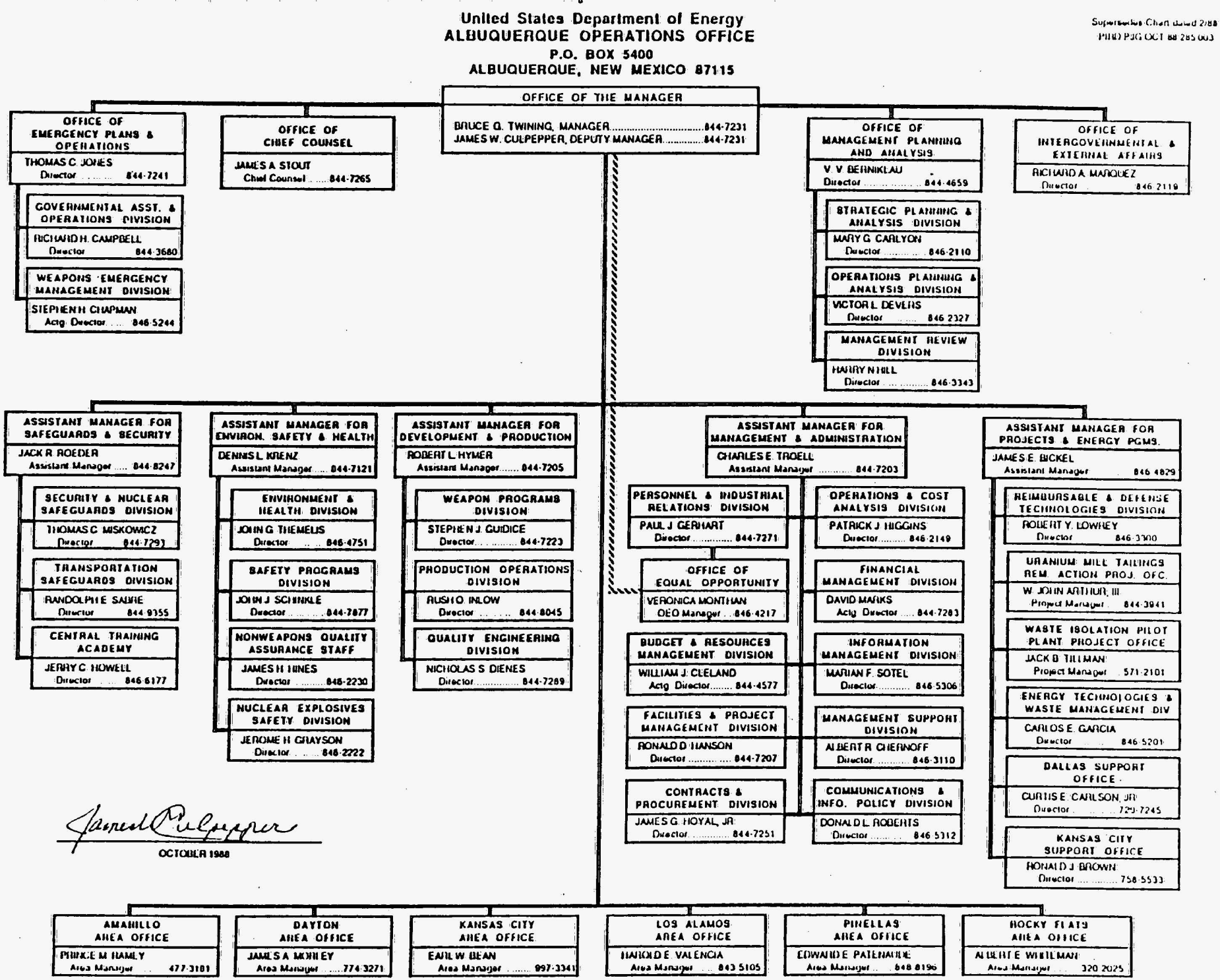
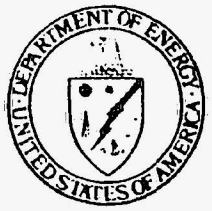


Figure 12. Organization Chart, United States Department of Energy, Albuquerque Operations Office



Department of Energy

ALBUQUERQUE OPERATIONS
ROCKY FLATS AREA OFFICE
P.O. BOX 928
GOLDEN, COLORADO 80402-0928

AREA MANAGER
Albert E Whiteman
Secretary-Jean S Finch

COUNSEL
Patrick G Currier

SAFETY OFFICER
Ronald D Reed

DEPUTY AREA MANAGER
Vacant
Secretary-Mary O Hammack

PLUTONIUM RECOVERY MODIFICATION PROJECT OFFICE
Donald R Riley, Project Mgr

OPERATIONS BRANCH
William C Rask
- Tod W Anderson
- Gary N Huffman
- Larry K Kwei
- Gary S Lietz
- Frazer R Lockhart
- Hugh G Miller
- David J Nickless
- William J Rosseau
- James D Steward
- Dorothy L Montez

ADMINISTRATIVE BRANCH
Claude H Barkmeier
- Victor V Candelaria
- Diane Kelly
- Elizabeth L McKee
- Rose M Davis

QUALITY ASSURANCE BRANCH
Robert J Rushton, Actg
- Willard K Johnson
- Wesley K Jones
- James T McDonough, Jr
- Royce E Monks
- Elver D Robbins, III
- Anthony C Snyder
- William J Lenten
- Linda L Ross

FACILITIES MANAGEMENT BRANCH
W Jack O'Brien
- Douglas G Coe
- Jerrol R Kluherz
- Joseph E Rau
- Robert R Reece
- Brenda S Summers
- Elaine H McNulty

SAFEGUARDS & SECURITY BRANCH
Nicholas J Roberts
- Terrel J Agy
- Elizabeth L Armijo
- Bert L Crist
- Gemmi C Holland
- Joan M Nelson

SAFETY & ENVIRONMENTAL EVALUATION BRANCH
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- Gwynn M Aldrich
- Felicia M Gallegos
- Teresa A Lachman
- Kari J Schneider
- Sandra D Spence
- Patricia A Knipp

SAFETY & ENVIRONMENTAL PROGRAM BRANCH
Candice C Jierree, Actg
- Linda Frank
- Niles D McGuire
- Richard J Schassburger

Figure 13. Organization Chart, United States Department of Energy, Rocky Flats Area Office

3.3.2 Rockwell International

Rockwell International, Rocky Flats Plant, Aerospace Operations is the prime maintenance and operating (M&O) contractor for the Rocky Flats site. As such, Rockwell is responsible for all onsite operations. The Rockwell organization chart for Rocky Flats Plant is shown in Figure 14. The Plant Manager is a president in the Rockwell International organization. The Rocky Flats organization consists of eleven directorates, four of which were involved in the chromic acid incident and are discussed in this report. They are: (1) Director of Support Operations, who is responsible for maintenance and utilities; (2) Director of Production Operations, who is responsible for non-plutonium production efforts; (3) Director of Safeguards and Security, who is responsible for security inspectors and the Shift Superintendents; and (4) Director of Health, Safety & Environment (HS&E), who is responsible for environmental protection, radiation, nuclear and industrial safety, industrial hygiene, and medical care.

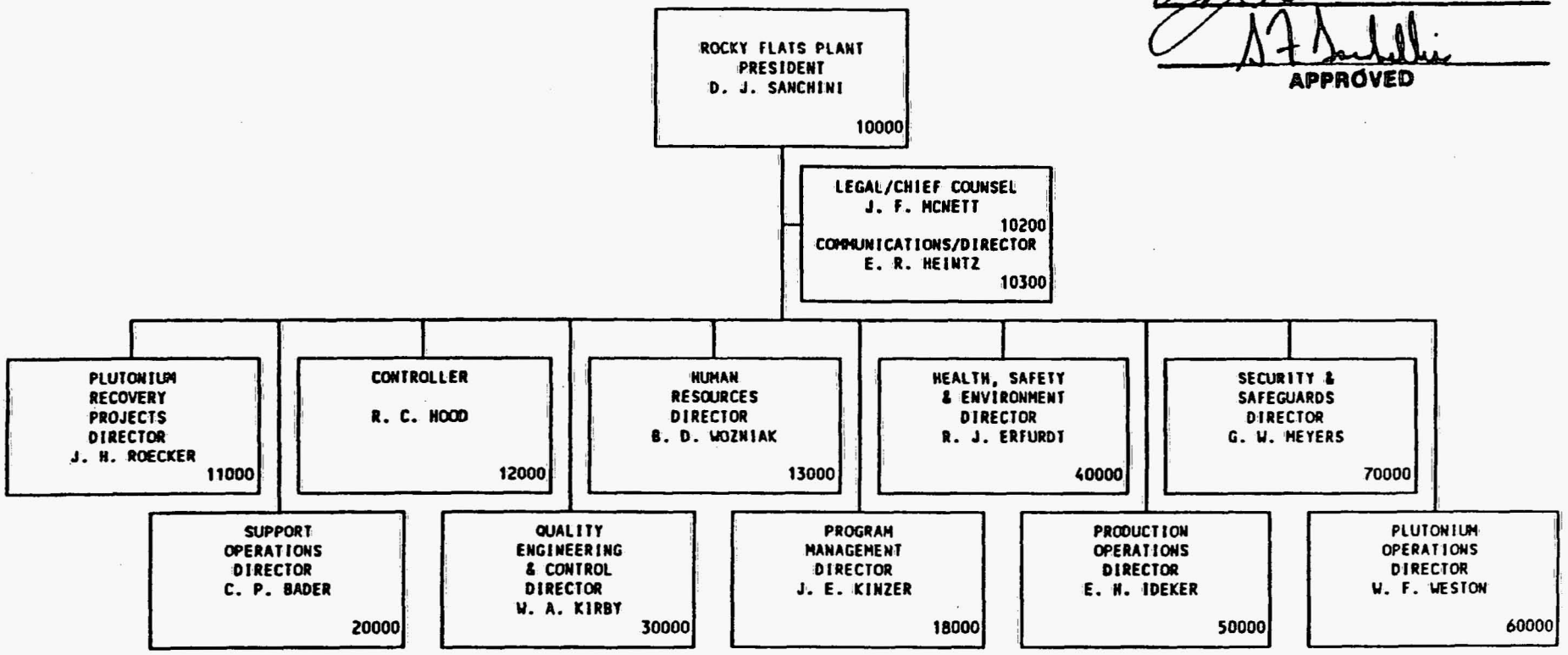
3.3.2.1 Production Operations

Eight managers report to the Director of Production Operations, of these, two are germane to this incident: (1) Building 444 Production Manager, and (2) Manufacturing Technology Development Manager. The Building 444 Production Manager serves a dual management role; both as a Building Manager and as a manager for operations under his cognizance.

Rockwell International

Aerospace Operations
Rocky Flats Plant

APPROVED



SEPTEMBER 12, 1988
CHART 10000
ROCKY FLATS PLANT

Figure 14. Organization Chart, Rockwell International, Aerospace Operations, Rocky Flats Plant

Rockwell has established the Building Manager concept for the buildings on plantsite. Building Managers report to the Director responsible for operations in the building; in this case, the Director for Production Operations. The Building Manager has line responsibility for operations under his cognizance, and carries line responsibility for the overall functions of the building, including all ES&H matters. Even though there may be several operations and support groups housed in one building, the Building Manager concept defines a single person who carries overriding line responsibility for all aspects of building operation, including the assurance of procedural adequacy and configuration control. The ES&H responsibility includes making notifications regarding incidents to the Shift Superintendent. At the time of the incident, the Building Manager for Building 444 had only been in that position for a period of 8 months.

Foundry Operations in Building 444 is one of several production operations assigned to the Building Manager. Under Foundry Operations, one of the functional responsibilities is production plating operations. Foundry Operations Foremen have line responsibility for production operations in the Plating Laboratory, Room 245A, and for the waste tank system in Room 9A in the basement. These foremen are responsible to assure that Foundry Operating Procedures for the Plating Laboratory are followed and are also responsible for reporting incidents up through their line of supervision.

With respect to building operations reporting to the Building 444 Manager, staffing is provided for three-shift coverage of a control room where the Stationary Operating Engineer (SOE) monitors such utilities as building fans, cooling, heating, water pumps, power, steam, etc. They perform rounds of inspections

every four hours for equipment that they carry line responsibility for. However, they may not complete these rounds if they have operational problems.

The Plating Laboratory where the incident occurred is not included in the inspection by the SOE's, nor are any alarm readouts of abnormal conditions in the Laboratory monitored. No readouts of alarm conditions for the acid waste tanks in Room 9A are monitored by the SOE's.

The Manufacturing Technology Development Manager (MTD) is responsible for development of process technology to support operations. One of the developmental areas is in coatings for components. A Coatings Manager reports to the Manager MTD and is the supervisor for Development Engineers who also work in the Plating Laboratory, Room 245A.

The Development Engineers make up plating baths, draft Foundry Operations Procedures for use by the production personnel in the Plating Laboratory, and perform development work. Procedures are not required for the work of the Development Engineers. One of the Development Engineers is designated as the "lead" engineer in the Plating Laboratory. The Coatings Manager is not located in Building 444 and has other groups reporting to him which are located elsewhere around the plantsite. The Coatings Manager is responsible for reporting incidents up through his line of supervision. The Coatings Manager had only been in his position four months at the time of the incident.

It must be understood from the above organizational presentations that two organizations under different mid-level management are present and performing operations in the Plating Laboratory, Room 245.

The two organizations are involved directly with the incident in the Plating Laboratory. The Development Engineers and the Coatings Manager were responsible for initiating the incident. However, the Foreman of Foundry Operations carries "ownership" responsibility for the waste tanks in Room 9A which overflowed. Both organizations, therefore, would be responsible for notifying higher supervision of the incident.

3.3.2.2 Safeguards and Security

Five managers report to the Director of Safeguards and Security. The Manager of Plant Security has building security inspectors reporting to him as well as personnel designated as Shift Superintendents.

The night Security Inspector who covers Building 444 and others, currently works 12-hour shifts. He reports to Security Headquarters by 1715 hours, to post by 1745 hours, and remains on post until relieved at about 0545 hours.

He performs four watch tours per shift, at approximately 1745, 2145, 0145, and 0445 hours. The duties, among others, are: to test and lock exterior doors on the first round, and unlock them on the last round; check in at watch tour stations placed in various locations throughout the buildings; and observe any unusual or alarm conditions and take appropriate action such as calling the SOE or Security Dispatch. Although Security Inspectors are expected to report alarm conditions they observe, they are not trained on specific functions of indicator/alarm panels which they pass on their rounds.

There is a watch tour station located in Room 245, and one in a room close to Room 9A which are checked on every round.

The Shift Superintendents report to the Director, Plant Security. They serve in a shift capacity in a plant communications center known as the Emergency Operations Center (EOC). The EOC is operational and staffed 24 hours per day, 365 days per year. It is the responsibility of the Shift Superintendent, among others, to log incidents and unusual occurrences, and to make notification to selected Rockwell and DOE officials on the basis of a predetermined plan.

3.3.2.3 Support Operations

The Director of Support Operations has six managers reporting to him. Of significance to this incident are the Utilities and Maintenance functions, each under their respective managers.

The Maintenance function is performed by crafts personnel assigned to a building with backup support from a central organization. Two types of maintenance are performed: (1) preventive maintenance on building equipment and designated process equipment on a scheduled basis and (2) repair and installation of equipment on a priority based Work Order System. The priorities are established by the Building Manager and the manager of a particular operation in a building. ES&H related maintenance is given highest priority.

Utilities Operations also include the operations of the Sanitary Treatment Plant (STP). The STP is staffed on a day-shift basis only, five days per week from 0712 to 1530 hours. For weekends and off-shifts, an operator from the Water Plant is required to check the STP once per shift (no particular time) to assure that the equipment is operating satisfactorily.

3.3.2.4 Health, Safety and Environment (HS&E)

Seven functional managers report to the Director, HS&E. The primary functions of the HS&E Division is to establish safety policy, perform functional overview of the safety and environmental program at the site, and provide medical services. Line Management has the primary responsibility for safety of the workers, plant, and environment. Responsibilities of the HS&E Division with respect to Building 444 are to:

(1) Establish Building 444 environmental policies and programs to assure that all building operations are conducted to minimize impact detrimental to the environment.

(2) Establish building personnel safety policies and programs in the areas of industrial hygiene and safety; fire detection and suppression; and radiation protection.

(3) Establish nuclear criticality safety rules and limits for the building and gathering information about the facilities, equipment and processes, and analyzing for potential accidents.

(4) Protect the health of Building 444 employees.

(5) Identify and report for correction any operations or conditions involving potential industrial hygiene and safety, fire detection and suppression, and nuclear criticality or radiation safety hazards.

(6) Document the condition of the environment in the building and surrounding areas.

(7) Review all additions or modifications to the building or its equipment.

As a corollary to the Building Manager concept presented earlier, the HS&E function provides a similar concept with the HS&E Area Engineer. Generally, the HS&E Area Engineer is assigned a group of buildings rather than a single building. The HS&E Area Engineer reports to the Director, HS&E through the Manager of HS&E. The major function and responsibilities of the HS&E Area Engineer are to:

(1) Administer and coordinate the Health, Safety & Environment Safety Team to assure that safety requirements have been considered and implemented prior to startup of new or modified operations or occupation of new or modified facilities.

(2) Evaluate and coordinate safety review of maintenance activities and special permits for hazardous operations.

(3) Assist management in the preparation of Operational Safety Analyses and Job Safety Analyses.

(4) Coordinate the investigation of minor accidents and incidents, and assuring that the appropriate corrective action is taken.

(5) Support the Shift Superintendent in major emergencies by coordinating all technical assistance from the HS&E disciplines.

(6) Coordinate HS&E audits of operations, facilities, and organizations.

3.4 Building 444 Plating and Related Waste Operations

3.4.1 Plating Operations

Plating operations within Building 444 occur primarily in Room 245. Both Metallurgical Operations (Met Ops) and Manufacturing Technology Development (MTD) utilize the facilities. Met Ops performs production operations while MTD uses the lab for development purposes. The plating operating procedures for production are prepared by MTD personnel as they develop the processes used by Met Ops. Another plating facility is currently being built in another room for sole use by Met Ops. The new facility is now undergoing operational tests.

A brief discussion of the operations performed by the two groups is presented in the next two sections.

3.4.1.1 Metallurgical Operations

The procedures for conducting the metallurgical production operations are detailed in written procedures identified by an FO (Foundry Operation) prefix. These contain the step-by-step instructions necessary to perform any plating operation and are drafted by MTD personnel. Specifically, FO-444-1039, the FO for the chromium plating operations includes Hazards and Safety, Emergency and Normal Shutdown, Federal Specification QQ-C-320a, Equipment Startup, Capillary Surface Tension Method, Solutions, Current Density and Plating Time, Part Racking, Light Chromium Deposits, Heavy Chromium Deposits, Stripping Chromium From Various Base Metals, and Troubleshooting.

An example of a typical light chromium plating operation on aluminum is discussed below. First, the part is degreased if

necessary, then rinsed with tap water to remove any remaining degreasing agent. The part is soaked in Turco 4215 cleaner, a caustic soap, for five to six minutes to remove any unwanted material from the part. The part is then rinsed with tap water. Next, the part is dipped in 15% by volume sulfuric acid at 80-85°C for two to five minutes. Again, the part is rinsed with tap water to remove any remaining unwanted substance. The part is then dipped in 50% by volume nitric acid, at room temperature, for one minute and again rinsed with tap water. The part is then dipped in 25% by volume Alumon D, at room temperature, for 10 to 15 seconds and rinsed with tap water. A copper cyanide strike (Rochelle type) is made on the part at 50°C, at 20 amperes per square foot (ASF), with the current on for one minute. This step activates the aluminum surface to facilitate the chromium plating. Following the copper cyanide strike, the part is again rinsed with water.

Finally, the part is loaded in the tank with the plating solution at 40°C with the current on. The plating process is conducted at a normal current density of one to 1.5 amperes per square inch (ASI) for 10 to 20 minutes. After the plating, the part is removed but not rinsed. Other plating operations follow similar steps with any changes to the sequence of events being based on the material to be plated. It should be noted the rinse solutions from these operations drain into the acid waste tanks in the basement. These tanks, when full, are pumped to the Process Waste Treatment Facility, Building 374.

3.4.1.2 MTD Operations

The MTD operations differ from the Metallurgical Operations in several areas. The primary difference is that there are no written operating procedures for MTD personnel. However, the

FOs used by production personnel are written by the MTD personnel based on their knowledge and experience of the process. The nature of MTD operations, development and experimentation, preclude the use of strict plating procedures due to the variable nature of the assignments/tasks. The MTD personnel do use the manufacturer's literature and the Material Safety Data sheets for bath operating parameters.

3.4.2 Plating Laboratory Equipment

The Plating Lab equipment consists of two systems: rinse tanks and plating baths, and control alarm systems. The integration of the systems forms a complete process.

3.4.2.1 Rinse Tanks and Plating Baths

The tanks are divided into two distinct categories: process tanks and rinse tanks. The process tanks consist of those containers related to the actual plating process. The rinse tanks are those which are used for cleaning with water and are not integral to the completion of the plating operation.

The process tanks are made of plastic to resist the corrosive tendencies of the contents and to avoid metallic contamination of the plating solution. The size of the tanks varies with the process involved but the largest of which does not exceed the size of an office desk. The process tanks are closely grouped due to the similar operating parameters. The chromium plating tank (see Figures 15 and 16) has a volume of approximately 365 liters or 95 gallons. The plating tank does not have a fixed top; instead, it has a removable plastic lid sized to fit the opening. The process tanks do not have a drain to either the sanitary or process waste system. In the event a process tank needs to be drained, the normal method is to transfer the contents directly to

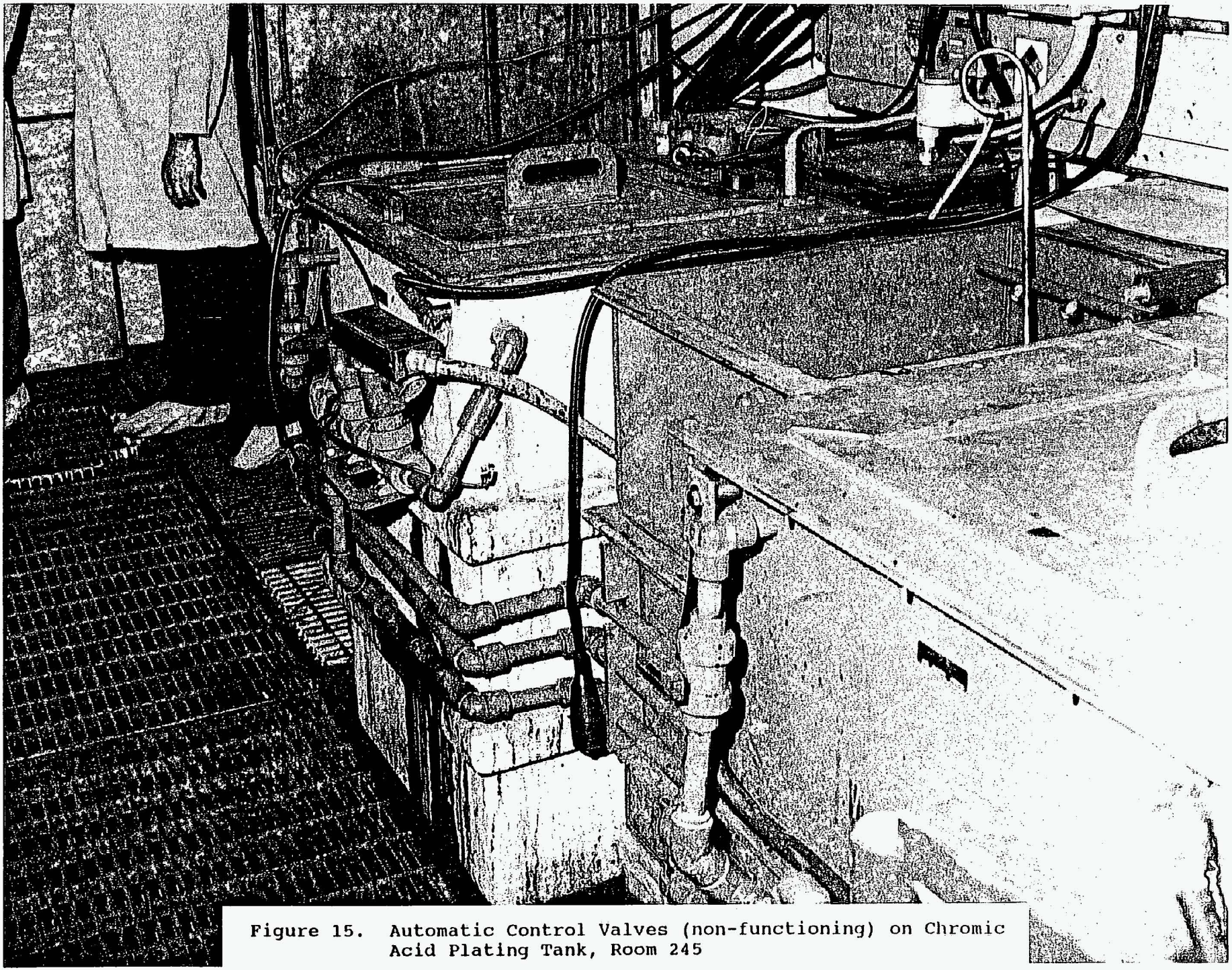


Figure 15. Automatic Control Valves (non-functioning) on Chromic Acid Plating Tank, Room 245

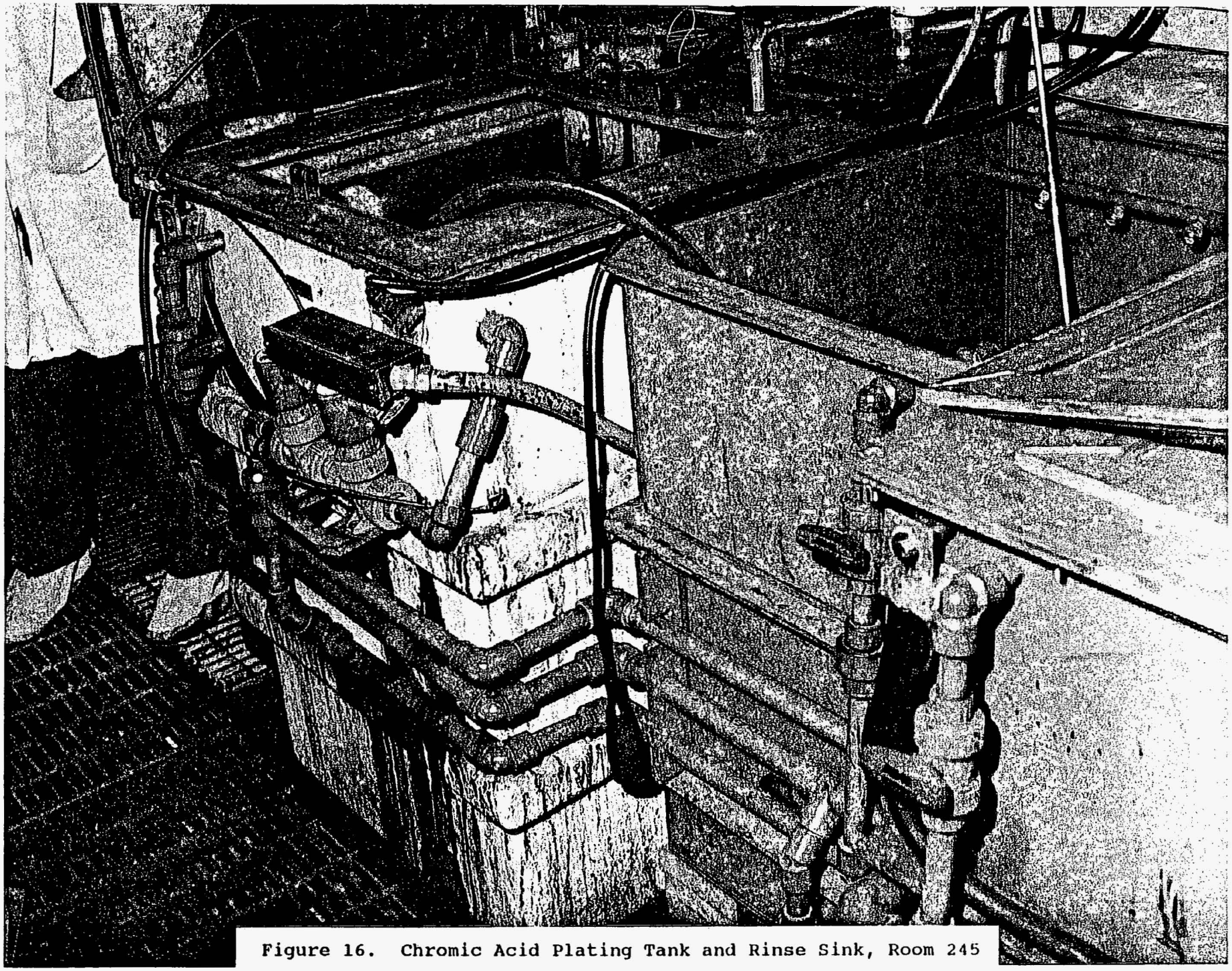


Figure 16. Chromic Acid Plating Tank and Rinse Sink, Room 245

a barrel. Ventilation ducts are built into those systems where the emissions from the liquid are considered hazardous and must be constrained. These ducts are connected to a scrubber. The water lines used to maintain the liquid level in the baths enter through holes in the side of the tank approximately five inches below the top of the tank. The holes are not sealed.

The rinse tanks are made of plastic to have a resistance to the substances generated during the rinsing process. The size of the tanks varies but are similar in size to the process tanks. The rinse tanks consist of two types: a spray rinse or a wash rinse. The wash rinse is a basin which is filled with the rinsing liquid and the object to be rinsed is dipped in the liquid. The spray rinse utilizes waterjets to scour the object to be rinsed. The spray-rinse tanks can also be utilized as a wash-rinse tank by simply filling the tank. Approximately two years before this incident, a rinse tank being used as a wash-rinse was overflowed causing a similar type incident.

3.4.2.2 Control/Alarm Systems

The control system implemented on the chrome plating bath is an example of the system utilized on the other acid-line plating tanks (see Figure 17). The control system is comprised of heaters (on the heated baths), a capacitance probe, a double-valve waterflow management system, a Programmable Logic Controller (PLC) in the laboratory office, an indicator panel across from each plating bath, a level sensor (float), and a thermocouple. These units are designed to operate as an integrated system for the control of the plating baths. The control system has a past history of chronic failure. At the time of the incident, not only was the PLC disconnected from the chrome plating bath and others in the acid line, but four out of the five plating baths had inoperative sensors.

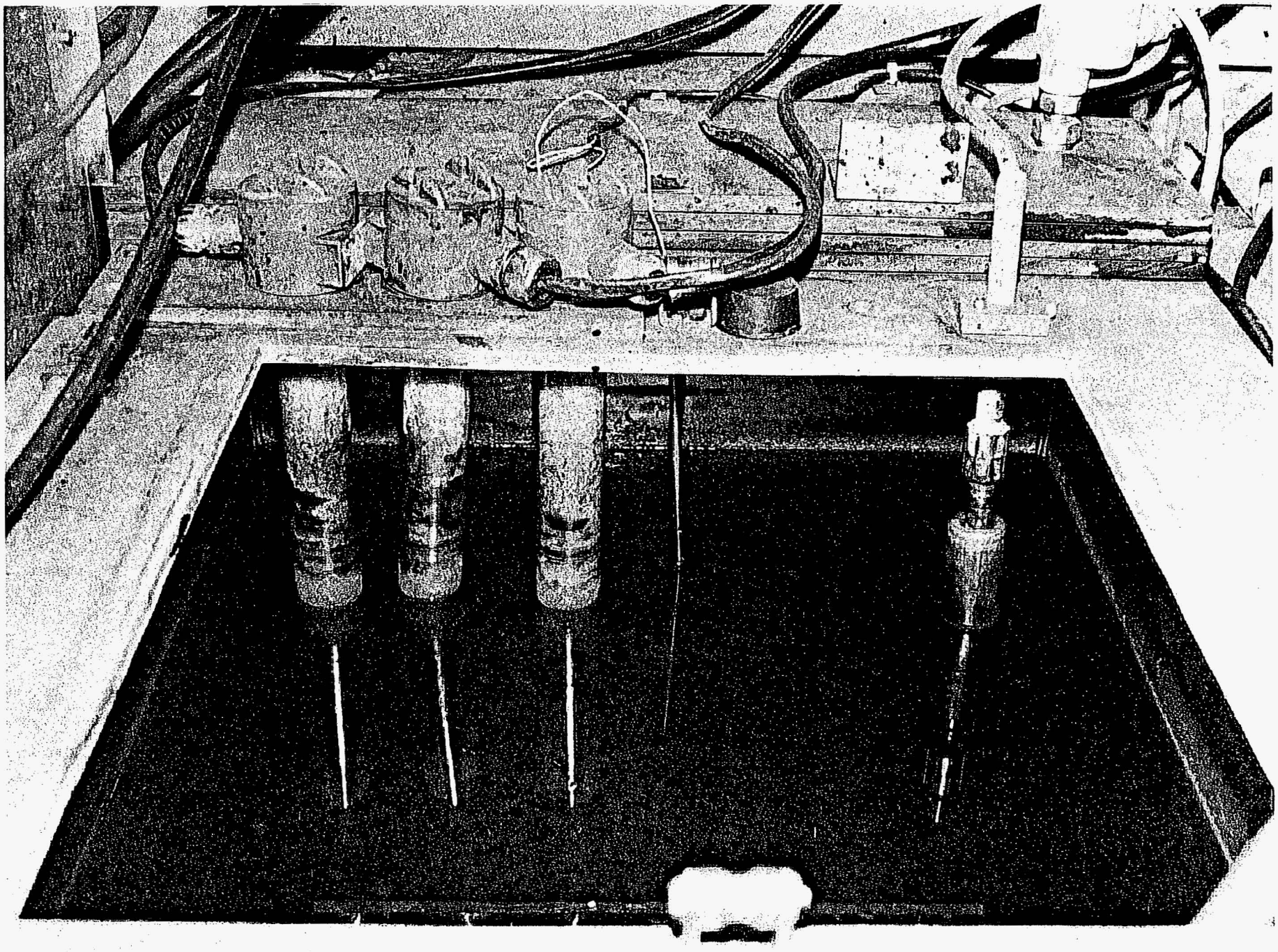


Figure 17. Chromic Acid Plating Tank Heaters and Level Detectors

The controlling unit is the capacitance probe. This probe controls the double-valve and the heaters. This is accomplished through the ability to set various "detection" points on the probe. There are four set points being used on this particular design: a low low-level point, a low-level point, a high-level point and a high high-level point.

The low low-level point acts as a final system to prevent a fire. This is accomplished by cutting all power to the tank in question, specifically to the heaters, if the liquid level falls too low. This should only occur in the event of a tank rupture, a valve failure, or a probe failure.

The low-level and high-level set points define the normal operating region. Both signals control the first valve of the double-valve water control system. When the low-level area is reached, the first valve is opened allowing water to enter the tank, and when the high-level area is reached, the first valve is closed to prevent overflow. The region between the two set points is defined as the operating area or the dead band.

The high high-level set point is the final control measure to prevent overflow. If the high level set point fails and does not close the first valve, then the high high-level set point will be activated when the liquid reaches that height and close the second valve to prevent an overflow. A signal is also sent to the PLC which will light an indicator light and sound an annunciator.

The second level sensor is a magnetic float utilized to warn of impending problems. The float sends a signal to the indicator panel across from each bath. This signal is sent when the liquid level of a tank reaches the high high-level. The signal will light a high liquid level indicator on the panel.

The PLC is the system status display panel located in the office, Room 245A. This panel displays the condition of the heaters (on or off), the float (alarm level or not), and the activation of a particular set point on the capacitance probe. All the acid-line plating tanks can be monitored from this panel.

The thermocouple is the unit responsible for maintaining a constant temperature within the baths. If it is inoperative, the heaters will not be activated and the bath will be rendered unusable.

Both the capacitance probe and the magnetic float sensors were disconnected from the PLC at the time of the incident because of chronic failure problems. Therefore, the Water Control System was inoperative and could not be used to add makeup water. This was accomplished by adding water manually via a hose line and a hand-operated valve. No operating procedures were developed for the off-normal condition. Met Ops had elected not to use the Plating Laboratory since early December 1988 because: (1) they had completed all single shift plating operations, and (2) plating operations requiring more than a single shift were felt to be unsafe because water levels could not be controlled and bath meltdown could occur.

3.4.3 Waste Operations

The operation of the holding tanks located in Room 9A in the basement is divided between two separate organizations, Metallurgical Operations and Liquid Waste Operations. Each organization has defined responsibilities with regard to normal tank operation. These responsibilities are delineated in the document WO-4010-A/0. The prefix WO stands for Waste Operations.

3.4.3.1 Metallurgical Operations Responsibilities

Metallurgical Operations officially own the holding tanks in Room 9A, and must perform a daily inspection of the tanks and their environment. These inspections are conducted on a one-shift-a-day (0700 to 1600 hours) basis, five days a week, Monday through Friday. These daily inspections include checking the liquid level in the tanks; if full, then switching the flow to the other tank; observing the condition of the tanks; observing the status/contents of the berm, and looking at the floor outside the berm for any unusual occurrence. A log is kept of any unusual occurrence. Metallurgical Operations, specifically, the Building Superintendent, Building 444, is also responsible for the "Maintenance [required] of the waste holding tanks, pumps and piping."

3.4.3.2 Waste Operations Responsibilities

Waste Operations is responsible for: (1) the control of valves, pumping equipment, and lockout systems for the waste tanks as it applies to waste transfer operations; (2) the proper sampling of waste tanks and maintenance of analytical data logs; (3) the disposition (transfer) of the wastes; and (4) notifying the user of any abnormalities in waste flow and need for modification or maintenance of the system. The Waste Operations personnel are directly responsible for those operations as they apply only to waste transfer and are responsible for the conditions of the transfer equipment.

A typical transfer operation is conducted as follows. At the beginning of the morning shift a Water Transfer Operator will enter Room 9A to check the tank status. If a tank is full, the operator will assure the other tank has ample volume for continued

operations, and will shut the valve on the in-piping and open another valve to allow flow to the other tank. A sample is then taken and transported to a lab for radioactivity and beryllium analysis and pH level; results are available in approximately four hours since such samples have priority. Once the sample results are known, the operator must receive permission from Building 374 Operations Manager to ship the tank contents. When permission is granted for shipment, the valves connecting the tank to the transfer pipelines are opened and, if necessary, unlocked. The transfer pump for the system is engaged and allowed to run until the entire tank contents have been transferred.

In an emergency situation, the major difference in procedure is the sequence of events dealing with the sample and transfer. A sample is taken, but instead of waiting for analysis, the operator immediately contacts Building 374 Operations Manager and requests permission to transfer a tank. The Operations Manager, using personal judgment, will either approve or deny the request. If approved, the contents of the holding tank will be transferred to an isolated tank in Building 374, if possible. The sample will be analyzed as normal to verify the type of waste transferred. All other operations are conducted as normal.

The waste operations associated with the plating operations are conducted in Room 9A. This area contains the waste water acid holding tanks and the waste water cyanide holding tanks. Waste transfer of the holding tanks is also conducted from Room 9A. The holding tanks are considered the primary containment and a separate berm surrounding each type of holding tank serves as the secondary containment.

The waste tank equipment can be divided into two areas: waste containment/transfer system and a control/alarm system.

3.4.3.3 Waste Containment/Transfer System

The two 400-gallon tanks which comprise a waste water acid (WWA) storage system (see Figure 18) and two 500-gallon tanks which comprise a waste water cyanide (WWC) storage system are located in Room 9A of the basement. Each system has similar characteristics with regard to the equipment used.

The WWA tanks each hold 400 gallons and are made of 304 stainless steel. They are located within a berm (see Figure 19) having a capacity of 1400 gallons. The berm has been painted with an epoxy paint and caulked to form a watertight seal to prevent possible leakage. The epoxy paint has deteriorated to the extent some paint has flaked off. The tanks are considered to be the primary containment system and the berm is the secondary containment system. The WWC tanks are likewise protected by their own secondary containment with a sufficient capacity to hold the contents of the two tanks should they fail. The two secondary containment structures share a common wall. One wall of the secondary containment for WWA is the building wall while the WWC secondary containment uses two building walls.

The tanks are connected to the process waste system via a series of piping and pumps. One primary pump (see Figure 20) was used to transfer both the WWA and the WWC tanks to Building 374, the process waste treatment facility. At the time of the incident, a recycle pump was connected to the cyanide system which could have been cross-connected, through the existing piping, into the acid tanks. This recycle pump can be utilized to pump to the process waste treatment facility should the primary pump become disabled. In the present piping configuration, tank contents cannot be recycled and mixed to ensure that a representative sample of the contents is obtained prior to shipment to Waste Operations in Building 374.

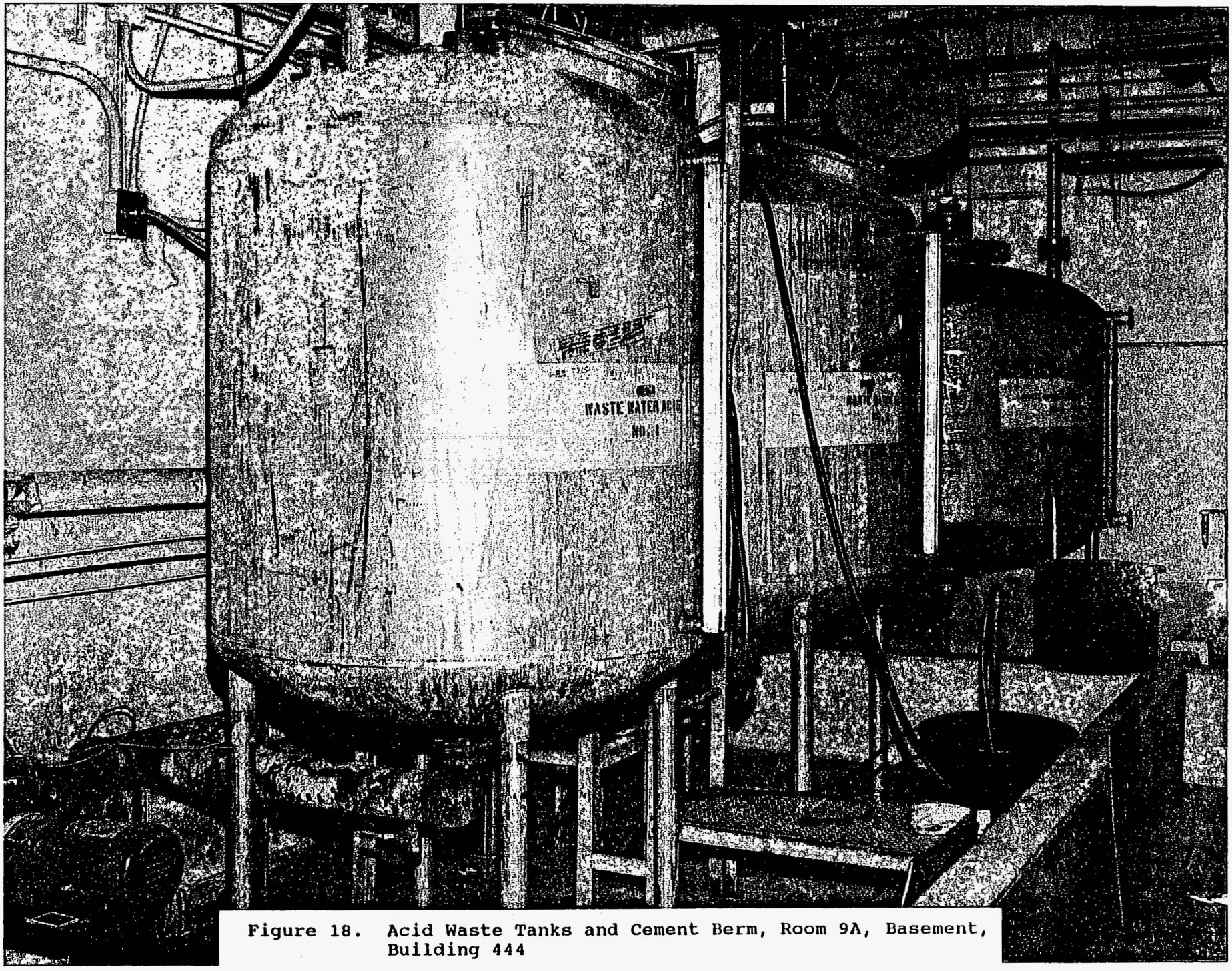


Figure 18. Acid Waste Tanks and Cement Berm, Room 9A, Basement, Building 444

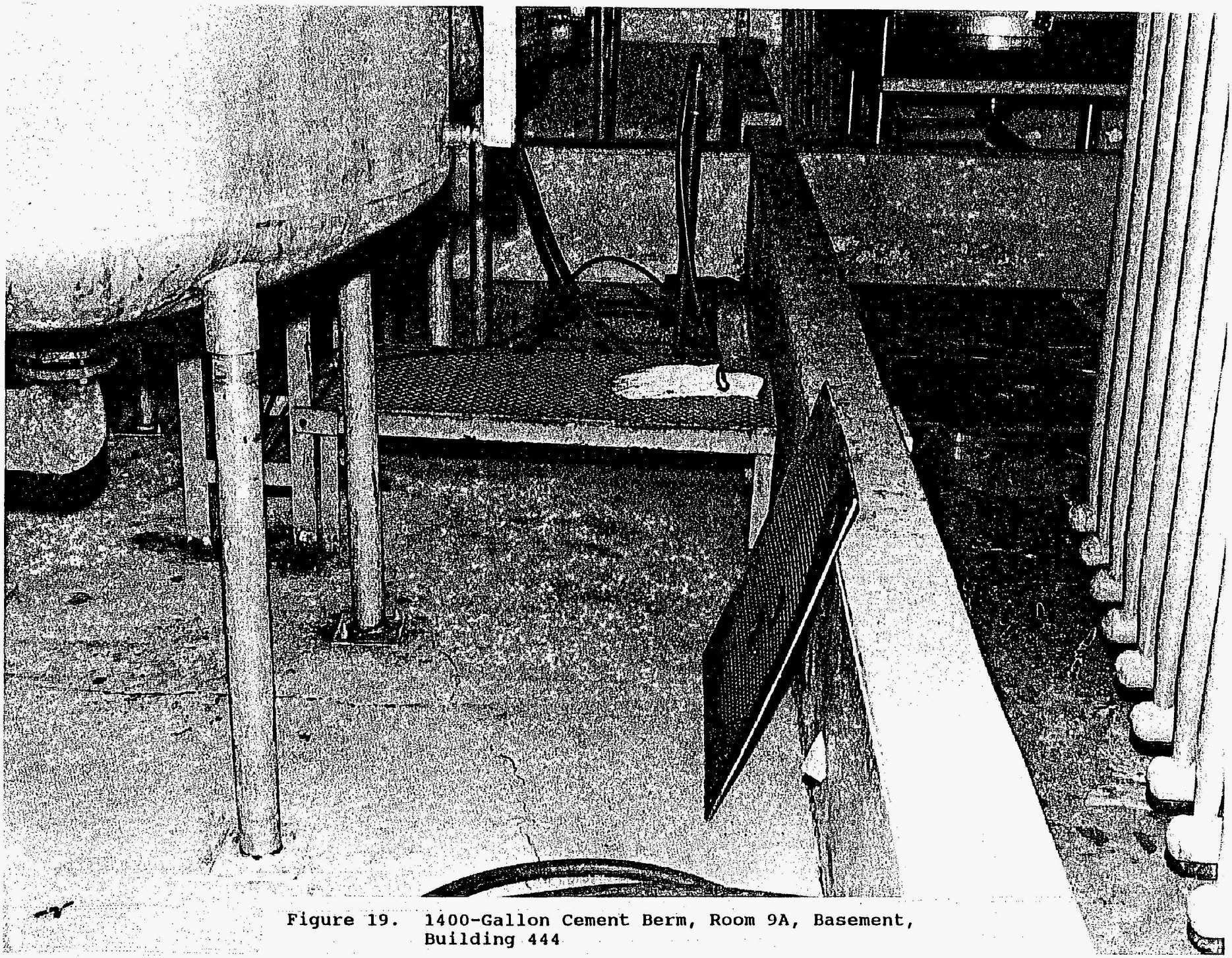


Figure 19. 1400-Gallon Cement Berm, Room 9A, Basement, Building 444

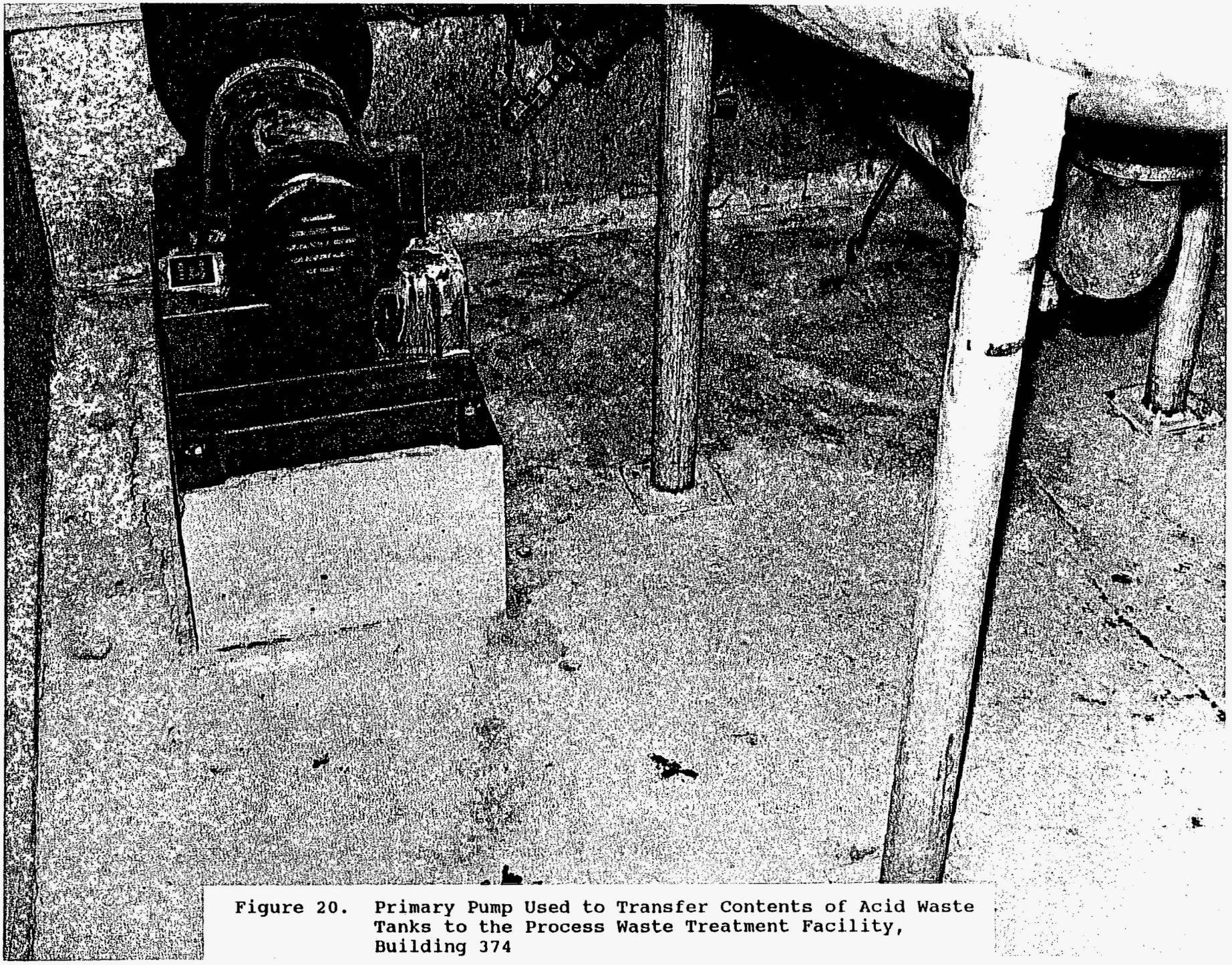


Figure 20. Primary Pump Used to Transfer Contents of Acid Waste Tanks to the Process Waste Treatment Facility, Building 374

3.4.3.4 Control/Alarm System

The control system implemented in the WWA tanks is slightly different than the waste water cyanide control system. The WWA control system is manual whereas the cyanide system is automatic.

The flow into the WWA tanks is controlled manually. Each tank has a valve which can be opened or closed manually to control the flow into the tanks from Room 245. The decision to open or close the valve depends on the level in the tanks, as determined by reading sight gauges. Each WWA tank has a high-level sensor which signals at a capacity of 350 gallons. The signal is sent to an indicator panel in Room 245 (see Figure 21), which activates both a visual and an audible alarm.

The flow control valves into the cyanide system are motor driven with their own automatic switching system to determine when the tanks are full. Only one tank is normally in use at any given time. If a tank is filled, the automatic switching system will then switch the flow to the other tank. A cyanide sensor is located between the tanks on the back wall at the height of the top of the tanks. If this is triggered, it will perform two functions. First, it will immediately sound an audible alarm in Room 9A. Second, it will send a signal to the indicator panel in Room 245, which will activate both a visual alarm and a distinctive sounding audible alarm.

It should be noted that while the alarms will annunciate in Room 245, this area is normally occupied only on the day shift, five days a week.

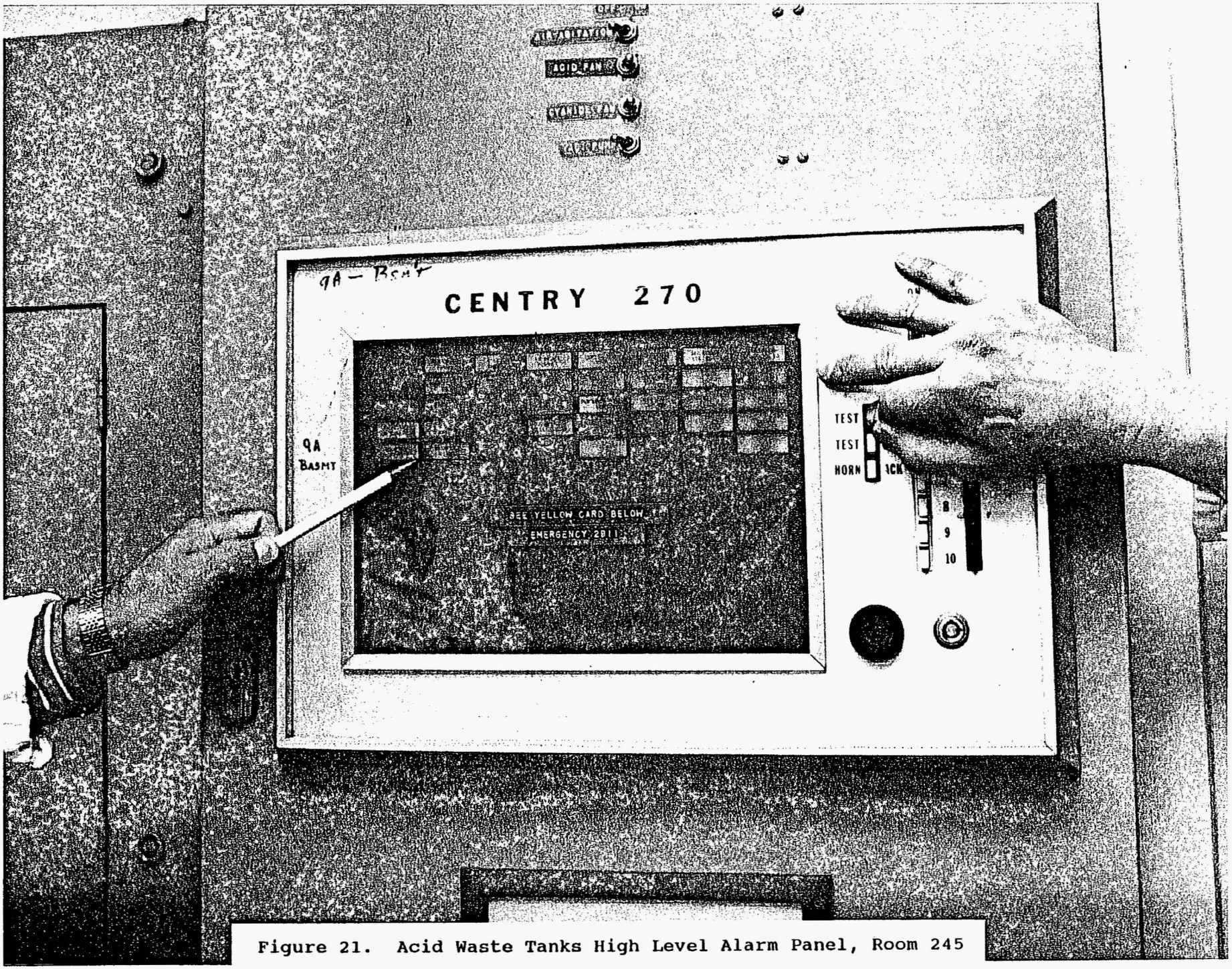


Figure 21. Acid Waste Tanks High Level Alarm Panel, Room 245

3.5 Chromic Acid Release Incident

3.5.1 Building 444 Activities

About 1600 hours on February 22, 1989, a Development Engineer from MTD checked the Plating Laboratory, Room 245, to ensure that it was secured for the day. Upon noting it had not been checked by the assigned person, he proceeded to secure the laboratory.

During this check, the engineer noticed that the liquid level in the chromic acid plating bath was low (see Figure 16). It was planned to leave the heaters on overnight for a plating project scheduled for the next day. To ensure proper operating conditions, the engineer opened the manual water valve to fill the bath with a hoseline. While the water was running, the engineer finished checking the rest of the laboratory and went home, forgetting that the water valve was on. The plating bath overflowed into the acid waste drain and collected in WWA tank T-1 in the basement.

Between the hours of 1600 and 0730, Building 444 is patrolled by a plant security guard. All exterior doors of the building are locked and alarmed. Alarms to these doors are activated at 1730 and deactivated at 0536 hours. The guard tours the building at two-hour intervals, the first tour starting at 1745. On the first tour, the guard tests the exterior door alarms and locks them. Also, all safes are checked and the guard will key in the security clocks that are encountered during this tour (this route differs from the normal clock route). When activated by the guard, a signal is sent from these security clocks to the dispatch office at the security building. The guard walks the normal clock route on the remaining security tours. A security clock is located in Room 245.

A pipefitter was held over on the PM shift February 22, 1989, to repair a condensate pump and steam coil on one of the plating baths in Room 245. About 1730 hours, two pipefitters that are assigned to the PM shift arrived in Room 245 to assist the pipefitter working overtime. All three pipefitters left the room for break at 1800 hours. After break, the overtime pipefitter did not return to Room 245, but performed some work in Room 104 and left the building at 2000 hours. The two PM shift pipefitters returned to Room 245 at about 2000 hours and completed the repair to the steam coil.

The acid waste tanks probably would have filled and overflowed, activating the high level alarms in the Plating Laboratory at about 1800 hours based on measured flow rates from the faucet.

The high level alarm is both audible and presents a flashing visual display. If the alarm is acknowledged by someone, the audible portion is silenced while the visual portion remains lit, but not flashing. Neither the security guard or pipefitters noted any audible or flashing alarms.

About 0430 hours, February 23, 1989, two painters scheduled to work overtime arrived at Building 444. They went to the paint shop, Room 9 in the basement, for their supplies. While they were in Room 9, they could hear liquid running in the adjacent Room 9A. Room 9A contains the liquid waste collection tanks for the Plating Laboratory (see Figure 18). These rooms are separated by a roll-up door that is normally closed. During the off shifts, between the hours of 1730 and 0535, this door is locked and alarmed. To gain access to Room 9A while the door is alarmed, Security must be notified.

Records in security indicate this door was not accessed while it was alarmed. Some time after the alarm had been removed, a painter went into Room 9A to obtain additional painting supplies, saw liquid on the floor and walked through it. The painter did tell a fellow lead person about the flooded condition in Room 9A, but neither of them contacted management.

A Waste Operations operator, who has responsibility for transferring all liquid process waste from the various buildings on the plantsite to Waste Treatment Building 374, entered Room 9A about 0715 hours. Upon entering the room, the operator discovered the acid waste tank T-1 was overflowing into the berm area and onto the floor (see Figure 18). The other waste tank T-2 had been filled and valved off the previous day. The Waste Operations operator closed the fill valve to tank T-1 and proceeded to the Plating Laboratory, Room 245, to inform Plating Lab personnel of the flooded condition in Room 9A.

The engineer who opened the water fill valve the previous night entered the Plating Laboratory at 0730, February 23, 1989. Just inside the room, he noticed the acid waste tanks high level alarm lights were lit (see Figure 21) indicating the tanks were full; however, the audio alarm was not sounding. The alarm was tested at a later date and found to function as designed. Seeing the alarm lights, the engineer remembered that the water valve had been left on to the chromic acid bath.

After shutting the water valve off, the engineer proceeded to the basement, Room 9A. On the way down, the Waste Operations operator was encountered and they both proceeded to Room 9A to assess the extent of the spill. The Waste Operations operator took a sample of the solution in the berm and the engineer informed the Metallurgical Operations manager of the incident. At a later

time, the engineer notified the Coatings Laboratory manager of the incident. The Metallurgical Operations manager notified the Building Manager of the incident. No further management notifications were made.

The Waste Operations operator obtained permission from Waste Operations management to ship the acid waste to Process Waste, Building 374, without waiting for analyses. After unlocking the appropriate valve and starting the pumps, it was discovered that the primary transfer pump screen was plugged (see Figure 20). The engineer initiated a work order to clean the screen. In the meantime, the Waste Operations operator continued the transfer using the recirculation pump. As soon as sufficient space was obtained in the waste tanks, the Development Engineer and an Advanced Chemical Engineer started transferring the liquid in the berm and floor to the tank, T-1. The engineers did not use acid protective clothing, or full-face respirators with chemical cartridges, while picking up the spilled solution.

A work permit was required to repair the primary transfer pump. This work permit was reviewed by the HS&E area engineer and Industrial Hygiene. The Industrial Hygienist visited the spill area and specified that a plastic rain suit (approved for use as protection against personnel contact with acid), acid resistant rubber gloves, and a full-face respirator with chemical cartridges be worn while cleaning the transfer pump screen. The HS&E area engineer made no further management notification of the spill.

After the liquid level had receded sufficiently, the pipefitter wearing the prescribed protective equipment cleaned the transfer pump screen. The remaining water in the berm and floor area was picked up by a Utilities Engineer and a Stationary Operating Engineer using a portable sump pump (see Figure 19) and was

transferred to the acid waste tanks. This solution was then transferred to Process Waste, Building 374.

Also between the hours of 0750 and 1200 hours on February 23, 1989, two carpenters worked in Room 245 replacing ceiling tile. While working there, the control panel alarm (see Figure 21) for the high level acid waste detectors was activated several times. The lights did flash and the audio portion sounded. When the acknowledge button was depressed by the Chemical Engineer, the sound discontinued and the lights stopped flashing.

After it was determined on February 28 that chromium was the contaminant detected at the STP, an attempt was made to see if there was a correlation between the chromic acid spill in Building 444 and the chromium found at the STP. On March 3, 1989, at about 1300 hours, a Utilities Engineer coordinated a dye test with Waste Operations on the process waste transfer line between Buildings 444 and 374. The dye test did not detect any leaks in the process waste transfer line.

A foundation sump pump in another area of Building 444 is connected to the sanitary sewer drain (see Figure 22). Samples of the solution in the sump were taken by a Utilities Engineer on March 3, 1989. When chromium was identified in the sample, the Utilities Engineer had the sump pump disconnected from the sanitary sewer drain and repiped into the process waste line. This pump is equipped with an automatic float control switch which allows the pump to run automatically when liquid reaches its set high point.

On the morning of March 6, 1989, a Utilities Engineer and a Stationary Operating Engineer performed a leak test on the berm around the waste tanks and the floor area in Room 9A by flooding

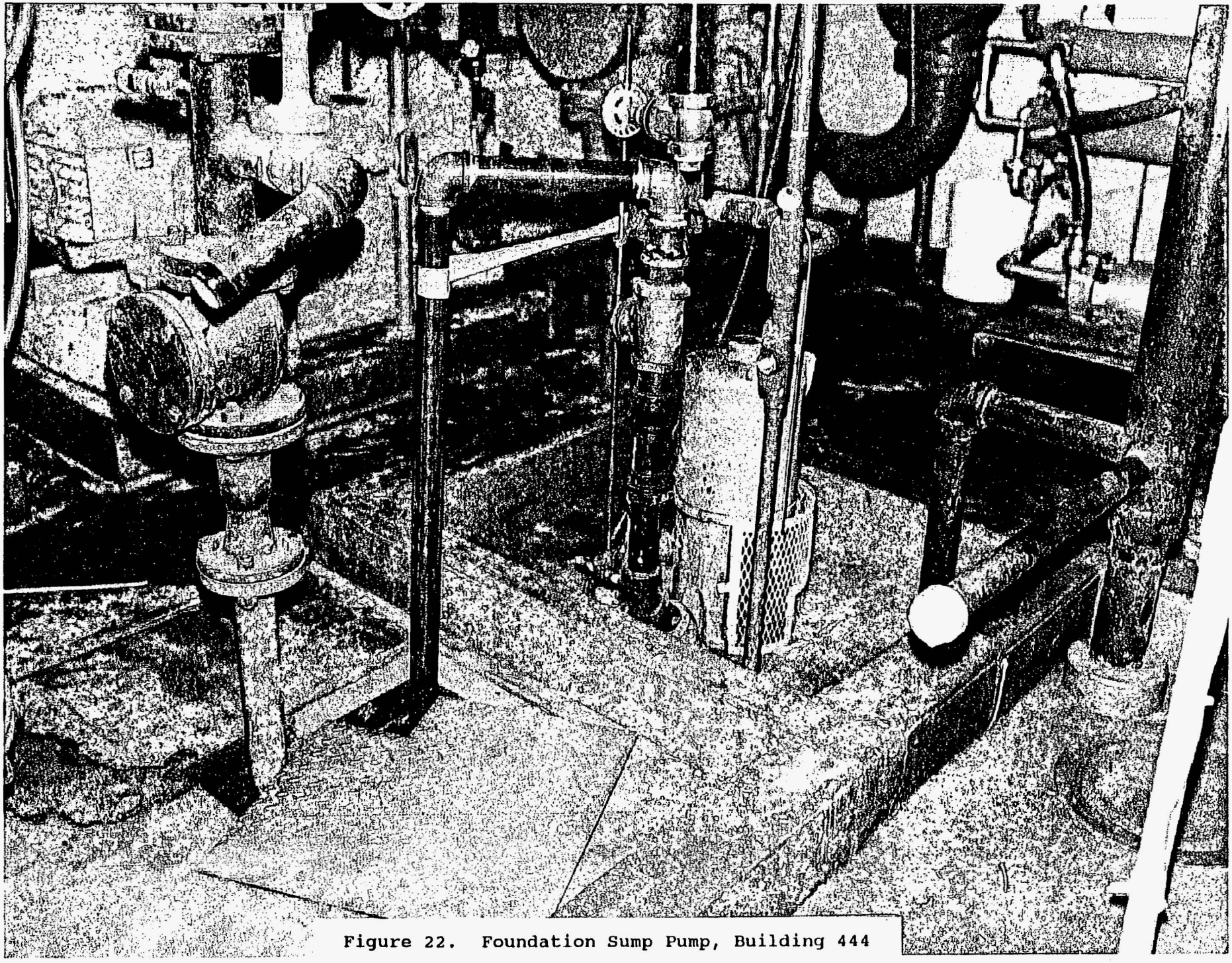


Figure 22. Foundation Sump Pump, Building 444

it with water and blue dye. The test was conducted to see if there was any correlation between the chromium found in the foundation sump and the spill in Room 9A. Flooding of the berm was completed by 1030 hours, and by about 1530 hours that same day the blue dye appeared at the foundation sump pump. The water was allowed to stand overnight to determine the rate of leakage. On the following morning, the water level in the berm had receded about one foot, which indicated that the chromic acid spill in Room 9A did leak to a significant degree to the building footing drains. From the footing drains, it collected in the building foundation sump and was pumped to the Sewer Treatment Plant (see Figure 9) thereby establishing the pathway for the contamination to enter the environment.

3.5.2 Sewage Treatment Plant

The STP operator first observed a yellowish-green discoloration in the primary clarifier (see Figure 23) at the STP at about 1030 hours on February 23. Grab samples were taken.

Notifications were made to the Plant Superintendent and to Health, Safety & Environment (HS&E) Environmental Management at about 1100 hours. Environmental Management responded to the notification and observed the color at the sewage treatment plant at about 1300 and obtained samples for the Analytical Laboratory. The discoloration was no longer evident in the primary clarifier by late afternoon of the same day and STP notified Environmental Management that discoloration had stopped at about 1600. The STP is staffed on the day shift only and is checked once per shift on the off-shift. The STP operator observed additional discoloration entering the plant on the following morning (about 0730 hours on February 24) and Environmental Management was notified once again.

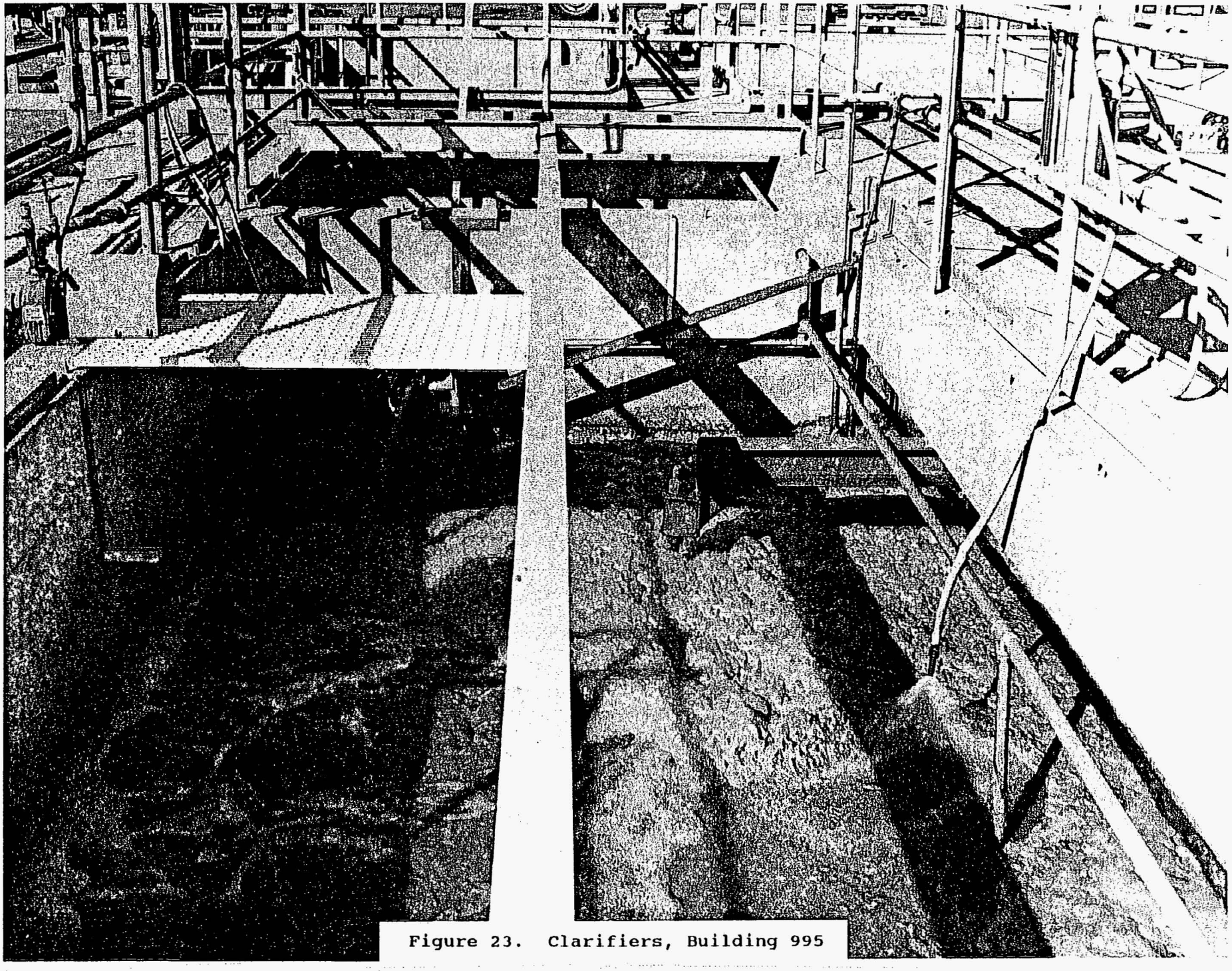


Figure 23. Clarifiers, Building 995

The samples taken by Environmental Management on February 23 were taken to the Building 881 laboratory with the request that they be analyzed for organic materials. The initial laboratory screening and investigation of the samples concentrated on organic materials because of the observed "iridescent" quality of the unknown material and because previous spills of organic materials had occurred. This led investigators to believe that the material was a commercial antifreeze (ethylene glycol) or a dye penetrant. At about 1500 hours on February 23, Environmental Management contacted the Building Managers of buildings known to use these materials to find out if there might have been a discharge into the sewer drain. The response was negative. The results obtained on February 24 indicated no organics. At about noon on February 24, a plantwide announcement was made requesting any information on the possibility of a dye penetrant or ethylene glycol down a sanitary sewer drain. There was no response.

After there were still no positive results from either the organic analyses and leads for potential organic spills by February 27, Environmental Management requested that the samples be screened for other than organic materials. By February 28, chromium was identified as the major contaminant in the STP influent grab sample at about 1400 hours, and reported immediately to HS&E Environmental Management. Analysis of total chromium in acid preserved and composited influent and effluent samples for the time period of chromium release was requested. However, only total chromium analyses were possible on these samples because the EPA protocol for chromium analysis requires that the analytical procedures for hexavalent chrome be performed within 24 hours on an unpreserved sample. The grab samples were not acid preserved. The results of the total chromium analyses on the composited samples indicated 13 ppm in the influent and two ppm in the effluent.

Based upon the volume of treated sanitary effluent during that 24-hour period (266,000 gallons), about 30 pounds of chromium were initially calculated to have reached the STP and about 5 pounds of chromium were calculated to have reached pond B-3, the spray fields, and other detention ponds. The remaining 25 pounds were retained in the Treatment Plant sludge.

3.5.3 Discharge From Sewage Treatment Plant

There is limited diversion capacity upstream of the STP: these are two 60,000-gallon basins, only one of which can be isolated at a time. Ponds B-1 and B-2, located below the STP, are "isolated" ponds not normally used in the discharge system. Moreover, they were effectively full when this incident began and unavailable for use. Thus, the release of chromium from the STP was irreversible and uncontrollable by the time the STP operator observed the unusual coloration entering the plant. There is no real-time monitoring for contaminants for either the influent to or the effluent from the STP.

Altogether, the incident resulted in intermittent flows of chromium-bearing waters over about a 24-hour period, during which a total of 266,000 gallons of sanitary waste was treated by the plant.

The STP discharge was flowing to pond B-3 at the time of the incident, which is the mode of normal operation. Waters collected from the STP in pond B-3 are required by the NPDES permit to be spray irrigated unless weather conditions prohibit such spraying. This was the method selected by EPA Region VIII during permit negotiations when the permit was issued in 1984 to limit discharges from the Rocky Flats Plant to as close to zero as possible. Some waters ran off from the spray irrigation fields into pond B-5. (See Figure 10 showing A, B & C series ponds.)

3.5.4 Environmental Sampling and Monitoring

3.5.4.1 Retention Ponds - Water Monitoring

The Rocky Flats Plant maintains an extensive routine sampling and analysis program for water. Additional monitoring was initiated after the identification of chromium in STP effluent. Much of the initial sampling focused on ponds B-3, B-5, and C-2 because of the knowledge that runoff from spray irrigation out of B-3 would flow predominantly to the B-5 and C-2 ponds. Samples were collected at those ponds on March 1, 1989, the day that the chromium discharge was confirmed by composite STP sample analyses. Additional samples of waters standing in the spray irrigation fields were collected. The pond samples were split for total chromium analysis onsite, and hexavalent chromium analysis at a contract laboratory (the onsite hexavalent chromium analysis capability was out of operation at the time that samples were collected).

We note that ice was still on the ponds at the time these samples were collected. For this reason, the representativeness of the samples relative to total pond volume concentrations is suspect.

Evaluation of the March 1, 1989, sample results led to establishment of a routine sampling program. The issue of accuracy of analytical results was addressed by using blind controls and environmental samples split between onsite and contract laboratories and providing known blind spiked samples to both laboratories.

The sampling program further evolved to include daily sampling of the following locations:

Location	Samples
Pond B-5	2
C-2	2
A-4	1
B-3	1
Walnut Creek at Indiana*	1
Woman Creek at Indiana*	1
995 (STP) Effluent	1

* When flowing

The results of all samples collected and analyzed through April 24, 1989, are shown in Table 1, Appendix C.

The weather warmed considerably prior to March 14, 1989. Concurrent with the warmer weather, chinook winds (70-90 mph ranges) melted residual ice covers on all Rocky Flats retention ponds and mixed pond waters. Consequently, sample results from March 14, 1989, may be homogeneous and thus more representative of total pond inventories of chromium. Periodic mass balances (trivalent/hexavalent oxidation states) indicate that on March 22, 1989, approximately 30% of the total chromium still existed in the +6 oxidation state or in anionic complexes in pond B-5. After March 22, all analyses for hexavalent chromium were below detection limits. Sample results several weeks after the chromic acid incident were at the analytical detection limit for total chromium (.010 ppm) for all surface water ponds except pond B-5. Total chromium levels at pond B-5 were in the .020-.030 ppm range during this same period. The drinking water

standard for total chromium (set on the basis of hexavalent chromium) is .050 ppm. Discharge options for pond B-5 are discussed in another section of this report.

3.5.4.2 Pond B-5 Profiling

A depth profile sampling was completed in pond B-5 on March 20, 1989, after ice cover melted to resolve the issue of representativeness of samples being collected. The results of sample analysis given in Table 1, Appendix C, indicate that the chinook winds that occurred prior to the sampling had sufficiently mixed waters in the pond that the grab samples being collected from the pond edge were representative.

3.5.4.3 Sulfate/Fluoride

Another issue that was considered was that the proprietary plating solution spilled in Building 444 contained sulfate and fluoride. This was ascertained from the Material Safety Data Sheet (MSDS). Special composited samples were collected at pond B-5 on March 15, 1989. Analysis of these samples gave the following results.

Concentration (ppm)		Drinking Water Limit (ppm)
Sulfate	99.9	250
Fluoride	0.51	1.4-2.4 (temperature dependent)

3.5.4.4 Spray Fields - Soils Monitoring

Thirty-four soil samples (including two field duplicates) were collected from areas potentially affected by the chromium release (see Figure 24). The solubility of chromium and the cation exchange capacity of the soil indicated that the chromium would be found in the upper portions of the soil profile. Therefore, to assess the

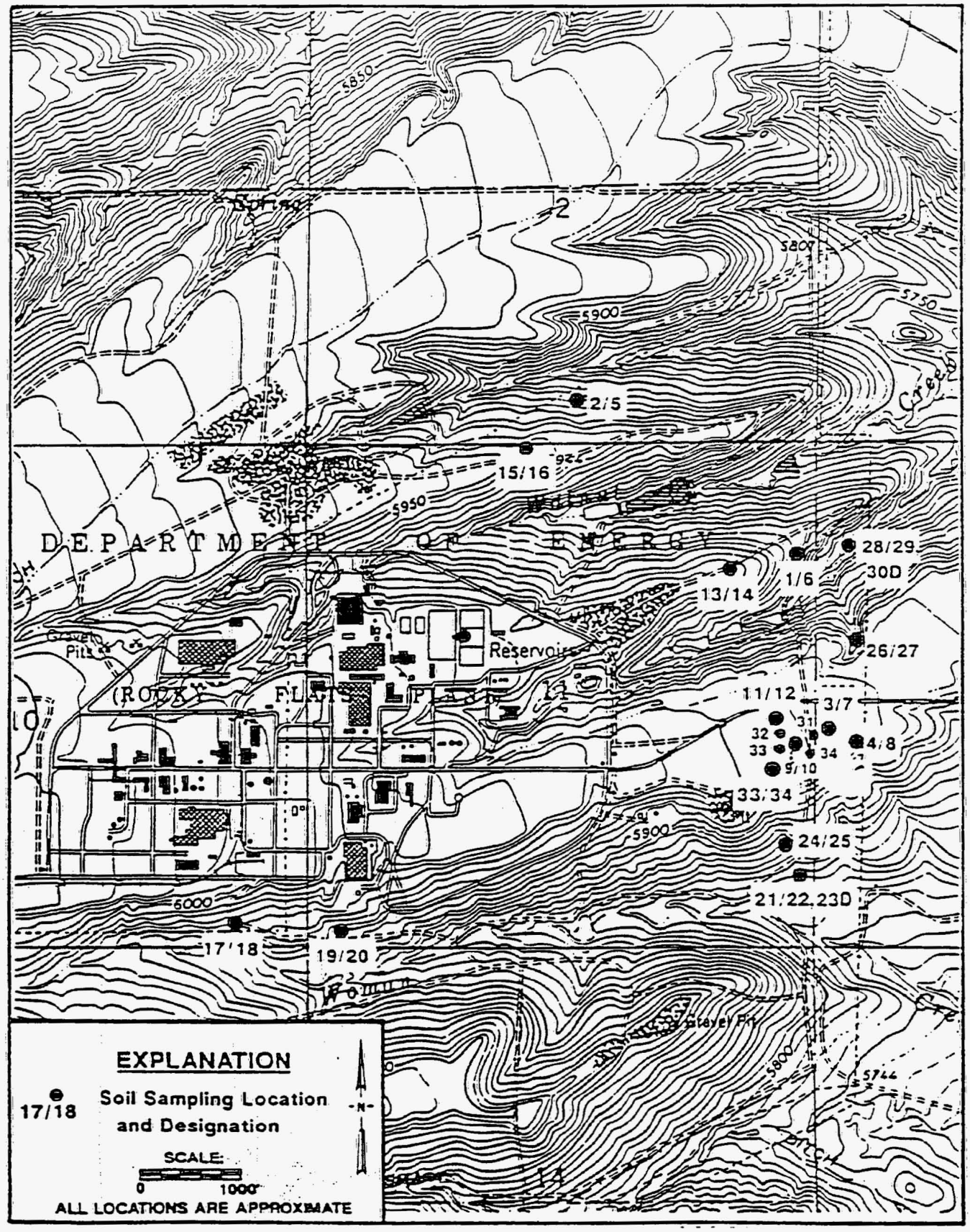


Figure 24. Soil Sampling Locations, Chromic Acid Release

concentrations of chromium in the soil, samples were collected at the ground surface, zero to one-inch depth, and from six- to seven-inch depth. Samples were analyzed for total chromium using the EPA EP Toxicity extraction procedure in order to measure the amount of chromium that is leachable from the soil and, therefore, a potential route of exposure.

Sampling locations were representative of the application, surface run-off and background areas. Background samples were collected in an area that represents the same soil types as those that were potentially affected. Samples collected within each spray field were in areas sprayed or influenced by water infiltration. Hillslope samples were collected in locations where the degree of slope lessened and allowed increased infiltration of the surface run-off.

The quantity of each soil sample collected was sufficient to allow additional analyses to be performed. Analysis for total chromium following soil digestion using EPA method SW-846 will provide a cumulative total of chromium contributed from the Building 444 release, plus that which occurs naturally in the soil.

Soil analyses available to date are summarized in Table 2, Appendix C.

One soil boring was taken next to the foundation drain outside of Room 9A, Building 444. Analysis of several samples from this boring, using EP Toxicity methods, indicated that no chromium accumulation was detectable.

3.5.5 Discharge of Water From Plantsite

Water from storm runoff and stored in ponds A-4, B-5, and C-2 is discharged into Great Western or Standley Reservoirs when the pond capacities reach 10% under the NPDES permit levels. Sampling is performed by Rockwell International and the Colorado Department of Health prior to release. The City of Broomfield in this instance expressed considerable concern over the proposed discharge of the B-5 pond into Great Western Reservoir (the source of drinking water for the City of Broomfield), even though the chromium levels were below the Clean Water Standard of 0.05 ppm. A one-time decision was reached with Jefferson County, Broomfield Officials, Rockwell, and DOE to pump the water from B-5 pond into Upper Church Ditch, which flows into a series of ponds near Jefferson County Airport. At the time of the discharge, May 18, pond B-5 had reached 50% of capacity due primarily to precipitation events.

During the routine sampling process of pond B-5 water, a longitudinal crack, parallel to the dam face, was noted on the top of the dam. The crack was approximately 1/4 inch wide and 20 feet long. The architect for the dam was contacted and a thorough inspection was made. The architect and an independent consulting firm concluded that the cracking was probably due to normal settlement within the dam, and as such, posed no imminent danger of collapse. It was also concluded the dam could continue to be utilized. This was verified April 14 by the U.S. Army Corps of Engineers, Omaha District, who the Rocky Flats Area Office retains to provide annual inspection of the pond dams.

The spray irrigation, required under the NPDES permit, saturated the soils in the north and south spray fields especially during cold weather when evaporation is at a minimum. The geologic make-up of the Rocky Flats Bench, a geographical feature upon which the plant

is located between the mountains and the plains, is composed of unconsolidated sediments over interbedded claystones and sandstones. These unconsolidated sediments are comprised of cobbles, boulders, soils, sands, and clays and are typically unstable. Evidence of the instability is exhibited by cracking and sloughing of canyon walls in the drainage pattern of the Bench. This is particularly noticeable in the north spray field where long cracks have developed near the canyon walls and sloughing has occurred.

Subsurface ground water movement from the south spray field is toward the northeast and appears as seeps in the canyon walls above the south side of pond B-5. No seeps were located below the B-5 dam to indicate water or sand boils around the dam.

3.6 Safety Policy and Procedures

3.6.1 General Policy

The Rockwell International policy for ES&H is stated in the Rocky Flats Policy Manual. Listed below are specific documents included in the manual which provide guidance of a general nature and policy statements with respect to ES&H.

- RFPM MHS 1-001: Health, Safety & Environment, 11/8/88
- RFPM MHS 3-065: Control of Employee and Environmental Exposures to As Low As Reasonably Achievable, 12/2/88
- RFPM MHS 16-210: Reporting of Unsafe Conditions/Actions, 11/18/88
- RFPM MHS 16-500: Incident, Accident and Unusual Occurrence Reporting, 3/2/87
- RFPM ONM 7-304: Building Management, 8/12/88
- RFPM PER 13-001: Standards of Conduct and Discipline, 2/28/85

Pertinent safety policy statements from these documents are presented in summary. Employees are required to participate in all applicable facets of the plant Health, Safety & Environment program and to comply with safety rules, requirements, and procedures; utilize all required personnel protective equipment; and report suspected unsafe acts and conditions to their supervision. (RFPM MHS 1-001, paragraph 8).

Rockwell's policy is to ensure that employee exposures are maintained ALARA for radioactive and nonradioactive toxic materials. Employees are responsible for following all rules and procedures to ensure compliance with ALARA concepts. (RFPM MHS 3-065).

Employees are encouraged to report any unsafe condition or actions to their immediate supervisor. The supervisor will evaluate and alleviate the situation. If the resolution is beyond his capability, assistance or guidance will be requested from the HS&E area engineer. (RFPM MHS 16-210).

Accidents or other significant incidents occurring in the course of plant operations must be reported without delay. Emergency notification is required for any event resulting in damage to, or radioactive/toxic material contamination of, property resulting in a loss of $1,000 or more. The immediate supervisor of the employee/ area is responsible for emergency notification . . . (RFPM MHS 16-500).

The Building Manager is the focal point for all activities within the respective building and has authority to act on problems, occurrences, emergencies, etc., as required. The Building Manager is responsible for the safety and proper supervision, operations, and maintenance of the facility, adjacent areas, and outlying buildings. The Building Manager assures that all building personnel are trained

to meet Rocky Flats Plant requirements in order to operate the building in a safe and effective manner. The Building Manager in production buildings is responsible for operations, production of product, quality of product, safety of personnel and facility, security of product/material, integration of facility modifications, working condition of facility and equipment maintenance and housekeeping of building grounds. The Building Manager has the authority to stop and/or start operations, establish priorities for all functional elements assigned to the building, and enforce plant policies and procedures with emphasis on housekeeping and safety rules (RFPM ONM 7-304).

3.6.2 Health and Safety Policy/Program and Procedures

The Integrated Safety Program is a policy level document which defines planned actions to ensure compliance with the ES&H requirements of the Department of Energy and industry-accepted standards necessary for safe operation of the Rocky Flats Plant. This document describes: safety responsibilities; the hierarchy of safety-related documentation; the system for identifying and implementing changes to requirements; and oversight and audit of the safety program. This document also defines the general structure of the safety program and introduces the Safety Requirements Manual, the Plant Safety Procedures Manual and the Self-Improvement Plan. It also discusses Standard Operating Procedures, Technical Specifications, Functional Procedures, Work Instructions and Desk Procedures, and Guidance Documents.

The Safety Requirements Manual and the Plant Safety Procedure Manual are in draft status. Together they are intended to eventually replace the currently existing Health, Safety & Environment (HS&E) Manual. The HS&E Manual contains requirements and procedures to be implemented in the field, and is the operating document relevant to this case.

The Self-Improvement Plan is a series of ongoing plans and schedules for activities to upgrade plant safety performance and bring plant operations into compliance with the Safety Requirements Manual. This plan is presently being implemented.

3.6.3 Environmental Policy and Procedures

In addition to the Health and Safety Plan, policy and procedures have been developed which address environmental issues under the RCRA/CERCLA environmental program. These policies and procedures for the Rocky Flats Plant are delineated in the following documents:

- RFPM MAT 19-004, Management of Hazardous and Mixed Waste
- Hazardous and Mixed Waste Requirements Manual, 12/1/878
- Hazardous and Mixed Waste Resource Conservation and Recovery Act Standard Operating Procedures, 10/16/87

Although training is provided for employees regarding hazardous and mixed wastes as defined under RCRA/CERCLA, there is considerable controversy among supervisors and employees as to what constitutes primary and secondary containment and what is the definition of a spill. A discussion is presented below relevant to these subjects and the incident which occurred.

A spill is any quantity of hazardous material which escapes primary containment, i.e., the waste tanks in Room 9A. The secondary containment in this case is the bermed area around the tanks including the building floor and a portion of the building wall. The Rockwell Hazardous and Mixed Waste Resource Conservation and Recovery Act Standard Operating Procedures (H&MW RCRA SOPs) state that buildings can provide secondary containment if appropriate berms, chemically resistant water stops and door seals are installed to prevent release to the environment. The SOPs additionally state that

vaults must have water stops at all joints and must have impermeable interior coating or lining that is compatible with the stored waste and prevents migration of the waste into the concrete. Drawings of Building 444 indicate that construction of joints between walls and floors did not include water stops. Dye penetrant tests revealed that water stops were not installed in the joints between the berms and the floor in Room 9A. Although the bermed area installed in Room 9A as secondary containment was caulked and coated with epoxy, leak tests performed after the incident determined that the secondary containment was not impermeable.

According to the Rockwell H&MW RCRA SOPs, minor spills (<10 gallons) are allowed to be cleaned up. For major spills (>10 gallons), or "if there are indications of unit failure or containment failure that threaten human health or the environment, the Rocky Flats Contingency Plan will be implemented by the Emergency Director immediately." The term "Emergency Director" as used in the regulations and the Rockwell SOPs is the plant Shift Superintendent for the Rocky Flats Plant. The H&MW RCRA SOPs indicate that the supervisor will contact the Emergency Director if he determines that the incident involves a hazardous waste or hazardous material. The H&MW RCRA SOPs do not state which supervisor should make the determination and contact, and SOPs imply that the supervisor must know what these hazardous wastes or materials are, and be able to identify them.

3.6.4 Building 444 Safety Policies and Procedures

3.6.4.1 Safety Analysis Report

A Safety Analysis Report (SAR) is required for the Building 444 complex by DOE and AL Orders 5481.1B and 5480.5a. The SAR program for Rocky Flats is further defined in the Health, Safety & Environment Manual, Chapter 26.01 and 03.

A draft Safety Analysis Report (SAR) was prepared for this building in 1978 and updated in 1982. The SAR has never been finalized. AL Operational Safety Division reviewed the draft SAR in September 1982. They concluded in their review that the SAR contained unnecessary verbage in view of the low degree of hazard the facilities and accompanying operations posed to the employees, the public and environment, and that the document could be significantly reduced. They also felt that failure modes and effects analyses were not required based on the relatively low hazard presented and also that analyses for response of the building from earthquakes and tornadoes could be analyzed in-house.

Rockwell interpreted the comments from the review to mean the content of the draft SAR was adequate, but the verbiage needed to be reduced. As such, they gave a low priority to the rewrite.

Insofar as potential accidents were concerned relating to the Plating Laboratory, three incidents were reviewed: (1) a low water level in a plating tank with meltdown of the tank from an internal heater; (2) a malfunction of the HVAC exhaust system for the cyanide plating baths, and (3) overhead sprinkler system malfunctions overflowing plating baths in both the acid and cyanide lines, overflow tanks, and berms in the basement, thus causing hydrogen cyanide gas to form. The first and third incident were dismissed as having no significance. The cyanide accident was analyzed. Workers were postulated to have inhaled hydrogen cyanide gas and two fatalities have occurred. The probability of occurrence was calculated to be 5×10^{-4} per year. No environmental accidents were addressed.

3.6.4.2 Operational Safety Analysis

An Operational Safety Analysis (OSA) is required for hazardous operations by the HS&E Manual (Chapter 2.03). An OSA was prepared for the Plating Laboratory. The OSA is titled "Plating and Surface Finishing Laboratories," No. 444.3, and was approved October 7, 1988. The procedures in the HS&E Manual require that the OSA be reviewed annually and updated if there is a significant change in operations. The existing OSA has not been changed since 1980. The OSA addresses, in general, potential personnel hazards associated with chemicals and processes in the Plating Laboratory and the risks associated with handling Uranium-238. The OSA does not address potential environmental risks. The OSA also does not place/require any limiting conditions for the conduct of operations in the Plating Laboratory.

3.6.4.3 Operating Procedures

Operating procedures for production operations are developed for each plating operation. An example of such a procedure and its contents was presented in Section 3.4.1.1, Metallurgical Operations for chromium plating.

There are no written operating procedures for MTD personnel in the Plating Laboratory. MTD personnel develop the operating procedures for production operations, and it is assumed by Rockwell management that based on their expert knowledge and experience of the processes they do not require written procedures in their development of plating processes.

3.7 Training

3.7.1 General Training Including Safety

All new Rockwell employees and contractors receive new hire orientation/training during their first month of work. The orientation consists of classroom training on topics including safety, health, security and business ethics. The list of courses given during new employee orientation is shown below. Passing a written test is a requirement for some of the courses.

Computer Security
General Radiation Safety
Glovebox
HS&E/Dosimetry
Industrial Hygiene
Industrial Safety (one time)
Lockout/Tagged
Nuclear Safety
Plant Physical Security
RCRA Hazardous Waste
Safeguards and Security
Training Records

Each employee then receives a selection of core and safety-related training courses according to his job classification and building location. Typical courses included in core and safety-related training are shown below. The courses include classroom or computer-based training with a written test.

Aerial Lift Training*
Asbestos Training*
Basic Radiation Safety (for non-hands on worker)
Beryllium Training
Computer Security Training
DOT Transportation of Hazardous Materials
Glovebox
Hazardous Waste-Low Level (Non-PSZ)
Hearing Conservation*
Hoist Use Training*
Laser Safety*
Lock Out/Tag Out*
Nuclear Criticality Safety
Nuclear Materials Safeguards
Nuclear Safety-Supervisors
Polychlorinated Biphenyls (PCBs) Training
Protecting Radiation Worker (new)
Radiation Worker OJT
Radioactive Source*
RCRA Hazardous Waste Training
Respiratory Protection (Indoctrination/Fit)
Supervisor Safety Training*
Supplied Breathing Air Training*
TRU Waste (PSZ)

* Safety Training which is not tracked as a "core" requirement.

The employee must be requalified in the required courses according to an established frequency. Unescorted visitors and contractor personnel in production areas are required to complete the same safety training as Rockwell employees.

In Radiation Safety (Pu), Glovebox, and Nuclear Safety training is given for the response to Criticality, Glovebox Overheat, SAAM, and Fire Alarms. There is no core training course that provides classroom training for the response to process specific alarms. This is currently provided through job specific on-the-job training (OJT). Before a person can work unsupervised in any process building, they must have completed core training and have received a building indoctrination as well as job-specific training according to job assignment. The indoctrination is safety oriented to provide the basic information required to assure the protection of employees, the facilities, and the environment. The indoctrination covers all applicable areas listed on a checklist as well as a physical visitation to the geographical locations of safety equipment, evacuation paths, emergency exits, assembly areas, etc., relevant to the employees' work area.

Every supervisor of an operation involving a hazardous chemical indoctrinates his/her employees regarding the specific chemical(s) present in that operation, and ensures that they are adequately trained and equipped to safely work with those chemicals. The supervisor accomplishes and documents this indoctrination before the employees first work at that operation.

All employees must attend periodic safety meetings conducted by their organization. The meetings are held monthly for operating/support/research personnel, and quarterly for office personnel.

3.7.2. Training for Plating Laboratory Personnel

Engineers working in the Plating Laboratory receive the required core training and must be classified as a Certified Plater Finisher (American Electroplater and Surface Finisher Society). The OJT is not formalized. The engineer works under the supervision of an experienced engineer before receiving his own project.

Metallurgical Operators working in the Plating Laboratory must successfully complete a progression program as well as the required core training. The Fissile Material Handlers Training program is a new set of courses that is being developed to comply with DOE 5480.5. Thirty-five courses have been identified for the Metallurgical Operators. A Metallurgical Operator would take only those courses required to perform his specific job assignment. The training includes classroom work, a written test, OJT training, OJT test, and an oral test to verify complete understanding. An implementation schedule was developed, but has been impacted because of the new accreditation requirements.

3.7.3 Training for Security Personnel

Training is provided to Security personnel as to responsibilities on their clock-route during off-shifts. The Security person looks for any abnormal condition such as running water, alarms (sounding or flashing lights), fire conditions, etc. The Security personnel are not responsible to routinely inspect process alarm panels.

3.7.4 Spill Reporting Training

All employees involved with hazardous waste management receive specific core training for that activity including RCRA hazardous Waste Training and Low Level or TRU Radioactive Waste Handling.

The annual RCRA training covers the requirements for training, collection and accumulation, inspections, record keeping, emergency response, and waste minimization. Spill reporting requirements are covered in the emergency response section as well as by the on-the-job Hazardous Waste Training checklist. As stated previously, however, there is significant issue as to what constitutes a spill in the eyes of management and workers.

In addition, OJT spill response training has been typically included in periodic safety meetings. A spill response training program was developed for Building 460 and the Oxnard Facility personnel. The program is facility-specific and covers spill reporting and response requirements. The program utilized a 10-Step procedure which can be incorporated in signs as a reminder.

3.8 Maintenance Activities

3.8.1 Plant Maintenance

The function of the Maintenance Department is to execute all maintenance activities including inspection, preventive maintenance, repair, overhaul and installation, part and equipment fabrication, construction and administration necessary to maintain the RFP facilities and equipment in an optimum condition at minimum cost.

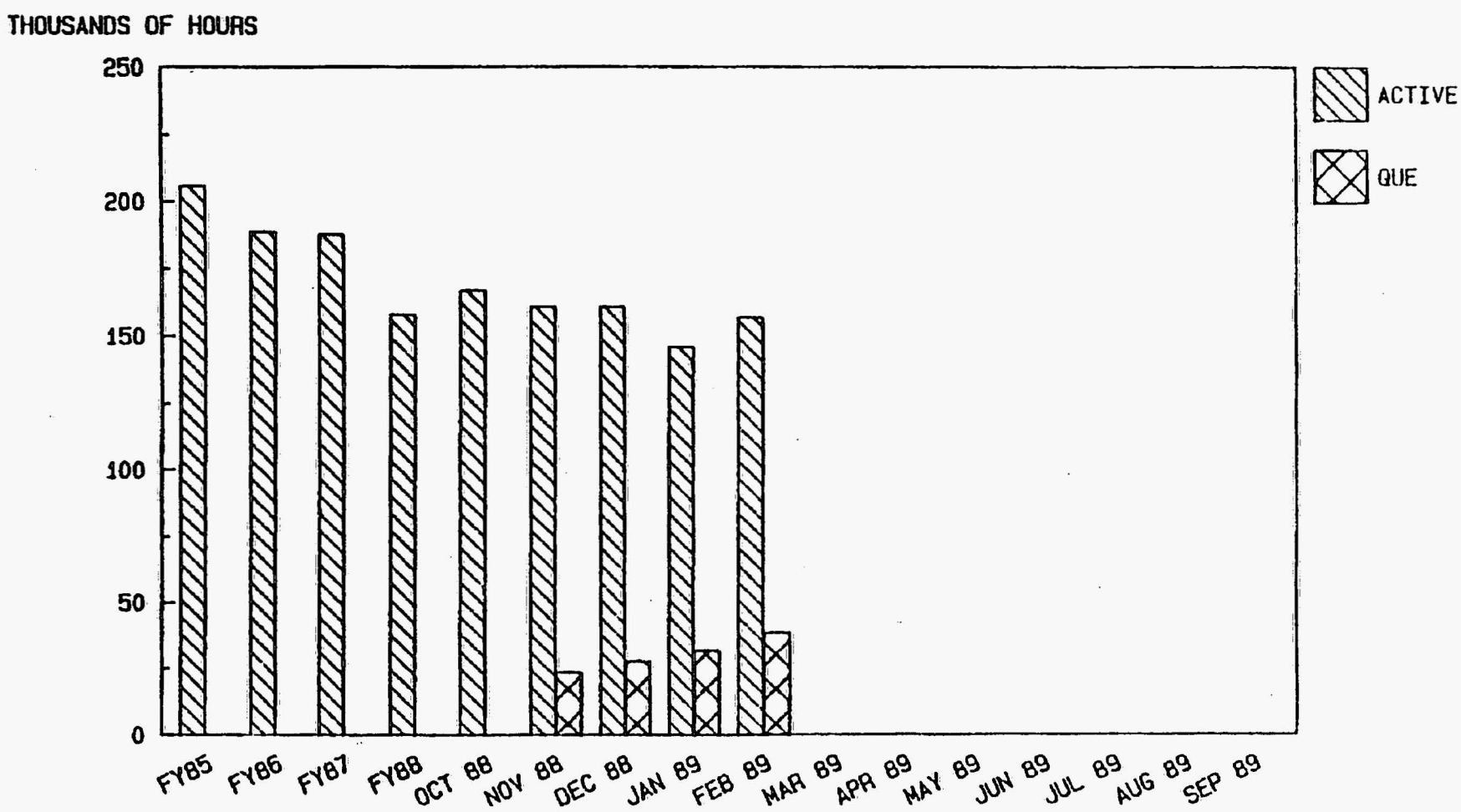
The Maintenance Manager, Zone Managers, Area Maintenance Managers, Maintenance Foremen and Craftsmen constitute the line organization of the Maintenance Department. The Area Maintenance Managers are each accountable to the Zone Managers for the entire Maintenance function in their geographical area, including work performance, safety and discipline of assigned personnel.

The Maintenance Work Order (MWO) is the authorizing document for all maintenance work. A work request must be written and processed for every job performed prior to the start of the job by the Maintenance Department. When directed by Maintenance management, work can proceed without an immediate MWO under certain emergency conditions, but one must be generated as soon as the emergency is secured. The work order system has been developed to provide for effective administrative control; responsiveness to plant needs; detailed planning and establishing work standards; securing the necessary approvals; proper cost accounting; and timely, safe accomplishment of all work.

A new work control plan was developed in September, 1988, to improve the efficiency of the Maintenance Department; however, implementation has been delayed due to staffing problems. A new MWO remains in que until it can be scheduled. A MWO can be scheduled after it has been planned and all material, equipment, support, and crafts are available.

Figure 25 illustrates the historical backlog in Maintenance. A special task team was created September 19, 1988, to reduce the number and age of MWOs that are in backlog. The task team is working on every MWO that was issued prior to June 19, 1988, and is expected to complete this work by September, 1989.

Work requests received by Maintenance must be reviewed for safety hazards. If required, a Radiological/HS&E Work Permit is issued to review a job for possible hazards and to identify necessary precautions for the safety and health of personnel and protection of property. A review by HS&E representatives can also be requested when questions arise and permits are not required.



BACKLOG HOURS AVAILABLE FOR CRAFTS
QUE - WORK IN PLANNING, ENGINEERING, PROCUREMENT
AREA MANAGERS AND FOREMEN MINIMIZE OLD BACKLOG

Figure 25. Historical Backlog Hours, Maintenance

Currently, the Area Maintenance Manager works with the Building Manager to establish the priority for completing MWOs. Priorities for maintenance work orders are as follows:

DO-IT-NOW (DIN)	Emergency - Threat to life, public, environment Emergency Breakdown - Condition which interrupts plant operations
HIGH (H)	Fire, Safety, Health, Ecology & Security - Not emergency, but potential problem Urgent Programmatic Need Management Directive
MEDIUM (M)	Normal Repairs, Capital Projects, Programmatic Improvements
LOW (L)	Functional Improvements, Overhauls, or Other Maintenance Work which can be deferred

In addition, safety-related MWOs that need immediate action to correct an unsafe condition can be stamped by the HS&E Area Engineer to ensure that action will commence immediately to correct the unsafe condition. A historical backlog of safety related MWOs is shown in Figure 26.

3.8.2 Building 444 Maintenance

Prior to October, 1988, the prioritization of work was informal with the Area Maintenance Manager establishing the priorities with input from the Building Manager and attention given to certain production equipment (subject to downtime reporting). This was considered to be inadequate by Rockwell management. Currently, the Area Maintenance Manager meets with the Building Manager and Production Operations Manager on a daily basis to establish the priority for MWOs. Support-type operations (i.e., Utilities, Manufacturing Technology) must inform the Production Operations Manger of their needs for maintenance support.

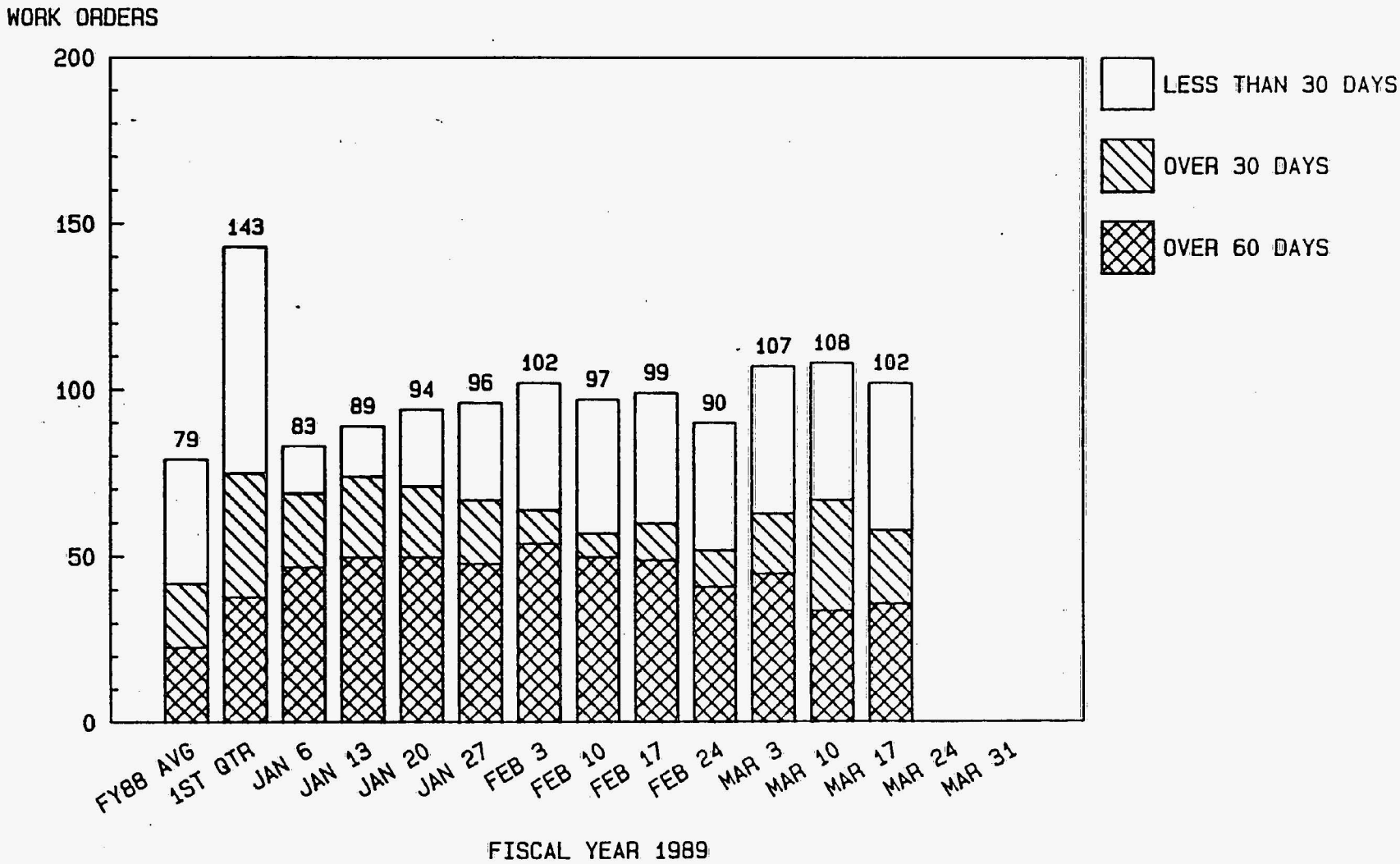


Figure 26. Safety Related Work Orders, Maintenance

The Area Maintenance Manager is also responsible to conduct monthly and annual building inspections to identify deficiencies. The Area Maintenance Manager initiates the MWOs to correct a deficiency and maintains a list of the deficiencies for tracking purposes.

3.8.3 Plating Lab and Room 9A Maintenance

The Coatings organization has the main responsibility for initiating MWOs for the repairing and/or modifying the Plating Lab facility in Room 245.

Metallurgical Operations owns some of the equipment in the Plating Lab and is responsible for initiating MWOs to repair and/or modify this equipment as well as for the waste collection system in Room 9A. Both groups have initiated MWOs to correct deficiencies in areas that they do not have the direct responsibility because they need to use the equipment or they have the expertise to identify the correct resolution.

A Plating Task Team meeting is held biweekly to discuss issues/ concerns of both groups. During this meeting, the outstanding MWOs are reviewed. Two outstanding MWOs for the Plating Lab facility were allowed to remain on backlog because other work orders were considered to have higher priority because they were production related. MWO No. 523280 was requested in September, 1987, to facilitate the separation of the acid and cyanide systems and to provide for recirculation and rapid transfer for both systems. It was initiated due to a safety and health concern but was not safety stamped because it was not considered a significant safety item by Metallurgical Operations. MWO No. 523611 was also requested in September, 1987, to install liquid level detection and alarms for the waste tanks' secondary containment. The alarm would have sounded in the Stationary Engineers office that has intermittent coverage during

off-shifts. Currently, the high level waste tank alarms sound only in the Plating Lab which is only occupied during the day shift. Metallurgical Operations did attempt to get Maintenance to complete this MWO but was unsuccessful.

Based on visual evidence and checking of maintenance records, very little maintenance was performed on the berms and sump areas in Room 9A.

3.9 Notification Actions - Chromic Acid Release

3.9.1 General Requirements

Various reporting requirements exist at the Federal, Department, and plantsite level covering hazardous chemical spills such as the chromic acid spill in Building 444. Depending on the nature of the spill, these reporting requirements must be fulfilled starting with the individual who observes the spill at Rockwell International and through the DOE Rocky Flats Area Office, Albuquerque Operations Office, and Headquarters. The following discussion notes the sequence in which the notifications took place.

3.9.2 Rockwell International

Rockwell International has two Standard Operating Procedures (SOP) at the Rocky Flats Plant governing hazardous and mixed waste. The SOP entitled Hazardous Waste Spills and RCRA Spill Kit Use, HW-11, dated April 25, 1988, specifically states that supervisors of areas generating hazardous and hazardous-mixed radioactive waste are responsible for responding to spill incidents. A major liquid spill, as defined in HW-11, is a spill of 10 gallons or greater in a workplace or one pint or greater outside a building. All major spills require immediate notification to the Plant Shift

Superintendent and to the Fire Department. The SOP, HW-13, states that the Plant Shift Superintendent shall implement the Rocky Flats Contingency Plan.

The painters were the first Rockwell International personnel to come in contact with the spill area with the spill still in progress. The painters entered the room to gather supplies for their daily routine. The painters, while visually acknowledging the spill, made no notifications.

Once the spill was first detected by the MTD engineer, the Metallurgy Operations Manager was notified at approximately 0750 hours on February 23, 1989. Within 10 minutes, the Metallurgy Operations Manager notified the Building Manager of the spill. The notification chain proceeded no further because he felt the spill was contained. The MTD engineer also notified the Coatings Manager between 0815 and 1000 hours on February 23, 1989.

An Industrial Hygienist (IH) was sent to review the situation prior to signing a work permit to clean up the transfer pump inlet screen. The IH made no notifications.

The Utilities Manager notified Environmental Management of a yellowish green color at the primary clarifier at approximately 1030 on February 23, 1989. Additionally, the Utilities Shift Supervisor notified Environmental Management of a color change at the treatment plant at approximately 1400 on February 23, 1989. The Stationary Operating Engineer at the treatment plant notified Environmental Management that the color had stopped at the treatment plant at approximately 1600 on February 23, 1989.

Based upon analysis of the samples taken at the treatment plant, Environmental Management was notified that the contaminant was

chromium at approximately 1530 on February 28, 1989. This was based on a positive chromium analysis from the Sewage Treatment Plant grab sample. The manager of Environmental Management requested a total chromium analysis begin on the treatment plant influent and effluent samples for the period of interest. The Manager of Environmental Management notified the Shift Superintendent that the contaminant was chromium at approximately 1600 on February 28, 1989. The analyses of the influent and effluent samples indicated 13 ppm and 2 ppm total chromium respectively. The results were reported to Environmental Management at approximately 0830 on March 1. The Manager of Environmental Management then notified: RCRA/CERCLA, HS&E, Communications, Safety Review, Utilities Waste Operations, and DOE Rocky Flats Area Office, all beginning at approximately 0900 on March 1, 1989.

On March 28, the chairman of the Rockwell investigation team attended a meeting of the Rocky Flats Environmental Monitoring Council. Attendees included Congressman David Skaggs and representatives from the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the City of Broomfield. The Rockwell representative reviewed the incident, along with the associated notification, environmental impacts, and planned actions. It was stated by the EPA and CDH representatives that the reporting had met requirements, the water which had been detained in pond B-5 had met drinking water standards, and that no off-site environmental impacts had occurred.

3.9.3 Rocky Flats Area Office

The DOE Rocky Flats Area Office (RFAO) received notification at approximately 0900 hours on March 1, 1989. At that time, the Duty Officer for RFAO was consulted for the proper action to take. The telephone log of the Environmental Branch Chief indicates the

following notifications were made on March 1, 1989: the Environmental Protection Agency at 1025 hours, the Colorado Department of Health at 1100 hours, and the Albuquerque Operations Office (AL), Emergency Operations Center (EOC) at approximately 1115 hours. The National Response Center (NRC) was notified at 1112 hours on March 2, 1989, approximately 44 hours after the initial discovery. Notification to the NRC is required by Title 40 of the Code of Federal Regulations Part 302. Notification to the NRC must be made within 24 hours once it is determined that the Reportable Quantity of a given chemical has been exceeded. The Reportable Quantity for chromic acid is 1,000 pounds, while the Reportable Quantity for chromium is 1 pound. It is estimated that approximately 5.0 pounds of chromium in the form of chromic acid that was released had passed through the sanitary sewer system and was distributed in the spray fields and ponds.

Following the initial notifications by RFAO on March 1, 1989, three separate telephone conversations between the Environmental Branch Chief of RFAO and the Environment and Health Division (EHD) of AL took place to refine the information received on the initial notification.

The Rocky Flats Area Office responsibilities for notification are delineated in AL Order 5484.1. The AL Order establishes the Area Manager with the following responsibilities: (1) establish procedures to assure that their contractors notify them; (2) notify the Director of the Operational Safety Division (OSD), currently EHD, AL; (3) establish procedures to notify the appropriate federal, state, and local agencies; and (4) transmit teletype messages to confirm the telephone notification of the occurrence.

3.9.4 Albuquerque Operations Office

The AL Order 5484.1, dated August 23, 1982, assigns responsibilities to OSD, AL. This organization, OSD, has been subdivided into the following organizations since the date of this order: the Environment and Health Division (EHD), Safety Programs Division (SPD) and the Governmental Assistance and Operations Division (GAOD) The GAOD, which includes the AL Emergency Operations Center, has informally been given the task of making notifications. The EHD has responsibilities to coordinate environmental activities and, related to spills, EHD will verify and refine information.

Upon notification from the RFAO, the AL/EOC notified EHD, AL of the incident. Three telephone conversations took place between RFAO and EHD discussing the incident. Notes from the initial telephone conversation between RFAO and EHD staff indicated that the "DOE-EOC" had been notified. EHD interpreted this to mean that this was the (AL) EOC and not the Headquarters (HQ) EOC, and did not obtain confirmation of which EOC the statement applied to. It was not until AL received a written fact sheet from RFAO on March 8, 1989, that EHD realized that only the AL EOC had been notified.

On March 10, 1989, AL formally notified HQ (EH-34) of the event in accordance with the requirements of DOE Order 5484.1. This notification explained why the HQ EOC had not been notified.

AL staff conferred internally with regard to recommending a Type A or Type B accident investigation. These conversations did not include the AL Manager. The RFAO Manager and the AL Assistant Manager for Environment, Safety and Health discussed the spill by telephone at 1105 hours on March 8, 1989, for a possible Type A investigation noting a potential for a sufficient property loss if the spray field was declared to be a RCRA clean-up site.

A facsimile message on March 8, 1989, from the DOE Headquarters Environment, Safety and Health (EH) site representative at the Rocky Flats Plant gave Headquarters the initial notification of the incident. A series of daily transmittals to DOE Headquarters Office of EH and to EHD AL was initiated.

Telephone conversations between EH management and the AL Manager and ensuing conversations between the AL Manager and the RFAO Area Manager at 1205 hours on March 8, 1989, noted a lack of proper notification to the AL Manager and the Assistant Secretary of the Office of Environment, Safety and Health, DOE Headquarters.

3.9.5 Press Releases

After notifications to local, state, and federal agencies were made, a press release was prepared (see Appendix B) and issued. Also included in Appendix B is backup information to be provided upon inquiry by news media and newspaper articles from the local press.

3.10 Potential Exposures to Chromic Acid

On the morning of February 23, two painters entered Room 9A to obtain painting supplies stored in cabinets on the wall opposite the acid waste tanks. They walked through the puddle of water containing chromic acid to reach the cabinets. They did not inform their supervisor of the overflow situation or of any potential exposure to hazardous materials. On March 14, the two painters and a carpenter reported to the Plant Medical Department claiming dermatitis, rashes, nausea, eye inflammations, sores, cramps, etc.; symptoms typical of chromic acid exposure.

The Rockwell physician examined the three parties at that time and concluded that they had not suffered acute exposures of a severe enough nature at that point in time after the exposure to warrant further medical attention, and could be returned to duty. These three parties and other workers potentially exposed to the chromic acid were interviewed by the Accident Investigation Board shortly thereafter. They were extremely agitated, concerned as to their well being, at great odds with their supervision and the Medical Department over the incident. The board requested Rockwell Management allow the parties' medical history and the elements to be reviewed by a specialist. Word spread among Building 444 employees, and in all, ten persons alleged exposure either directly to the chromic acid or through vapors transmitted by the heating and ventilating system. Analysis of samples of the painters' shoes and shoelaces indicated positive for chromium. The report of the Medical specialist concluded that two of the employees had developed a sensitivity to chromium. The findings of the medical specialist are presented in Appendix D.

We note that the Development Engineer in MTD and the waste operator involved in the Room 9A cleanup did not report to the Medical Department nor suffer any symptoms reported by others. The interviews of the craft persons revealed a lack of communication between them and their management, alleged insensitivity to safety and welfare, and lack of maintenance on safety systems, etc.

Interviews with their supervisors supported an opposite view. There appears to be a problem area with some of the hourly employees and their management, which is indirectly related to the incident but not considered germane to it. The situation warrants further management attention.

4.0 ANALYSIS

4.1 Events and Causal Factors

4.1.1 Events and Causal Factors Chart

The Events and Causal Factors Chart, presented in Appendix F, depicts the events of the incident in a chronological fashion with notable conditions listed prior to the events. The events are enclosed with rectangles and the conditions which set up an event are enclosed with circles.

This chart is more complex than a typical case because up to five separate main lines of events developed. The five main event lines occur simultaneously at different stages of the incident. The five main event lines include notification, Room 9A (acid waste tank location), sewage treatment plant, and sampling.

Conditions that are deemed Less Than Adequate (LTA) include the following: (1) LTA monitoring of the plating bath status; (2) LTA automatic controls on the plating baths; (3) LTA communication in shutting down the Development Laboratory at end-of-shift on February 22, 1989; (4) LTA procedures for adding make-up water in the chrome tank; (5) LTA area orientation of pipefitters for entry into any area with hazardous chemicals without checking alarms; (6) LTA response by Waste Operations operator in shutting off fill valve to Tank T1 could have caused flooding in Room 245; (7) LTA training of painters for entry into a flooded area that contains hazardous chemicals without protective clothing; (8) LTA notification by painters of a hazardous condition; (9) LTA internal spill reporting; (10) LTA reporting of incident by AL organizations; (11) LTA secondary containment for Tanks T1 and T2; and (12) LTA notification procedures at AL and LTA notification by Rockwell International personnel.

4.1.2 Energy Trace and Barrier Analysis

A barrier analysis is a tool available to investigators in order to assure adequate consideration is given to the failures that lead to an incident. A barrier is a physical material or administrative control that will prevent, stop, impede, or control the flow of an incident either by design or coincidence. The energy that is traced through the incident is viewed as an unwanted energy flow. The unwanted energy in this case is the spill of chromic acid. An analysis of the barriers indicates that a total of 12 barriers had to fail to allow the chrome in the plating bath to reach pond B-5 and the spray fields.

The automatic fill and shut-off system at the plating bath was the first barrier. This system had been nonoperational since December, 1988; therefore, filling of the tanks was a manual operation. The other barriers within the laboratory area that failed were, the Operational Safety Analysis and Operational Safety requirements failed to provide a review of this operation, and the administrative control for the filling operation was less than adequate.

There are two 400-gallon waste acid tanks located in the basement that receive waste from the plating laboratory. Only one tank was available to be filled the evening of the spill. The volume of liquid far exceeded the capacity of the waste acid tank. Thus, this barrier failed as the tank overflowed. A critical barrier that failed was the high-level alarm system. This alarm sounds when the level in the tank is approaching capacity. The testimony received during the investigation phase of this report indicated that no personnel heard or responded to this alarm. The alarm may have failed or was silenced without a corrective action response. Testing of the alarm system subsequent to the spill indicated the alarm does not have the capacity to shut itself off, and if it had "burned out,"

the alarm would not have functioned for the testing following the incident. Thus, there is no evidence that the alarm had failed.

Other barriers that failed relating to the waste tanks and the associated secondary containment include the following: A work order was submitted to install a new alarm in the secondary containment to detect any leaks and was given a low priority and had not been completed. The secondary containment system associated with the waste tanks has a capacity of 1,400 gallons. Due to the excess volume and the liquid head pressure that developed, the secondary containment overflowed and leaked. The cement floor slab was another failed barrier as sufficient liquid head pressure, cracks, and holes were present or developed to facilitate a leak.

Proper notifications within Rockwell International did not take place in a timely manner as directed by the Standard Operating Procedure HW-11. This caused a delay in responding to the incident.

Additionally, the failure of Sewage Treatment Plant personnel to divert the water to a holding pond upon noticing the color differential created another barrier.

Two barriers that worked properly during the life of the spill incident were the Stationary Operating Engineer observing the color change at the treatment plant and making the proper notification. Secondly, the administrative procedure of retaining the spilled material in the B series ponds allowing for frequent sampling prior to discharge from the plantsite.

4.1.3 Management Oversight and Risk Tree (MORT)

The MORT chart analysis was performed for this incident to enable the investigators to use an idealized safety and management program as a direct comparison to the existing situation at the Rocky Flats Plant.

MORT is a state-of-the-art investigative tool and analytical method that is a yardstick to measure the thoroughness, accuracy, and objectivity of an accident investigation. The primary purpose is to prevent the recurrence of accidents, discover potential hazards, improve management and staff functions, and increase safety in DOE program and operations. The emphasis is on discovering all cause-effect relationships from which practical corrective actions can be derived.

The MORT chart contains nineteen defined symbols in an analytical tree. These symbols are then systematically examined and compared with facts and evidence. The several hundred symbols on the chart were color coded to aid as a diagnostic investigative tool. Pink indicates a Less Then Adequate (LTA) or unsatisfactory condition that needs to be resolved. Green indicates a satisfactory condition that needs no correction. Blue indicates a non-applicable event or condition.

The subsequent discussion of the MORT analysis will not be especially meaningful to those who are not trained to interpret the MORT chart.

A brief discussion of the analysis provided by the MORT chart is included in this report; however, a legible copy of the MORT chart will not be included for reporting simplicity. A photo of the MORT chart is available for those familiar with the MORT chart, in order to indicate the functional areas that are considered less than adequate. A master copy of the MORT chart will be kept on file for detailed review.

Management had assumed a total of six risks for this incident, the acceptance of these risks were analyzed to be adequate. The risks that were assumed by management are as follows: (1) adequate barriers on objects; (2) barriers having been provided;

(3) secondary containment was assumed functional; (4) low potential for task performance errors; and (5) employee is not considered deviant. General risks assumed by management include: (1) availability of and distance to medical attention; and (2) control of spills is considered practical.

The control of the barriers is considered less than adequate due to several factors. A prime reason is the maintenance of level sensors in the plating bath. Maintenance was not timely to prevent the incident as the process operations were allowed to proceed with the level sensors inoperable. Secondly, performance errors contributed to the controls being less than adequate. These included leaving the manual fill system unattended and the possible silencing of the high-level alarm without a corrective response. Leaving the manual fill system unattended while filling can be considered within the range of normal variability; however, silencing an alarm without correctly responding would be regarded as deviant and deliberate. Less than adequate safety analysis of the task is also considered a performance error. A prejob analysis is required, but none was made for the chrome plating operation. It is considered in the analysis normally performed that there is a high potential for hazards with regard to worker safety and a low potential environmental hazard. Additionally, there appears to be no formal mechanism for employee suggestions or input into the process that leads to a task safety analysis; however grievance procedures, employee Safety Suggestions, as well as other methods do exist for employee input.

In general, the supervision is considered less than adequate due to the task performance errors previously cited and the failure to correct the hazards that existed once the plating bath sensors were nonoperational. It is also noted that the Building Manager had only been in his position 8 months and the Coatings Manager 4 months at the time of the incident. Not being totally familiar with

the operations in the plating laboratory could have contributed to the LTA condition. Although the sensors did not function well in the chromic acid environment, no other controls were recommended. The correction of this hazard was not timely due to the delay in processing work orders; thus, leading to the decision to allow the plating operations to continue in a manual mode. These operations continued with administrative controls.

The technical information about the process is considered less than adequate primarily because changes in the design controls for the plating bath were not adequately analyzed prior to operation. The analyses are generally focused on the neighboring cyanide operations as they are considered to be a greater hazard. The functional operability of the facility is considered less than adequate. There are no current drawings for the process that are readily available.

The maintenance, supervision, technical information and functional operability of the facility all contribute to the barriers and controls being less than adequate.

Within the management system, numerous factors lead to a less than adequate ranking. Beginning with the risk assessment system, the review of the safety programs is considered less than adequate with the difficulty of obtaining complete up-to-date drawings for review. The hazard analysis process fails with the lack of a mechanism to detect and review changes for safety. This mechanism does exist within RFP in the uranium areas but not for this particular facility. Additionally, there is no plan or requirement in the 400 area of RFP to perform an analysis on the life cycle of the facility and any impacts thereof.

The design and development plan for this facility indicates several inadequacies. Control procedures for such an incident do not exist.

The automatic controls were nonoperational and the manual override system decreased the control. Additionally, there were no warnings available where nonduty personnel could hear and respond. The operational specifications are less than adequate as no task procedures exist to determine if criteria for the operation are being met. The supervision of these specifications is also considered less than adequate. The responsibilities are known, but there are no guidelines.

The general design process and documentation are less than adequate as the design information is not available and changes are not documented. Configuration control currently exists at RFP; however, it was not applied at the initial conception of this process.

The human factors review indicates a less than adequate rating. The alarm displays are not immediately clear or accessible to nonduty hour personnel. Also, the controls for the plating bath were inoperative. The current methods of review and analysis did not allow RFP to predict that such an incident could occur.

All of these factors lead to a less than adequate rating for the risk assessment system. The implementation of the various systems and plans is also considered less than adequate. The methods, criteria and analytical capabilities exist but were not applied to this operation. The budget and manpower resources for the maintenance operations is limited, thus requiring prioritization of work orders received by Maintenance and the Building Manager. Work orders for operations receive a higher priority than work orders from research and development activities. The factors for the risk assessment system and implementation lead to a ranking of less than adequate for the management systems factors.

4.2 Building 444 and Related Operations

4.2.1 Plating Lab Equipment

The chrome plating equipment currently functions at a nonideal state. There are several factors which contributed to the less-than-adequate (LTA) system performance.

Sensor failure is a prime factor in LTA system performance. There are two sensors utilized in the control/alarm system; a capacitance probe and a magnetic float. The reliability and maintainability of these sensors is a major issue of contention. The sensors have a history of chronic failure and periodic replacement. This condition was accepted as normal.

The capacitance probe sensor did not function at ideal performance. The sensor had been inoperative since December, 1988. The probe was rendered inoperative due to the corrosive environment, the inability of the probe to maintain its calibration, and the supply of replacement parts (extra probes) was LTA. With the capacitance probe inoperative, the automatic control/alarm system was rendered inoperative, and therefore, the tank was filled by a hose connected to a water faucet. This circumvented the engineering controls and, to compound the problem, there were few administrative controls, and nonrestricting operation of the plating system.

A magnetic float sensor was not installed at the time of the incident. The absence of the float rendered high high-level indicator lights on the bathside panel inoperative. Without the indicator lights enabled, a person would not know of the critically high-liquid level in a plating bath without physical examination of a plating bath. There are spare magnetic floats in stock, but the defective float was not replaced.

A Programmable Logic Controller (PLC) is located in the Plating Lab office. The PLC was installed in the mid-1980s, but was never fully implemented due to repeated sensor failure. This unit is designed to provide a status indicator of the acid-line baths. The PLC has indicator lights on the front panel and an annunciator which would be engaged if a bath reaches the high high-level condition if all systems were operating. At the present state, the annunciator has been disabled requiring that an individual visually inspect the status panel to check for a near-overflow condition. The location of the PLC allows the indicator panel to be observed upon entering and leaving the office area for the lab through the south door, but is not readily visible from the desks in the office. The function of the PLC is limited strictly to the acid line, five baths, and is not connected to the other vats in the laboratory.

The water makeup system is a double-valve design. The valves are controlled by the capacitance probe. The first valve is the operating valve, and the second valve is the emergency cut-off valve. If the capacitance probe is inoperative, the valves are locked closed. There is no manual override on the valves.

The status/alarm panel for the holding tanks in Room 9A, the cyanide systems in Room 245, and other systems is located in Room 245, the Plating Lab. This panel has both lights and an annunciator. If an alarm condition is generated, a holding tank overflow or a cyanide system equipment malfunction, the respective indicator light will blink and the annunciator will sound. An acknowledge button must be pressed to silence the annunciator and stop the blinking light although the light will remain continuously lit. Regarding the incident, no individual recalls hearing or acknowledging the alarm. In subsequent tests and cleanup operations, the annunciator worked without error and the proper indicator light blinked. No concrete or physical evidence has been found to prove that the alarm indicators

were inoperative on the panel. The alarms only go to this station which is continuously manned for only one shift in a 24-hour period.

The chrome plating vessel is made of a plastic material with a volume of approximately 365 liters (95 gallons). The vessel has a lift-off lid where the parts for plating are lowered into the bath. The water makeup system feed lines are introduced into the interior of the vessel through holes in the top 5 inches of the vessel sides. These holes are not sealed and any liquid reaching this level will flow through the holes around the pipes rather than overflowing the top.

The containment system for overflow in the lab consists of a trench/drain system built into the floor. This trench channels any liquid to a drain which connects to the holding tanks in Room 9A. The trench basin on the plating bath side is lined with a rubber-like material to prevent leaking through the floor, as had happened in the past. Only the floor and walls of the trench basin are covered; not the surrounding lab floor area. The lining material periodically needs mending, but there have been no reports of lining failure although there have been seam leaks due to inadequate installation.

4.2.2 Plating Lab Procedures

The lab is utilized by two separate organizations, Metallurgical Operations and MTD. The lab is officially the responsibility of MTD, but is used by Met Ops for production and by MTD for development purposes. Met Ops has not used any plating system within Room 245 since the control system has been inoperative since December, 1988. Some Met Ops plating operations continue for more than one shift and need constant control for the duration of the process. MTD continued to use Room 245 facilities and relied on personal experience and skill to supplant the engineering controls which had failed.

Met Ops has a written procedure covering the electrodeposition of chromium on various substrates. This procedure is detailed in FO-444-1039. The actions detailed therein were compiled by MTD personnel based on their experience in developing the proper procedure for the desired result. FO-444-1039 was issued on June 16, 1986, and contains information which is no longer valid because of changes in the plating bath mixture and operations. Continued use of FO-444-1039 without corrections will enhance the probability of production operations problems.

MTD personnel use the laboratory facilities for development purposes. Due to the changing requirements of MTD operations a detailed procedure for standard operations is not available. There are no written procedures for the chrome bath other than the manufacturer's literature and Material Safety Data Sheets. All other operations are performed on an as-needed basis, based on the personal experience of the MTD engineer.

4.2.3 Waste Tank Equipment

The waste tank system has areas of operation which are LTA. There are several factors which contribute to the LTA system performance.

The containment structures are a factor in the LTA performance. The primary containment system is the holding tanks. The tanks show no evidence of leaking and do comply with RCRA regulations. The performance of the control system for the primary containment is LTA since a high-level sensor on the WWA tanks only alarms in Room 245, the Plating Lab. There is not an overflow sensor on the tanks. The sight gauge on the tanks is partly made from clear plastic tubing. The plastic tubing becomes discolored with use making it difficult to obtain an accurate measurement of the volume in the tanks. The fill system for the holding tanks is controlled by manual valves rather

than an automatic switching/control system as that implemented on the cyanide waste tanks located in the same room.

The secondary containment system is LTA. The secondary containment area floor and walls are not watertight. The epoxy paint and/or caulking did not function as an impermeable seal and the secondary containment could not fulfill its purpose. There are no sensors within the secondary containment to detect an overflow or tank failure. The secondary containment was not part of the original construction. It was added later and poured on top of the existing floor, and the dye tests indicate there are no water stops between the walls of the secondary containment and the floor. There is no history of any integrity testing of the berms. It should be noted there are also no requirements for the testing of secondary containment under RCRA.

The piping configuration connecting the tanks, both acid and cyanide, to the waste transfer system was LTA. Due to the interconnections between the cyanide recycle pump, the cyanide tanks, the waste transfer piping system, the acid holding tanks, and the primary waste transfer pump, it was possible to pump acid into the cyanide tanks and to pump cyanide into the acid tanks. The recycle pump, used to provide a homogeneous mixture in the tanks for sampling, was no longer used to recycle the waste water acid tanks. It is still used for cyanide tank mixing, yet this leaves a deficiency in the sampling of the acid tanks since there was no mixing for a homogeneous mixture in the tanks.

4.2.4 Waste Tank Procedures

The documents regulating the utilization of the WWA acid tanks need to be reviewed. The documents deal with the operation of the tanks and the parameters which must be satisfied for continued tank operation.

The waste transfer operations of the tanks are defined in WO-4010-A/O, a document governing the operation of waste tanks in Building 444. The procedure includes sections on Hazards and Safety, Emergency Shutdown, Description and Responsibilities, Storage and Sampling of Waste, Waste Transfer, and Operating Data. These sections delineate the normal operation of the tanks and operation under emergency conditions during waste transfers. The subject of a tank overflow is not addressed. The responsibility for the tanks in such a situation lies with the owner of the tanks, which in this incident is Metallurgical Operations. Waste Operations personnel are responsible for the equipment and operations as they apply to waste transfer. In this incident, the fill valves to the waste tanks were closed causing the liquid to begin to pool in Room 245's drainage trench. Although no detrimental effects were produced, the potential for serious consequences is real without the formalized standard procedure for emergency operations. A major point is that the Waste Operations personnel responsibility is to isolate the tanks while Production personnel responsibilities are to the lab and its preservation. The steps detailed for the transfer of waste are adequate. Information on which valves to turn and the proper method of sampling is complete.

The parameters to be met by holding tanks are delineated in HW-13, Hazardous and Mixed Waste Resource Conservation and Recovery Act Standard Operating Procedures. This document "outlines requirements necessary for operating hazardous or mixed waste collection, storage, or treatment tanks in a legal and environmentally safe manner." The secondary containment in place at the time of the incident did not conform to the prescribed design. The above procedure states that such systems must have "a leak detection system to detect failure of either the primary or secondary containment within 24 hours." There was no leak detection system employed on either the primary or secondary containment. The secondary containment system must also "have an impermeable interior coating or lining that is compatible

with the stored waste and that prevents migration of the waste into the concrete (or other material)." The secondary containment in question was painted with epoxy paint to form a sealed barrier but was not leak tested, and it was later determined by a dye test that the secondary containment leaked. HW-13 addresses the issue of controls to avoid overfilling a tank. The procedure states that such controls must include a control "to prevent overfilling such as waste feed cutoff system or bypass system to a standby tank." Tanks 1 and 2 have a manual waste feed cutoff system, but this simply causes the waste to accumulate in the drainage basin in the Plating Lab. The bypass system implemented requires that each tank act as a standby tank for the other tank. However, both tanks are commonly used which restricts the available capacity of the tank for overflow from the other tank. Proper notification requirements and responsibilities are detailed in HW-13 and HW-11, Hazardous Waste Spills and RCRA Spill Kit Use. HW-11 defines the criteria for each type of spill. A spill of 10 gallons or more is a major spill. HW-11 then states that "Any spills not meeting the above criteria are major spills that shall be reported immediately to the Plant Superintendent and to the Fire Department." HW-13 then states that "If a major or potentially major leak or spill or containment system failure that threatened human health or the environment, the Rocky Flats Contingency Plan will be implemented by the Emergency Director (Plant Superintendent) immediately." This means that the Shift Superintendent will direct the actions which are to be taken. In the instance of the incident, the MTD engineers began cleanup themselves without higher management direction. These actions do not follow the prescribed procedure.

4.2.5 Sewage Treatment Plant Equipment

The Sanitary Waste Treatment facility is a tertiary system. The system consists of a series of settling areas and activated sludge aeration/digestion areas. The system suffered only mild upset due

to the incident. The turbidity of the facility effluent increased over a five-day period, from one to seven units, and the system returned to normal operating standards within a week. The toxic shock to the system was potentially threatening to the stability of the waste treatment facility operations. There was a noticeable decrease in the effectiveness of the activated sludge but no long term effects were observed. The issue of chrome hold-up in the activated sludge is minor due to the turnover and replenishment of the sludge in a timely manner.

The waste treatment system does have sampling and analysis services. The sampling is conducted approximately every 30 minutes but the samples are combined into a composite sample. The analysis of the sample can take up to 2 weeks rendering any corrective action to be taken ineffective. There is no system in place for near-real time monitoring. The most effective monitoring is performed by the Stationary Operating Engineer (SOE) on duty at the facility. The facility is manned on a one-shift basis, during the day, and is checked once each subsequent shift by a SOE. If a condition is not noticeable or is not observed by a Waste Treatment Facility operator, the incident will go unnoticed unless there are further effects on the waste system. Even if a situation exists requiring action, isolation of the stream is not an option. There are no holding ponds or diversion ponds of significant capacity before the waste treatment facility to contain the liquid if detected.

The response to the spill by the Sewage Treatment Plant personnel was correct. It was the judgement of Environment Management that the contaminant was organic. This was based on the fact that there had been previous releases of antifreeze and dye penetrant to the Sanitary Waste System. This assumption caused a delay of several days in identification of the contaminant because the lab was conducting analyses to identify an organic substance. The delay caused in the subsequent analysis for inorganics delayed the search for the source and the identification of the material.

4.3 Organizational Responsibilities

4.3.1 Operations

The Foundry Operations personnel traditionally relied on the development engineers to keep the Plating Laboratory equipment operational. In December, 1988, the operations personnel refused to continue operating the chrome plating bath because the bath level could not be reliably controlled overnight, a criterion they needed for long production runs. This appears to have been an appropriate decision, but there was no formal follow-through. The operations personnel relied on informing the Development Engineers for the problem to be resolved.

Rockwell has formal safety program systems including Lockout/Tagout (as indicated in the next section) which are designed to resolve HS&E issues, but the operations personnel did not use the formal systems available to them. This indicates that they did not fully discharge their responsibilities.

The supervision of the Development Engineers, i.e., the lead Development Engineer and the Manager of Coatings, did not take appropriate action in addressing the problems of the chrome plating bath. They allowed the bath to continue operating with a faulty sensor (safety) system, while they attempted to find a solution. Other than writing a purchase requisition to install a new sensor, there was no formal attempt made through established safety and engineering organizations and procedure systems to resolve the problem, and they did not shut down the bath.

4.3.2 MTD Operations

The system was designed to automatically control levels in the plating baths. This system was not entirely effective, and was

modified some time after initial installation. After modification, the system was not reliable. This indicates less than fully adequate execution of the engineering design task including follow-through.

The level control system was designed in response to a prior incident which indicated the need for such a system, rather than as part of a systems approach to control of all potential failures and HS&E vulnerabilities. It appears that the Plating Laboratory was not subjected to a systems engineering review. A significant vulnerability which does not appear to have been thoroughly analyzed, either for the Plating Laboratory or the waste tanks in Room 9A, was that of a large overflow condition. This is considered to be a significant issue because both rinse tanks and the acid waste tanks had been overflowed within the past two years.

4.3.3 RCRA Inspection and Certification

The bermed area in Room 9A intended to provide secondary containment does not qualify as such in accordance with the regulations. These regulations require, among other things, specific construction features and a leak detection system. Construction features include chemical-resistant water stops in place at all joints (i.e., between building wall and floor) and an impermeable interior coating or lining that will prevent migration of waste into the concrete. In the case of the building wall and floor being used as containment in Room 9A, detection would be required which would be able to detect releases from the primary containment (i.e., the tank itself) or the secondary containment structure (i.e., the building wall and floor) or detect the presence of hazardous waste in the secondary containment structure (per 6CCR1007-3, 265.193). Approximately 2 1/2 years ago, Rockwell had a team evaluate primary and secondary containments. Room 9A was reviewed, and no recommendations for corrective actions were made. It should be noted that the

regulations do not require testing and certification of the primary or secondary containment systems.

The performance of the secondary containment system in Room 9A of Building 444 does not satisfy the current state regulations governing RCRA tanks. Title 6 of the Code of Colorado Regulations 1007-3, 265.190 allows a facility until September, 1989, to have the integrity of a tank system certified by a professional engineer, and until September, 1990, to bring the secondary containment systems up to standard. After these dates, the Plant will be out of compliance with the state regulations.

4.4 The Chromic Acid Release

Manufacturing Technology Development (MTD) has responsibility for the Plating Laboratory, Room 245. Part of that responsibility is to check the Plating Laboratory, Room 245, and the office safes at the end of the day shift. During this check on February 22, 1989, a Development Engineer noticed that the chromic acid tank liquid volume was low. This bath was scheduled to be used the next day and the heaters were to be left on overnight. Therefore, to insure the liquid level would be adequate for the next day and at operating temperature, the engineer opened the manual water valve and left.

There is no administrative control for this operation that would have prevented the person from leaving without shutting off the water.

After the incident, the water flow rate was measured at the valve used to fill the chromic acid bath. The flow rate was measured at three gallons per minute, but was estimated to be about 2.5 gal/min. Based upon these flow rates and the time the water valve was left on (from 1600 to 0730), it is estimated that approximately 2,600 gallons of water were released.

The plating bath was estimated to have been 80% full at the time the engineer started filling it. The one acid waste tank in Room 9A that was set up to receive waste solutions has a maximum capacity of 400 gallons. The size of the berm area around the acid waste tanks was estimated to contain about 1,400 gallons. Based upon these estimates and the estimated volume of water released:

- 20 gal. were required to fill the plating bath to overflow
- 400 gal. were retained in the waste tank
- 1,400 gal. were retained in the berm
- 40 gal. were left on the floor outside the berm

About 750 gallons of dilute chromic acid leaked from the building into the footing drains.

Based upon the estimated flow rates and holdup in the associated vessels, it is calculated that the chromic acid bath was overflowing while the pipefitters were working on PM shift in Room 245, February 22, 1989. However, because of the configuration of the plating bath and the pipe penetrations (see Figure 16), the solution would have cascaded down the side of the bath with little splashing. It is possible that the pipefitters would not have heard it overflowing. It is also possible that the guard would not have heard the chromic acid bath overflowing during the scheduled security tours through the building.

The overflow solution from the chromic acid bath ran down the floor drain (see Figure 16) into the acid waste Tank T1 in Room 9A. The calculated flow rate derived above indicates that the high level alarm activated sometime between 1810 and 1830 hours. Based upon these estimated times, it is conceivable that the pipefitters, working in Room 245 should have heard and or seen (flashing lights and audio) the alarm (see Figure 21). Also, the guard could have noticed the alarm during the scheduled Building security tours.

A test was performed on the acid waste tank alarm. This test did not uncover any reason why the audio portion of the alarm might have failed. The alarms did respond according to design. It was reported by pipefitters working in Room 245 the next day, February 25, 1989, that the tank high level alarm did sound a number of times. Because of these findings, it is believed that the alarm was fully functional at the time of the spill and that someone silenced it.

Two painters worked overtime on the morning of February 23, 1989. They were in Room 9 between the hours of 0430 and 0700, and did hear solution flowing in Room 9A. The roll-up door that separates these rooms was closed, locked, and alarmed. The painter crewleader told a fellow leadperson, but no attempt was made to contact management about the spill.

Some time after the alarm was taken off the roll-up door around 0536 hours on February 23, 1989, one of the overtime painters went in Room 9A. At that time, the floor was covered with liquid. One of the painters walked through this liquid without taking any precautions while going through it. Also, the painter did not inform management of the flooded condition in Room 9A. Because the roof leaked after precipitation events, thereby causing water to puddle on the floor, (and also to deteriorate pipe insulation in Room 9A), the painters accepted water on the floor as a commonplace event. In this case however, they noted the berm overflowing, causing the puddle, and knew that the tanks contained acid solutions. Walking through the potentially hazardous conditions, with one of the painters being a leadperson is considered a violation of safety procedures.

A Waste Operations operator arrived in Room 9A the morning of February 23, 1989, saw the acid waste tank overflowing, and took action by shutting off the fill valve. He intended to notify the personnel in the plating laboratory, Room 245. Due to the time it

would have taken to contact the plating laboratory personnel, this action could have caused flooding in the laboratory that would have compounded the problem.

When the engineer returned to work the next day and discovered the acid waste tank alarm was lit, he took action to stop the overflow. Action was taken to contain and pick up the liquid. However, no action was taken to notify the HS&E area engineer of the spill.

Special clothing was specified for the pipefitter to repair the transfer pump in Room 9A, but the engineer did not contact the Industrial Hygienist to determine what precautions and clothing should be worn while cleaning up the spill. Additionally, Room 9A should have been roped off to limit personnel access.

The sanitary drain in Room 9A was plugged and capped. Consequently, it was felt that all of the liquid from the spill was contained within Building 444. Also, the liquid was considered to be mostly water; therefore, it was considered not to be a reportable incident by the Building Manager.

The dye tests that were performed by the Utilities Engineer that identified the leak path of the chromic acid to the Sewer Treatment Plant helped to shorten this investigation. As a result of identification of the leak path, the underfloor drains were repiped to the process waste tanks to preclude similar incidents from entering the Sanitary Sewer System and going undetected.

4.5 Safety Policy and Procedures

4.5.1 General Policy

For the most part, the Safety Policy and Procedures documentation by Rockwell appears to be adequate and provides line management with the responsibility for Safety Procedures which are traceable. The Building Manager concept for safety within a facility where multi-operations are conducted under supervisors of different organizations is a good concept and is working. The concept was used several years ago, abandoned, and has been reinstituted within the past year or so.

The Building Manager for Building 444 understands his assigned responsibilities but has only been in the position for eight months. He is in the process of assimilating all the operations in the building.

The ESH Organization is also structured within a similar concept in that the Area Safety Engineer has oversight of several buildings, but more of a functional support role through direct line responsibility.

The policy and procedures for RCRA action have been established. The non-reporting of the chromic acid spill incident by the Building Manager, the Coatings Manager, and the Area ESH Engineer is considered to be LTA and deficient. Training had been provided but apparently was not well understood.

4.5.2 General Procedures

HSE 2.07, HS&E Work Order Priority System, applies only to safety related work orders. The work orders for replacement of the sensors

for the chrome plating bath were not stamped "Safety Related - Immediate Action Required" or "Safety Related - Early Completion Required". This level of priority was justifiable for the level control sensors and subsequent control of the plating solution levels.

HSE 2.08 Lockout/Tagout Procedure requires lockout and tagging when unexpected energization, start-up, or release of stored energy could cause injury to personnel and/or damage to property or equipment. Supervisors, as equipment custodians, are required to place "Do Not Operate" tags on equipment, systems, or components when they are found to be defective, and are to notify the Building Manager. This procedure was not used in connection with the defective sensors on the chrome plating bath.

HSE 9.07, Hazardous Material Control Program references the RCRA/CERCLA Program Office and Waste Operations for proper disposal of hazardous wastes and provides requirements and procedures to follow. Supervision and plating laboratory personnel were not familiar with the provisions of this program.

4.5.3 Building 444 ES&H Policy and Procedures

The Draft Safety Analysis Report for Building 444, which was prepared in 1978 and revised in 1982, presented some accident situations involving the plating laboratory; a cyanide accident, meltdown of a plating tank, and a fire sprinkler system opening up and flooding the laboratory. All but the cyanide incident were dismissed as being of lesser consequence and not analyzed further.

The cyanide accident was represented as a worst case non-nuclear accident. No environmental releases of a non-nuclear nature were presented in the SAR as the main focus of the AL SAR Program was

nuclear oriented. Additionally, the non-plutonium nuclear facilities, such as Building 444, represent a much lower potential hazard and, consequently, much less attention is focused on them.

The Operational Safety Analysis (OSA) for an operation or laboratory is to provide a detailed evaluation of the potential hazards associated with the operation(s), discuss mitigating safeguards both administrative and hardware related, and provide limiting conditions for the operation. Whereas the Building SAR is a broad representation of the potential hazards from several operations in the case of Building 444, the OSA is much more detailed and encompassing to the specific operation. The OSA is subject to an annual review to reflect changing conditions in the operation or new regulations. The OSA for the plating laboratory primarily addressed the cyanide plating line with limited discussion of the other plating lines. The other plating lines were addressed only in general terms regarding safety. The analysis of potential accident situations was deficient. No limiting conditions were identified for the laboratory and Administrative Safeguards were LTA. The sensor situation has been previously discussed regarding safety and maintenance aspects. There was no record of the OSA having been reviewed or updated for the past eight years.

The acid waste tanks in Room 9A and the plating rinse baths have been overflowed within the past two years. While the situation was known to exist and attempts made to remedy it, low priorities assigned to the project were lost in the maintenance backlog.

It should be noted that the Colorado Department of Health, in their August 1988, RCRA inspection report, also noted that level sensors to detect overflow from the acid waste tanks were needed, and that the cyanide alarm in Room 9A needed to be moved to permit a better monitoring position. The maintenance work order was included to

provide the overflow sensors and readout in Utility Operation (SOE) for the building were included in the maintenance backlog. The cyanide monitor will be moved in the Correction Action Plan, prior to September 1989.

With respect to Operating Procedures for the plating laboratory, while the production operations are covered by procedures; the activities of the development engineers and the dual occupancy of the laboratory are not. This is considered to be an unacceptable practice. The responsibilities for operations and maintenance should be documented.

Based on interviews with the painters, carpenters, and other hourly crafts persons, the Investigation Board was left with a general impression that considerable adversity exists between them and their management. This adversity was downplayed by the supervisory personnel when they were interviewed. There appears to be considerable indication and allegations of poor communication, lack of information and concern about safety, and poor maintenance. On follow up to some of the allegations, the situation appears to be one of perception rather than actual situation. There does appear to be some merit on allegations regarding communications. Management should review the situation.

4.6 Training

Core-type training is provided to all employees and contractors. Building and job specific training is provided to each employee to provide him adequate knowledge to perform his/her job assignment. There is less than adequate training of employees and their understanding as to what constitutes a spill of a reportable nature. In addition, there is less than adequate understanding of the spill reporting requirements.

4.7 Maintenance

Maintenance of the Plating Laboratory facility was less than adequate because production areas in Building 444 consistently received higher priority. Procedures are in place to prioritize MWOs and a special program had been initiated in 1988 to reduce the backlog of old work orders. Dual management responsibility for development and production operations has contributed to the lack of proper maintenance in the lab. The practice for identifying safety MWO was less than adequate prior to 1989.

The maintenance activities in Room 9A are also considered less than adequate. Several reasons were advanced during the course of the investigation and are considered to have merit: (1) the room is located in the basement and is used as an access hatch for removal of large pieces of equipment from the basement, (2) the hatch roof over the room has deteriorated as a result of being removed several times and consequently leaks during precipitation events resulting in puddles on the floor and deteriorating pipe insulation, and (3) management's low priority in fixing the situation has created a situation of indifference. The caulking and epoxy paint in the tank containment berms has deteriorated because of lack of maintenance and the contained small sumps in the rooms showed no evidence of maintenance.

The low priority given by Building Management to the work order to alleviate the potential cross connection between the acid waste and cyanide tanks because they regarded the dilute nature of the contents not being of safety significance and resulted in the work order to remedy the situation being delayed in the backlog of maintenance.

4.8 Environmental Concerns

4.8.1 Sewage Treatment Plant

There is no real-time monitoring on either the influent or effluent streams for the STP. Thus, there is no advance warning when a contaminant enters or leaves the plant. Although real-time monitoring technology is not available for gamma radiation or many other contaminants, there are generic monitoring capabilities such as capacitance or pH that would provide some information on the quality of the influent or effluent stream.

Approximately 30 pounds of chromium in the form of chromic acid were calculated to be released to the STP. Of this amount, 25 pounds were collected in the sludge and the remaining 5 pounds distributed between the pond water, pond sediments, and the spray fields.

4.8.2 Spray Irrigation and Holding Ponds

The issue of runoff from spray irrigation has been recently discussed with EPA Region VIII personnel in preparation for reissuing the Rocky Flats Plant NPDES on June 30, 1989. The possibility of continuous discharge to pond B-5 and the use of pond B-3 only to hold new discharges while B-5 is being monitored, verified to be acceptable for release, and released is one option under discussion. An important note is that this option or any other similar option would not have prevented contamination of pond B-5 by the chromium spill. Once material enters the STP, there is no available method for stopping the release. In the current method of operation, the release from pond B-3 to pond B-5 was by runoff from spray irrigation instead of a direct release to pond B-5 in the proposed option discussed above.

There has been consideration as to whether pond B-3 could have been used to contain the spill if the EPA would have allowed direct discharges around that pond (in violation of the NPDES permit). First, the pond has about 400,000-gallons total capacity and there are about 1,250,000 gallons discharge from the STP in the 5 days from the first day observing the spill until chromium was identified. Also, removal of pond B-3 from the system would also remove the ability to hold, monitor, and verify the acceptability of waters for discharge, i.e., there would be no facility to retain water while pond B-5 is discharging. This second problem would be unacceptable to all regulatory agencies involved (i.e., Region VIII and Colorado Department of Health).

Concern does exist over the stability of spray fields near the canyons especially during periods of low evaporation where saturated soil conditions are common. Cracking, and sloughing has occurred at the North Spray field and evidence throughout the drainage confirms the general instability of the soils. The crack which appeared in the top of the B-5 pond appears to be associated with settlement within the dam and poses no imminent danger of collapse. Both the dam architect and the Omaha District, U.S. Army Corp. of Engineers, confirmed the dam's suitability for continued use.

4.8.3 NPDES

The NPDES permit issued for the Rocky Flats Plant in 1984 by the EPA was intended to control offsite discharges to as near zero as possible by use of spray irrigation. There is a 0.05 ppm total chromium monthly average and a 0.1 ppm total chromium daily average limit for discharge from pond B-3 but no chromium discharge limit for pond B-5. Water being removed from pond B-3 by the process of spray irrigation has no limitations established by the permit.

While it is true that the current permit/discharge system has some flaws, it does allow the very important reassurance that all surface waters can be held, sampled, and analytical results evaluated prior to discharge. Maintaining this capability must be carefully considered in any new agreement/permit.

It might be proposed that pond B-3 be removed from the system to hold any suspect discharges until the material could be identified and possibly treated. The current system allows the use of pond B-3 to retain continuous STP discharges while pond B-5 is being discharged (after the required sampling and analysis and result evaluation). STP discharges would flow directly to pond B-5 and out of that pond without final sampling, analysis, and data evaluation if pond B-3 were to be removed from use to hold a suspect material. This would have the additional advantage of eliminating false BOD violations from pond B-3 algal contributions.

Discharges to pond B-5 without spray irrigation and discharges around Great Western Reservoir are other options currently being evaluated. The renewal of the Rocky Flats NPDES permit in June-July, 1989, will also involve public hearings and comment periods which may raise yet unidentified issues.

4.8.4 RCRA

Pursuant to the Colorado Hazardous Waste Regulations (6 CCR 1007-3, 265.56 (J)), the RCRA Contingency Plan was implemented on March 1 since an interim status RCRA tank was involved. The plan was implemented for the purpose of assessing and mitigating potential environmental impacts from the chromic acid spill. As required by Section 265.56 (J), a RCRA Contingency Plan Implementation Report was prepared and mailed to the Colorado Department of Health and U.S. Environmental Protection Agency (Region VIII) on March 10, 1989.

On March 29, a report was filed with the Colorado Department of Health and U.S. Environmental Protection Agency pursuant to Colorado Hazardous Waste Regulations (6 CCR 1007, 265.196 (d) (3). This report is required when there is a release from an interim status RCRA tank system.

RCRA corrective action at the Building 444 foundation drain appears to be unnecessary because analysis of soil borings from this area showed only background levels of chromium. However, the affected areas will be targeted for further investigations under the auspices of the plant's Environmental Restoration Program.

The soil samples taken in the North and South spray fields show that chromium levels in the two fields are within background levels associated with the plant site and no RCRA corrective action is necessary.

4.8.5 CERCLA

On March 2, 1989, DOE-RFAO notified the U.S. Environmental Protection Agency's National Response Center pursuant to 40 CRF 302.6. This report was made based on a reportable quantity for chromium of one pound. When the source of the chromium was determined to be chromic acid, it was realized that the reporting to the National Response Center was unnecessary since the reportable quantity for chromic acid is 1,000 pounds.

An Emergency Release Notification to community emergency coordinators and the State Emergency Response Commission pursuant to 40 CFR 355.40 was not made since notification is not required if the release "results in exposure to persons solely within the boundaries of the facility." Furthermore, since the release of chromic acid to the environment did not involve a reportable quantity of 1,000 pounds, notification under 40 CFR 355.40 is not required.

As discussed in the preceding paragraphs, the areas potentially impacted by the chromic acid spill will be targeted for further investigations under the auspices of the plant's Environmental Restoration Program.

4.8.6 Pond B-5 & C-2 Treatment/Discharge Options

The possibility of treating holding pond waters in situ was considered early after chromium was identified to have been discharged from the STP.

Additional detailed evaluation of options was completed by Facilities Engineering of pond B-5 structural assessment and discharge recommendations. The structural assessment and rates of fill are important because those factors control the amount of time available to implement options. The eight options considered were:

1. Discharge to Great Western Reservoir
2. Discharge to Upper Church Ditch/Jefferson County Airport Pond
3. Discharge to pond A-4
4. Transfer to Raw Water Treatment
5. Transfer to STP
6. Evaporate with Fog Spray
7. Use Reverse Osmosis
8. Commercial Treatment

Only the first three options were found to be viable because of problems/time limitations with other options. Only option 3 represents a method to gain time.

The option finally selected was to pump the water from pond B-5 to Upper Church Ditch and hence to the Jefferson County Airport Pond. The water discharge was initiated April 18, and was completed May 30.

4.8.7 Summary Assessment

A summary of potential environmental damage and costs directly attributable to property damage from the chromic acid incident is presented below.

- The release of chromium to the environment was in the form of chromic acid. Under RCRA standards, spills of up to 1,000 pounds are not reportable. This incident released 30 pounds of chromium in the form of chromic acid.
- Of the 30 pounds released to the Sewage Treatment Plant, 25 pounds were collected in the sludge and 5 pounds released to pond B-3 and the spray fields.
- Soil samples collected at one and five inch depths in the spray fields are within background levels for chromium in the site soils.
- Water samples in ponds B-3 and B-5 are below the 0.05 ppm level for chromium as specified in the Clean Water Act.
- No off-site discharge of the effluent occurred in accordance with the plant NPDES permit.
- Soil samples from borings taken in the vicinity of the Room 9A building footing drains indicated background levels of chromium and as a consequence no RCRA action cleanup is required.
- No direct costs are attributable to the incident for property damage with only minor impact to the environment.

4.9 Corrective Actions

The in-depth investigation into the Chromic Acid Incident identified a number of primary and contributing causes for the spill and also identified areas where improved procedures and practices would have reduced the impacts of the incident. While this incident proved not to be damaging, larger spills or more concentrated/hazardous materials could potentially impact employee safety, property, and the environment or the public. Recognizing this, Rockwell has,

concomitantly with the investigation, prepared a Corrective Action Plan to address the areas where improvements are indicated. The plan was issued on May 17, 1989.

The plan addresses both the specific operations of the Building 444 Plating Laboratory, and plantwide improvements. The thirty-eight specific actions included in the plan address procedural, technical, facility, and management issues. Some of the actions were short-term and have already been completed. Others could be multi-year and could require several millions of dollars per action. For the larger projects, the actions typically require a study, or preliminary phase, which would identify the needs and benefits, as well as the resource requirements of the total project. Whether the total project is completed would therefore be dependent upon the analysis of need/benefit vs cost and the availability of funding.

Appendix E contains a summary of the Corrective Action Plan.

4.10 Notification

4.10.1 Rockwell International

Within Building 444, the following personnel were aware of the chromic acid spill on the morning of February 23, 1989: an MTD Engineer; an Industrial Hygienist; the Metallurgy Operations Manager, Coatings Manager, and the Building Manager. There were no notifications to the Plant Shift Superintendent nor to the Fire Department, as required by Rockwell International SOP HW-11. This represents a breakdown, by several organizations and levels of management, in the approved procedures for notification. However, Rockwell International made the proper notification to the Area Office once it was determined the contaminant was chromium.

It is unclear whether the Manager of Coatings should have notified the Manager of Joining Technology of the incident. This line of management has responsibility for the work of the development engineers, but does not have responsibility for the overall building, nor the waste tanks in Room 9A. It is clear, however, that notification was required to be made to the Building Manager, due to his overall responsibility for the building.

The Building Manager's judgement not to make further notification about the incident resulted from his misunderstanding the requirements and procedures regarding spills, and their relation to primary and secondary containments. He understood that as long as a spill was contained within the building, they were free to clean it up, and did not have to notify anyone. Interviews with several personnel revealed this misunderstanding to be commonplace.

The Sewage Treatment Plant Manager made the proper notification to Environmental Management upon observation of an abnormal condition in the primary clarifier.

The facts indicate that the spill was large and outside of primary containment, and that it contained a hazardous material, chromic acid. Although the Rockwell requirements and procedures could be more explicit, it is clear that a supervisor was responsible for determining these essential facts and notifying the Emergency Director.

4.10.2 DOE

The spill did not exceed the Reportable Quantity (RQ) threshold of 1,000 pounds of chromic acid; therefore, notifications to the EPA, CDH, and NRC were not required. However, based on the uncertainty of the quantity and source of the spill, RFAO made notifications.

For this reason, RFAO also notified the AL EOC. The AL EOC in turn notified EHD in accordance with AL Order 5484.1.

Per AL Order 5484.1, EHD should have made all further notification within AL, including the Manager, and also notified the HQ EOC if the incident conditions so dictated. These notifications were not made by EHD.

4.10.2.1 Rocky Flats Area Office

The Rocky Flats Area Office acted properly once the information of the spill was available. All of the proper notifications were made to the Federal, state, and DOE offices.

There is a question regarding the notification to the National Response Center (NRC). Regulations state the notification must be made within 24 hours once it is determined a reportable spill has occurred. The Rockwell International Environmental Management was notified that the contaminant was chrome at 1530 hours on February 28, 1989. The source of the spill and the quantities were still unknown at that time. The NRC did not receive notification until 1112 hours March 2, 1989, nearly 44 hours after Rockwell International was informed.

While the notification to the NRC does not meet the 24-hour requirement of 40 CFR 302, determination of the quantity and chemical composition of the spill was nebulous with the source of the spill being unknown. Regulations require notification for a chromic acid spill of 1,000 pounds or more and a spill of chromium of 1 pound or more. It was unclear to plant personnel which category of reportable quantity applied to the spill. Plant officials acted properly in using the conservative RQ value and reporting the spill as exceeding the one pound RQ for chromium.

4.10.2.2 Albuquerque Operations Office

Misinterpretation by EHD staff of the RFAO comment that the DOE EOC had been notified was the reason the HQ EOC was not notified as required by DOE Orders 5000.3, 5400.1, and 5484.1. EHD staff interpreted the RFAO comment to mean the HQ EOC, whereas, it actually referred to the AL EOC. This misinterpretation was explained in AL's March 10, 1989 memorandum to EH-34, formally notifying HQ of the incident.

The AL Manager was not notified of the spill and had no knowledge of it until approximately 1200 hours on March 8, 1989, when DOE Headquarters made an inquiry into the spill and lack of notifications.

The AL/EOC, EHD, and the AL Assistant Manager for Environment, Safety and Health all had knowledge of the spill. Consultations between the AL Assistant Manager and EHD led to a tentative conclusion that the spill was not of imminent danger to the public nor to the environment.

5.0 CONCLUSIONS

5.1 Findings

Listed below are the findings developed from the chromic acid spill investigation, the facts as determined from that investigation, and the analysis of those facts.

1. The Plating Laboratory, Room 245, is utilized in a matrix mode by two organizations under different management with differing responsibilities. One group is responsible for development of plating processes; the other is responsible for production operations.

2. The use of the equipment in the Plating Laboratory is divided between the two groups. Until very recently, the maintenance responsibility was fragmented--whoever broke the equipment fixed it. There is still holdover from the old systems, and a backlog of maintenance exists.

3. The manager for Metallurgical Operations, who is also the 444 Building Manager, had been in his present position for eight months at the time of the incident. The Manager for Coatings had been in his present position for four months at the time of the incident.

4. There has been a chronic malfunction history for level sensors in the chromic acid plating bath. The inoperability of level sensors was not limited solely to the chromic acid bath. At the time of the incident, level sensors were inoperative for 4 out of 5 plating baths. Plating Laboratory personnel did not seek outside help and technology to any great extent.

5.1 Findings (continued)

5. The plating bath level status board in the office area of the Plating Laboratory was disconnected from the sensors and thus incapable of notifying personnel of unsafe conditions. Therefore, a less-than-adequate safety condition existed.

6. The failure of the chromic acid plating bath level sensors caused the automatic control system for adding makeup water to be inoperable. Makeup water was added by a hose line connected to a faucet, thereby not using the control system. No written procedure was developed, nor was one considered a requirement, for the manual addition of makeup water to the plating tanks by hose line for either production or development operations. A less than adequate safety condition was created and had existed for at least two months prior to the incident.

7. Production operations had not been conducted in the chromic acid bath, Room 245, since December, 1988, because new production effort required multi-shift operations (e.g., longer than a single shift).

8. Overflowing tanks have been a recurring problem. Both rinse tanks in the Plating Laboratory and the acid waste tanks in Room 9A have been overflowed in the past. The last such incident in Room 245 was two years ago when a rinse tank overflowed. A lesser interval of overflow existed for the acid waste tanks.

9. An MTD engineer noted the chromic acid bath had a low solution level. He added water by a hose line connected to a faucet as the automatic water makeup system was inoperable. He forgot to shut off the water when he left at end of shift.

5.1 Findings (continued)

10. The MTD engineer scheduled to perform the shutdown inspection in the Plating Laboratory did not perform the inspection but did notify personnel he would not be able to do so. This was not communicated to other lab engineers. Consequently, when the second engineer noted the inspection had not been performed he did the inspection and initiated the filling of the chromic acid bath while on inspection rounds.

11. No written procedures were developed nor required for MTD operations in the laboratory. The only documentation followed was manufacturers requirements for solution makeup and material Safety Data Sheets. There were no other effective administrative controls.

12. A draft Safety Analysis Report (SAR) for Building 444 was issued in 1979 and updated circa 1982. It contained a brief discussion of a cyanide tank accident and a potential meltdown of a plating tank. The SAR did not adequately address non-radiological hazards nor their releases to the environment.

13. The Operations Safety Analysis (OSA) for the Plating Laboratory dwells primarily on the cyanide plating operations. The acid plating lines are addressed in one paragraph. Overflows, etc., were not addressed. No limiting conditions were included in operating procedures for the Plating Laboratory.

14. The acid waste tank in the basement which accumulated the overflow activated a high-level audible and visual alarm in the plating laboratory some time between 1810 and 1830 hours. The alarm could have been placed in an "acknowledged" status by persons unknown prior to pipefitters returning to the laboratory

5.1 Findings (continued)

14. (contd)

at approximately 1945 hours. The tank high-level status was indicated, but the audible portion and flashing panel light were "silenced." Subsequent testing of the alarm system and its operability the following day validated its viability.

15. The acid waste and cyanide waste tank alarms are not monitored after first shift, holidays, or weekends due to the location of the alarm panel. No alarm readout is provided to the Building 444 Stationary Operating Engineer's Office, which is manned 24 hours except when the engineer is making his appointed rounds.

16. A Stationary Operating Engineer is assigned to Building 444 for all shifts. He normally reviews equipment he is assigned responsibility for during these rounds, but does not especially look for other alarms. During his rounds, he passes within 50 feet of the Plating Laboratory. He noted no alarm condition during the night of February 22.

17. Room 9A, where the acid waste tanks are located, has a removable portion of the roof, through which large equipment items from the basement are removed. The roof leaks and puddles of water on the floor are common after a precipitation event and probably contributed to the painters' indifference to walking through water puddles on the floor. Insulation on pipes located in Room 9A is also deteriorating because of leaks.

18. Room 9A also provides an unmarked auxiliary emergency exit route from the basement via a ladder located adjacent to the cyanide waste tanks.

5.1 Findings (continued)

19. Both acid waste tanks and cyanide solution waste tanks are housed in Room 9A inside 18-inch-deep concrete berms. The piping configuration associated with the tanks is interconnected and mixing of the contents of the tanks is a credible event. Release of hydrogen cyanide gas could result from the mixing. It should be noted this situation was corrected prior to the release of the report.

20. There were no liquid level sensors in the secondary containment area of the waste tanks. A work order was written in September, 1987, by MTD to provide such an alarm. This was also noted in August, 1988, by the Colorado Department of Health as the result of a RCRA survey. An alarm readout was to be provided to the Building 444 Stationary Operating Engineer. The work order written in 1987 was designed by plant engineering in January 1988. The work order was given a low priority for execution by Building 444 management.

21. The relocation of the cyanide gas detector in Room 9A per the recommendations in the August 1988 Colorado Department of Health Survey also has been scheduled for completion by September 1989.

22. The containment integrity of the waste tank berms was inspected and accepted at an earlier date as providing adequate containment. The sanitary sewer drains in Room 9A had been sealed to preclude entry of solutions into the sanitary sewer system.

23. There is no real-time monitoring of hazardous substances at the sewage treatment plant. No technology currently exists for real-time monitoring of waste waters for environmental levels of

5.1 Findings (continued)

23. (contd)

radioactive materials processed at Rocky Flats Plant. The effluent from the Sewage Treatment Plant is sampled and analyzed for total long-lived alpha and beta contamination. Surface water is not released from final detention ponds until the waste is sampled and determined by Rockwell and the Colorado Department of Health to be free of radioactive materials of concern.

24. There is no ability for extended diversion of Sewer Treatment Plant outfall. A limited diversion capacity (e.g., holdup) of 60,000 gallons exists at the inflow to the treatment plant. The daily outflow from the Sewer Treatment Plant is 250,000 to 300,000 gallons per day.

25. The NPDES discharge permit requires spray irrigation from Pond B-3. Both the North and South spray fields have saturated soil conditions during cold weather and high precipitation events. The geologic makeup of the Rocky Flats Bench is alluvial deposits and is composed of typically unstable soils. Cracking and sloughing of soils at the edge of canyons near the north spray field is present.

26. Surface runoff can occur from the spray fields into holding ponds. Subsurface ground water movement from the south spray field is towards the northeast and appears as seeps in the canyon walls above the south side of pond B-5.

5.1 Findings (continued)

27. A longitudinal crack has appeared (1/4 inch wide by 10 feet long) along the top of the south end of pond B-5. Investigations by the dam architect of the conditions have led to lowering the dam safety factor from 1.5 to 1.24. This safety factor is designed into the dam to resist static and dynamic events associated with water inflow from the maximum precipitation event. No imminent failure of the dam was projected.

28. It is estimated that 30 pounds of chromium were released from Building 444 and entered the Sewage Treatment Plant. Approximately 25 pounds remained in the dried sludge which is disposed of as hazardous waste and about 5 pounds were discharged into pond B-3.

29. Environmental chromium levels in the north and south spray fields were within background levels of 8-13 ppm found in the Rocky Flats Plant soils.

30. The total chromium levels in B-3 and B-5 pond water is below the 0.05 ppm maximum permissible drinking water standards listed in the Clean Water Act.

31. Announcements which were made over the public address system regarding the discoloration of the influent at the Sewage Treatment Plant were noted by the 444 Building Manager, but the connection to the chromic acid incident as the contaminant was erroneously assumed to be organic in nature. Followup inquiries by HSE to the Building Manager regarding organic spills also produced no results as it was not perceived by the 444 Building

5.1 Findings (continued)

31. (contd)

Manager that a release had occurred from the building. Rockwell HSE diligently pursued the identification of the contaminant and its source.

32. The piping configuration for the acid waste tanks in Room 9A does not permit recirculation of the contents and, as a consequence, a representative sample of the tank contents could not be made.

33. Painters entered Room 9A prior to 0600 hours, February 23, to obtain painting supplies located in storage cabinets. They noted the overflow solution on the floor, and walked through it. They failed to notify supervision of the incident as water was often in puddles on the floor. They, and other people in the area, contacted Rockwell Medical approximately two weeks later and were referred to an offsite specialist as being potentially subjected to chromic acid exposure.

34. It is Rockwell policy that safety is the responsibility of line management. The Building Managers are also responsible for overview of safety in their buildings.

35. Operating procedures specific to the particular plating operation are developed as necessary for Met Ops personnel. Some safety precautions for the operators are included. None of the precautions address level sensor status or other limiting operating conditions.

5.1 Findings (continued)

36. RCRA training is provided to employees regarding spills of hazardous materials. Confusion exists as to what amounts constitute a spill.

37. Several Rockwell International organizations and levels of management failed to make the proper notification of a major spill as required by Rockwell's internal RCRA SOP HW-11.

38. Proper notification was made to the Plant Shift Superintendent and Rockwell Management when it was determined chromium was the contaminant.

39. Once the contaminant was identified, proper notifications were made by Rockwell to Rocky Flats Area Office (RFAO). RFAO properly notified Colorado Department of Health, Albuquerque EOC, and the Environmental Protection Agency.

40. The Sewage Treatment Plant Manager notified Environmental Management when he observed abnormal water coloration in the primary clarifier.

41. Once it was determined that a release containing chromium had occurred, a total of approximately 44 hours elapsed before Rocky Flats Plant personnel notified the National Response Center, although it was later determined that notification was not required based on identification of chromic acid as the contaminant. Notification procedures require immediate notification within 24 hours upon detection of a spill exceeding a reportable quantity.

42. The AL Order 5484.1 has not been revised in approximately 6 1/2 years.

5.1 Findings (continued)

43. There is no detailed system for implementing the requirements of AL Order 5484.1. Additionally, the Order is out-of-date with respect to the current AL Environment, Safety, and Health organization.

44. The AL Manager was not promptly notified of the incident. Although the AL EOC and EHD became aware of the incident on March 1, 1989, the Manager did not learn about it until March 8, 1989.

45. EHD, AL perceived the chromium release as not posing an imminent danger situation to the environment.

46. Building 444 underfloor drain system was connected to the Sanitary Sewer System. After it was determined chromium had entered the foundation footing drain, it was repiped to the process waste drain system.

47. The Waste Operator who transfers full waste tanks to Building 374, closed the inlet valve to the overflowing waste and immediately went to investigate the source of the incoming solution. This caused the acid waste drain system to back up, but not overflow elsewhere because the water had been shutoff by the engineer in Room 215 at approximately the same time.

48. The Waste Operator receives supervision from other than Building 444 Management and works independently from MTD and Metallurgical Operations.

5.1 Findings (continued)

49. Low priority was assigned to the work orders pertaining to Room 9A and the Plating Laboratory by Building 444 management. This included work orders which would have been responsive to CDH RCRA survey and Plating Laboratory maintenance deficiencies. Some work orders for Room 9A date to 1987.

50. A "We Care Program" for maintenance was instituted since September 1988 to work off low priority backlog (older than June 1988). This work-off is expected to be completed in June 1989.

51. The secondary containment for the acid waste tanks leaks, as a result of several factors, including poor caulking, epoxy paint condition, and holes drilled in one side of the berm to provide anchoring for pipe support.

52. Maintenance work orders for the plating laboratory were given a low priority by Building 444 management and consequently items were left in disrepair. Just prior to the incident, a new Maintenance Policy had been established for the plant--a weekly walkthrough of all areas by the Area Maintenance Manager and supervision, including the Building Manager, responsible for an area. Maintenance requirements are identified, priorities established, and status of old work orders reviewed. This new system had not been initiated in the Plating Laboratory at the time of the incident.

53. The Room 9A containment sumps and the secondary containment have had very little maintenance performed on them.

5.1 Findings (continued)

54. Building 444 management and operations supervision felt that repiping the cross-connection between acid and cyanide waste tanks was of low priority as "they were mixed in Building 374 anyway."

55. There is a general attitude of unconcern among Plating Laboratory Management and operators towards maintenance of systems in the Plating Laboratory, preparation of written procedures, and operational ability of safety systems.

56. There is, in general, a poor attitude and relationship between management and hourly employees in Building 444 regarding information flow, and safety conditions (both real and perceived).

57. Every new employee receives basic safety training, as well as a building indoctrination, and where required, specific job safety training. RCRA training is also provided for those employees involved with hazardous work.

58. A good working interface appears to exist between Rockwell personnel and local governments, and state and federal agencies. This is not to imply total agreement exists, but communications are open and the interface is working.

59. The U.S. Army Corps of Engineers, Omaha District, who performs annual dam inspections at the Rocky Flats site, conducted a special inspection on the B-5 dam on April 14. The preliminary findings agreed with that of the architect for the dam that there was no danger of imminent failure. A report of the April 14 inspection is being prepared.

5.1 Findings (continued)

60. A problem exists at Rocky Flats Plant regarding the discharge of liquid effluents from the site and alternative holdup provisions of suspect discharges.

61. Soil borings in the vicinity of the Building 444 foundation drain system were made and the analytical results indicated no leachable chromium was present in the soils.

62. The pumping of water from pond B-5 via Upper Church Ditch to Upper Church Lake on Jefferson County Airport properly began on April 24.

63. Building 444 and vicinity has been declared a candidate site for environmental restoration.

64. The incident created negligible environment impact. The amount of chromic acid did not constitute a reportable quantity. Final discharges from pond B-5 contained less than drinking water standard levels of total chromium. Soil contamination was insignificant based on the EPA toxicity extraction procedure.

65. The MTD development engineer and the Waste Transfer operator did not wear protective clothing during cleanup operations in Room 9A.

66. The discharge from the foundation sump pump was rerouted into the process waste drains after chromium was identified in the foundation footing drains to preclude any further discharge into the sanitary sewer system.

5.1 Findings (continued)

67. In addition to the two painters who walked through the dilute chromic acid solution on the floor of Room 9A on the morning of February 23, eight other employees perceived they were exposed indirectly and were referred to a medical specialist.

5.2 Probable Cause

The probable cause of the incident was an inoperable automatic level control system in the chromic acid plating tank resulting in operators not using the level-controlled water makeup system for the tank. The operator added makeup water by a hoseline connected to a faucet. The operator forgot to turn off the faucet at the end of the shift. The secondary containment for the acid waste tanks leaked, allowing the chromic acid to enter the Sanitary Sewer System.

5.3 Contributing Factors

Listed below are factors which contributed to the incident in varying degrees.

1. The high-level acid waste tank alarms are not monitored off-shifts, holidays, and weekends.

2. The containment berm high-water level sensor with a 24-hour monitored alarm system had not been installed. Work order for installation is circa 1987.

3. The secondary containment system for the acid waste tanks leaked and permitted the chromic acid solution overflow from the waste tank to enter the building foundation drain system and into the Sanitary Sewer System.

4. Poor definition of hazards in the Operating Safety Analysis for the plating operations. Inadequate operating safety requirements that provide limiting conditions for development and production operations in the laboratory.

5. Split management responsibility for development and production operations conducted in the laboratory contributed to lack of proper maintenance and operability of the Plating Laboratory.

6. Inadequate training of employees as to what constitutes a spill of a reportable nature.

7. The Plant Shift Superintendent, Area HS&E Engineer, and upper Rockwell Management were not notified of the chromic acid spill.

8. The acid waste high-level alarm was silenced (with a high degree of probability) in the Plating Laboratory. Pipefitters were working in the room and security guards made routine periodic watchman tours.

9. Inadequate safety documentation and limiting operating conditions combined with a lack of operating procedures.

10. Minor spills and leaking roof allowing water puddles to collect resulted in complacency regarding solutions on the floor and the reporting of such incidents.

5.4 Judgments of Need

The Judgments of Need, based on findings generated by the investigation, are listed below.

1. A need exists to resolve the split management role and activities in the Plating Laboratory and assign a single line of responsibility for safety, maintenance, and training.

2. A need exists for retraining of the Building Manager and other supervisory personnel performing operations in Building 444 as to specific responsibilities for safety, maintenance, and training requirements.

3. A need exists in the Plating Laboratory to resolve the level sensor problem and provide appropriate alarms. A distinction should be made between operating status signals and those alarms indicating a potentially hazardous situation.

4. A need exists to assure the automatic control system for adding makeup water to plating and rinse tanks is properly maintained and calibrated.

5. A need exists to upgrade the Building 444 Safety Analysis Report from draft status to reflect operations with non-radioactive hazardous materials and consequences of release to the environment.

6. A need exists to update the Operational Safety Analysis specific to Plating Laboratory Operations for both Development and Production operations with Limiting Conditions to be included in the operating procedures.

7. A need exists to have formal operating procedures in the Plating Laboratory for both development and production operations. The procedures should include end-of-shift inspection.

8. A need exists to assure proper indoctrination for alarm conditions is provided to transient personnel (e.g., craftspersons) performing work in the Plating Laboratory. This is especially appropriate on off-shift when no Plating Laboratory personnel are present.

9. A need exists to assure alarm situations are recognized and appropriate notifications made. Security guards on watchtours and other off-shift personnel are likely to encounter such situations.

10. A need exists for those alarms which indicate a potentially hazardous situation to personnel or to the environment be monitored on a 24-hour basis.

11. A need exists to provide an adequate roof over Room 9A to accommodate equipment removal and provide protection from the elements.

12. A need exists to review the emergency exit routes from the basement of Building 444, especially the auxiliary exit through Room 9A via the ladder next to the cyanide waste tanks.

13. A need exists to assure no cross connection exists between the acid waste tanks and the cyanide waste tanks.

14. A need exists for all building management and supervisors to review maintenance requirements and establish appropriate priorities for ESH type work and related work.

15. A need exists for periodic review of maintenance work orders and conditions in the Plating Laboratory and other areas requiring maintenance by Building and Operating management.

16. A need exists to review the Colorado Department of Health RCRA inspection report of August 1988 to ensure that their recommendations will be addressed in a timely manner.

17. A need exists to assure integrity of primary liquid containment structures. The need for a leak detection sensor for these structures in the secondary containment with appropriate monitoring capability should be reviewed.

18. A need exists to evaluate state-of-the-art, real-time monitoring of the influent and effluent to the Sewage Treatment Plant for hazardous solutions.

19. A need exists to evaluate options to provide diversion capability for the Sewage Treatment outfall and an action plan to implement a diversion action.

20. A need exists to assure that adequate provisions are made to obtain a representative sample from the waste tanks prior to shipment to Building 374.

21. A need exists to relocate supplies and equipment not directly associated with Waste Operations out of Room 9A.

22. A need exists to alleviate the confusion regarding spills and appropriate RCRA actions, and internal plant notification for spills of hazardous materials both inside and outside of buildings. Notification and communication is paramount.

23. A need exists for the plant site to establish a coordinated external notification plan that will ensure required notification to be made within the proper time limits.

24. A need exists to update the AL Order 5484.1 with respect to notification procedures and the organizations involved.

25. A need exists to review and establish a protocol for the receiving and dissemination of notification information to appropriate AL organizations.

26. A need exists for response training to spill conditions in Room 9A including the use of appropriate protective gear.

27. A need exists to coordinate waste tank shipments between Waste Operations and Plating Laboratory management.

28. A need exists to improve worker and management attitudes towards maintenance of systems in the Plating Laboratory, written operating procedures, and safety systems.

5.5 Other Areas and Concerns

The Accident Review Board also reviewed other areas and concerns at the site and has made the following Judgments of Need in peripheral areas:

1. A study needs to be performed to evaluate the long term problem of discharge of liquid effluents from the Rocky Flats Plant both because of the spray irrigation required by the current NPDES permit on unstable soils and the holdup/diversion considerations.

2. A need exists to review the margin of safety in the B-5 dam structure in view of continued spraying in the South spray field.

3. A need exists to review foundation footing drains in other on-site facilities where hazardous materials could be introduced into the Sanitary Sewer System.

4. A need exists in Building 444 to improve the generally poor attitude and relationship between management and the hourly crafts employees regarding information flow and safety conditions, both real and perceived. An indifference to job performance exists.

6.0 SIGNATURES AND ACKNOWLEDGEMENTS

The investigation was conducted and the report prepared by:

W. B. Sayer
Acting Director
Facilities and Project
Management Division
Albuquerque Operations Office
Chairman

R. F. Reddick
Environmental Engineer
Environment and Health
Division
Albuquerque Operations Office
Trained Investigator, Member

R. D. Reed
Safety Officer
Rocky Flats Area Office
Albuquerque Operations Office,
Member

S. N. Callahan
Chemical Engineer
Defense Program-DP22
DOE, Headquarters, Member

Advisor to the Investigation Board:

R. W. Ferenbaugh, Los Alamos National Laboratory,
Environmental Advisor

Members of the Rockwell International accident investigation team who served as Technical Advisors to the board were:

T. J. Healy	Chairman
D. R. Ferguson	Trained Investigator
M. J. Johnson	Facilities Engineering & Corrective Action Plan Coordinator
G. L. Moyle	Administrative/ Clerical Support
A. L. Schubert	Resource Conservation and Recovery Act Issues
G. H. Setlock	Environmental Issues

APPENDIX A

Establishment of DOE Investigation Board

AL P 1325.8

United States Government | Department of Energy

memorandum

Albuquerque Operations Office

DATE: MAR 1 0 1989

REPLY TO ATTN OF: EHD

SUBJECT: Establishment of Investigation Board

TO: W. B. Sayer, Acting Director, FPMD

I hereby establish an Investigation Board, with you as the Chairman, to investigate the occurrence involving an accidental chromium release which occurred at the Rocky Flats Plant on February 22, 1989.

The following persons are appointed to the Board:

W. B. Sayer, Acting Dir., AL/FPMD
- Chairman

R. F. Reddick, Environmental Engineer, AL/EHD
- Member (Trained Investigator)

S. N. Callahan, Chemical Engineer, DP-22, HQ
- Member

R. D. Reed, Safety Officer, RFAO
- Member

The following person is appointed as advisor to the Board:

R. W. Ferenbaugh, Los Alamos National Laboratory
- Technical Advisor

The Board shall investigate the subject occurrence (including the Albuquerque Operations system for notification of occurrences), determine the cause(s) or probable cause(s) for the occurrence, and prepare and submit to me a written report, including recommendations for appropriate corrective action(s) to prevent similar occurrences.

The investigation is to be conducted and the report prepared in accordance with DOE and AL Orders 5484.1. Neither the report, nor any portions thereof, during its preparation, other than facts for technical accuracy, shall be given to any persons without my approval. Four copies of the draft report shall be given to the Director, Environment and Health Division, for review prior to its preparation in final form.

The Board is assigned the authority to call on any technical or administrative assistance it may require from either the Area Office or the RFAO contractor. The Area Office and contractor shall make every effort to assist the Board.

By copy of this memorandum, I am advising the supervisors of each of the Board members that this assignment is full time until the investigation and report are complete. The advisor to the Board shall assist the Board in the investigation on a priority basis and provide input to the Chairman, as requested.

Bruce G. Twining
Manager

cc:
T. E. Wade, Asst. Sec., DP-1, HQ, FORS
Brig. Gen. P. F. Kavanaugh, USA, Dep. Asst. Sec., DP-20, HQ, GTN
Capt. L. R. Newby, USN, Dir., DP-22, HQ, GTN
R. P. Berube, Dep. Asst. Sec., EH-20, HQ, FORS
Edward Blackwood, Dir., Safety Comp., EH-34, HQ, GTN
A. E. Whiteman, Area Mgr., RFAO
J. M. Puckett, HSE-DO, LANL
C. E. Troell, AM/OMA, AL
J. G. Themelis, Dir., EHD, AL

APPENDIX B

Press and Media Releases

News

Rockwell International

Aerospace Operations
Rocky Flats Plant
P.O. Box 464
Golden, Colorado 80402-0464

Contact: Communications
(303) 966-2882

For Immediate Release: March 12, 1989

DRAFT

The Rocky Flats Plant implemented its RCRA (Resource Conservation and Recovery Act) Contingency Plan on March 1 following an unplanned release of chromic acid to the plant's sanitary waste water treatment system and to holding ponds in the plant's buffer zone.

None of the chromic acid has been released offsite and there is no health risk to the public.

Rocky Flats personnel are continuing extensive sampling and evaluating any potential impacts to the environment. An investigation also is under way to pinpoint the source of the chromic acid and determine the precise circumstances surrounding the unplanned release.

State of Colorado and Environmental Protection Agency (EPA) officials were notified of the unplanned release, including the EPA's Emergency Response Center.

The RCRA Contingency Plan was implemented to assess and mitigate any potential environmental impacts and prevent future impacts which could result from future releases.

Results of initial samples taken following the unplanned release have been reported to the Colorado Department of Health and EPA. Those agencies will continue to be informed of the results of later samples and any corrective actions that might be taken.

(more)

A preliminary investigation indicates that the chromic acid--used in certain plating operations at Rocky Flats--may have been released from Building 444 late last month. Chromic acid is considered a hazardous substance under EPA regulations.

The material was first detected at the plant's sanitary waste water treatment plant. Water treated in the sanitary waste system is eventually discharged to a series of holding ponds on plantsite before it is spray irrigated on native grasses in the plant's buffer zone.

Extensive water and soil samples have been taken and analyzed for chromium. Water samples taken from the holding ponds in early March were at or below EPA drinking water standards. Initial soil samples collected where the water was spray irrigated were all below 1 ppm (parts per million). These levels do not indicate any imminent threat to public health or the environment.

Additional information will be available following completion of the investigation.

The Rocky Flats Plant, owned by the U.S. Department of Energy and operated by Rockwell International, produces nuclear and non-nuclear components for the nation's defense program.

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Rocky Mountain News Sun., March 12, 1989, Denver, Colo.

Toxic substance leaks into Flats water

Acid-laced liquid stays on plant site

By KATIE KERWIN
Rocky Mountain News Staff Writer

Potentially dangerous levels of a toxic substance leaked into the water treatment system at Rocky Flats nuclear weapons plant last month, and the polluted water was used for irrigation on plant property, officials said yesterday.

After a worker discovered a green liquid that looked like antifreeze at the sewage treatment plant Feb. 23, Rocky Flats officials tested the substance and found that it was chromic acid.

The poisonous liquid drained into the water system after an overflow system failed in Building 444, where the acid was used for chrome plating, said Ed Heintz, a spokesman for the nuclear weapons facility.

Officials are investigating human error and equipment failure as possible causes for the spill. From the sewage treatment plant, high concentrations of chromic acid drained into two ponds, B3 and B5. Water from these ponds was used to spray fields to the north and south of the ponds on the east side of the Flats property.

The spill "indicates that there was an operational problem that had the potential for impacting a water supply. It is a serious concern that this could happen and it indicates that there should be changes in procedures," said Fred Dowsett, a hazardous-waste enforcement official with the Colorado Department of Health.

Flats officials notifed local officials, the Environmental Protection Agency and the Colorado Department of Health on March 1, once they identified the acid.

Initial tests showed that the water flowing into the ponds contained 13 parts per million chromic acid — well over the drinking water standard of 0.05 parts per million. Later, samples of the pond water taken about the first of March had decreased to 0.08 and 0.19 parts per million, and the most recent sample dipped below safe levels, Dowsett said.

"The key thing is that we have determined at this point that there is no danger to the public health. ... Whatever there is out there, whatever spilled, is contained on the plant site and is not any danger to the public. There's no danger of it leaving the site," Heintz said.

Dowsett agreed that the spill did not threaten communities off the plant site, but said it could have been dangerous if the contaminated water had been released into nearby creeks, as Flats officials frequently do.

The health department will review soil and water tests conducted by Flats officials to see whether chromic acid seeped into the ground water after being sprayed onto the fields, he said.

"There will probably be some elevated levels (of chromic acid) in the areas where it was sprayed," Dowsett predicted. "This is something that will have to be continually watched and monitored to see that there aren't any environmental problems or releases (of water off the plant) from those areas," Dowsett said.

The chrome plating operation has been shut down until investigators discover how the leak occurred, Heintz said. Officials haven't determined how long the leak had been going on when it was discovered.

"There was some delay in reporting (the spill). It took a few days before anyone got a handle on what happened. It's hard to tell (why) ... we have an alarm system, but we can't tell if it did not go off. We're trying to re-create the incident to determine how it could have happened to prevent it in the future," Heintz said.

Rocky Flats' toxic spray investigated

Officials fear the spill may taint area water

By JANET DAY
Rocky Mountain News Environmental Writer

Rocky Flats nuclear weapons plant could face stiff fines for spilling a toxic chemical into the plant's sewage system and then spraying the tainted water on surrounding fields.

"The investigation is just starting. We need to find out more information before we decide if there's a violation" of state hazardous waste laws, said Patty Corbetta of the Colorado Department of Health. "It shows that there are some bad operating procedures that need changing out there. They found this waste and went ahead and sprayed even before they had the analyses back."

Chromic acid, including hexavalent chromium — a highly toxic metal used in plating operations — overflowed from a holding tank into the plant's water treatment system Feb. 23. Later, it was sprayed onto fields, the common practice for disposing of treated wastewater.

The facility's treatment plant is not designed to treat high levels of toxic metals. After some spraying had occurred, officials found high levels of chromium in wastewater to be sprayed. Spraying has since been stopped, officials said.

Health officials are awaiting the results of soil analyses, but tests of the water showed levels of chromium far greater than the state health-protection standard.

"We had two inspectors out last week for follow-up investigations. We've also been on the phone with the facility to find out exactly what happened," Corbetta said. "Now we're waiting for results of soil analyses."

Initial soil analyses conducted by plant officials showed readings far below the health standard, said Pat Etchart, plant spokesman.

"We're continuing extensive sampling and evaluating the effects on the environment," Etchart said. "We plan to assess and mitigate the environmental consequences."

The spill and spraying pose no public health danger and no employees were exposed to dangerous levels, officials said.

But the mistake could cause problems for nearby water supplies.

"There's definitely an environmental threat — Woman Creek may be in danger," said Nat Miullo of the Environmental Protection Agency. Woman Creek feeds Standley Lake, the water supply for several cities in the northwest suburban area.

Some of the spraying occured in an area that drains into Woman Creek.

Rocky Flats tests its treated water only for a limited number of pollutants. EPA officials who are reviewing the facility's discharge permit may increase the monitoring requirements, Miullo said.

"This is the kind of incident that leads to questions about who's on first, where are the people who should have caught this, how is it this happened?" said Melinda Kassen, a member of the governor's Rocky Flats environmental monitoring committee.

Rocky Flats manufactures plutonium triggers for the nation's nuclear weapons. No radioactive contamination was found in the sprayed wastewater.

■ Radioactive blocks of waste on way to Nevada from Flats/23

3 pages for
Terry Healy – Bldg. 150

THE DENVER POST

Tuesday, March 14, 1989

4B

Toxic-acid overflow at Flats raises concerns

By Alan Gottlieb
Denver Post Staff Writer

A leak of a toxic, carcinogenic substance into the waste-water system at the Rocky Flats nuclear weapons plant raises serious concerns about plant operations, state and federal officials said Monday.

Although health officials said the leak poses no public health threat, they said it is possible minute quantities of the chromic acid could end up in Standley Lake and Great Western Reservoir, which supply drinking water to Broomfield, Westminster, Northglenn and Thornton.

And they questioned why neither the Colorado Department of Health nor the federal Environmental Protection Agency were notified of the spill until Feb. 28, five days after it was discovered.

Plant officials said they held off on notification because they weren't sure what had leaked, or where the leak had originated.

A worker at the plant found a green substance in water at the waste treatment plant Feb. 23. Tests revealed the substance was chromic acid, used in plating operations at the facility.

According to Fred Dowsett, of the state health department, the leak apparently resulted from a night shift worker forgetting to shut off a faucet in a laboratory in Building 444. A vat containing the acid overflowed, the liquid poured down drains, into the sewer system and from there into two retention ponds just east of the plant.

"There need to be changes made at the plant to make sure something like this doesn't happen again," Dowsett said.

Plant officials were puzzled Monday that the overflowing tank didn't trigger an alarm. Ed Heintz, spokesman for plant contractor Rockwell International, said the alarm system appears to be functioning properly. "It's possible it could have been shut off at the time."

Some of the contaminated water subsequently was sprayed onto irrigation fields south and east of the main plant site. Dowsett said he is concerned some of the chromic acid could have leached through the soil into groundwater.

But according to plant officials, soil samples taken from the fields show minute amounts of chromic acid in the soil.

Even if chromic acid is found in the two reservoirs, it will be in such low concentrations that it will pose no health hazard, according to Suzanne Wuerthele, an EPA toxicologist. Although initial readings of water flowing to the plant's retention ponds showed levels of chromic acid far above drinking water standards, those levels had dropped below the standard by the weekend.

Also, once chromic acid mixes with water, it usually breaks down into a far less toxic form, Wuerthele said.

Tues., March 14, 1989, Denver, Colo. Rocky Mountain News—7

Rocky Flats' toxic spray investigated

Officials fear the spill may taint area water

By JANET DAY
Rocky Mountain News Environmental Writer

Rocky Flats nuclear weapons plant could face stiff fines for spilling a toxic chemical into the plant's sewage system and then spraying the tainted water on surrounding fields.

"The investigation is just starting. We need to find out more information before we decide if there's a violation" of state hazardous waste laws, said Patty Corbetta of the Colorado Department of Health. "It shows that there are some bad operating procedures that need changing out there. They found this waste and went ahead and sprayed even before they had the analyses back."

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Initial soil analyses conducted by plant officials showed readings far below the health standard, said Pat Etchart, plant spokesman.

"We're continuing extensive sampling and evaluating the effects on the environment," Etchart said. "We plan to assess and mitigate the environmental consequences."

The spill and spraying pose no public health danger and no employees were exposed to dangerous levels, officials said.

But the mistake could cause problems for nearby water supplies.

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"This is the kind of incident that leads to questions about who's on first, where are the people who should have caught this, how is it this happened?" said Melinda Kassen, a member of the governor's Rocky Flats environmental monitoring committee.

Rocky Flats manufactures plutonium triggers for the nation's nuclear weapons. No radioactive contamination was found in the sprayed wastewater.

■ Radioactive blocks of waste on way to Nevada from Flats/23

Flats leak no danger, official says

Toxic acid contamination not expected to reach Broomfield's water

Daily Camera
WEDNESDAY
March 15, 1989

By BILL SCANLON
Camera Staff Writer

Water contaminated with 100 gallons of highly toxic chromic acid from Rocky Flats apparently won't reach Broomfield's drinking water, but state health officials say they are investigating the plant and it may lead to stiff fines.

A faucet, left running overnight Feb. 22-23, pushed 100 gallons of chromic acid past two containment vessels and into the drain pipes leading to the sanitary water treatment plant at Rocky Flats, eight miles south of Boulder.

First tests at the treatment plant measured 13 parts per million of chromium, well above the .05 parts per million standard for drinking water.

Subsequent readings of pond water detected .18 ppm and .08 ppm. Most recent readings dipped below safe levels, said Colorado Department of Health hazardous waste specialist Patty Corbetta.

No radioactive contamination was found in the sprayed wastewater, officials said. The chromic acid was of the toxic hexavalent chromium variety and used in plating operations in Building 444.

"From the initial sampling, there appears to be no health risk to the public," said Rocky Flats spokesman Pat Etchart. "Any sort of unplanned release is of concern. But it is all contained at the plant site."

The sanitary plant is supposed to purify the water to meet municipal drinking standards. But the plant's filters weren't prepared to deal with the unexpected chromic acid, said Corbetta. About 4½ gallons of the 100 gallons of acid made it past the treatment process.

The treated water sits in holding ponds because releasing it into nearby streams is illegal. Routinely, it is sprayed onto nearby fields where it may sift into the groundwater.

But Rocky Flats workers sprayed from a holding pond even *after* they knew it contained the toxic acid, said Corbetta.

"They noticed the release and sprayed the solution before they received the analysis back," said Cor-

(See LEAK, Page 2C)

(From Page 1C)

betta. "That's not a good practice."

"It shows that there are some bad operating procedures that need changing out there," she said.

But Etchart said permits from the Environmental Protection Agency and the National Pollution Discharge Elimination System mandate that water remain on site, leaving spraying as the only way to ease the overflow.

Some of the acid sprayed from pond B3 made its way to pond B5, which usually picks up only rain and snow runoff. When snowfall is heavy, Rocky Flats officials can get special permission from the state and Broomfield to release some of that water into Walnut Creek.

Walnut Creek feeds Great Western Reservoir which supplies drinking water to Broomfield homes.

No water from pond B5 has been released recently.

Some of the acid still might make it into the ground water, after which it will be hard to detect its route. "There's definitely an environmental threat — Woman Creek may be in danger," said Nat Miullo of the EPA. Woman Creek feeds Standley Lake, the water supply for several cities in northwest metropolitan Denver.

"We're continuing extensive sampling and evaluating the effects on the environment," said Etchart. "We plan to assess and mitigate the environmental consequences."

No health risk reported

Golden Transcript
Thursday, March 16, 1989

Rocky Flats chromic acid overflow raises questions

by Jacque Scott
Transcript writer

A carcinogen — chromic acid — was accidentally permitted to flow into the Rocky Flats sanitary treatment plant when a tank in Building 444 overflowed late last month.

The spill is causing Environmental Protection Agency and Colorado Health Department officials to question whether the "unplanned release" of the hazardous material indicates "operational problems" at the facility.

They stress, however, that the incident does not appear to pose any health risk to the public.

The chromic acid was passed through the treatment facility into a settling pond, according to Rocky Flats spokesman Pat Etchart Tuesday. And water from the pond was used to "spray-irrigate" on site.

The spill caused the nuclear weapons plant located north of Golden to implement a Resource Conservation and Recovery Act contingency plan on March 1.

None of the chromic acid has been released off site and there reportedly is no health risk to the public, Etchart said.

Even Tuesday's high winds reportedly would not have caused a public health risk by blowing any contaminated soil off site, said Patty Corbetta of the state health department. "It could blow some soil but in the

Continued on Page 3

Spill

present concentration it would not be an immediate health risk," she said.

The concern expressed by Corbetta and Nat Miullo, Rocky Flats project coordinator for the EPA in Denver, is that the spill occurred at all.

"We are not very concerned about the low amount. It will definitely have an environmental impact on site, which will have to be dealt with. The biggest concern, however, is that it could occur in the first place," Miullo said Tuesday.

"We don't know if it was human error or equipment failure. We don't know if someone forgot to turn the valve off or the high level alarm did not go off. Someone may have turned the alarm off," Miullo said.

The matter is being investigated and reports are being forwarded to the state health department, which also has biweekly inspectors on site and is expecting soil samples from Rocky Flats by the end of the week.

Corbetta also said she was informed that the Department of Energy reportedly will conduct an internal investigation to see if Rockwell International, which runs the plant for the DOE, handled the situation properly.

According to Etchart, official notification of the spill was issued Feb. 28.

He said a tank overflowed and the chromic acid solution got into the sanitary treatment plant. Some was passed into the settling pond identified as B3, one of a series of settling ponds on site.

Rocky Flats is not allowed to release from B3, but it does use the water for spray irrigation. "We did spray," Etchart said, and apparently as a result of the spraying some of the contamination was detected in pond B5, which is the last in the series of ponds and is basically used as a 100-year flood collection pond.

The contamination in B5 is particularly serious because discharge sometimes is permitted from that pond, which feeds into the Great Western Reservoir, one of the sources of drinking water for the Broomfield community.

"Water was not released from there," Etchart stressed.

The amount of contamination in the ponds was "elevated" with some below EPA standards and some "slightly above," Etchart said.

Options were being evaluated early this week, he said, but no method of cleanup was indicated as yet.

The initial release of the chromic acid from Building 444 was caused when a plating bath tank overflowed. Current estimates are that between four and five pounds of chromium may have been released through the sanitary treatment plant.

Changes in the plumbing already have been made, according to Corbetta, to prevent any future overflow from spilling into the sanitary treatment plant.

Initial soil samples collected where the water was sprayed were all less than 0.1 parts per million. According to EPA protocol, materials containing 5 ppm of chromium are considered a hazardous waste.

"The fact that it occurred has raised and heightened awareness of some potential problems at the facility," concluded Miullo. "We are very positive it is not a public health risk. But we are concerned about plant operation."

"I think this is one isolated instance," Corbetta said. "But it seems to indicate some operational problems as far as hazardous waste goes. It can be corrected. And we've been told it may already have been corrected."

MAR 17 '89 10:06 ROCKWELL COMMUNICATION 966-4255 P.2

Energy Department team to check Flats acid spill

By Alan Gottlieb
Denver Post Staff Writer

The federal Energy Department has dispatched an investigative team to the Rocky Flats nuclear weapons plant to determine how chromic acid was allowed to spill into the facility's sewer system and later be sprayed onto fallow fields.

The team will remain at the plant, 16 miles northwest of Denver, for an undetermined length of time, "gathering data, evaluating the problem and making recommendations," said Anna Bachicha, an Energy Department spokeswoman in Albuquerque.

Also, Rep. David Skaggs, a Boulder Democrat, issued a statement Wednesday saying he was "deeply concerned" that plant management had allowed such a mishap to occur. "While the plant is working to improve its health, environment and safety programs, this incident is a reminder that a lot remains to be done."

State health department and federal Environmental Protection Agency officials stressed Wednesday that soil and water tests have shown that the spill has remained on the plant site, and that levels of chromic acid are too low to pose any public health hazard.

At higher levels the acid, also known as hexavalent chromium, is toxic and carcinogenic, especially when inhaled.

The spill apparently occurred Feb. 22 or 23. A worker noticed a green substance in the wastewater system Feb. 23. Officials later discovered that a vat containing chromic acid had overflowed, probably because a faucet was left on at the end of a night shift.

The acid solution washed down drains and into the sewer system. From there, it was released into two retention ponds, from where it was sprayed on the fields.

State and EPA officials weren't notified of the accident for five days. Rockwell International, the Energy Department's contractor, held off on notification until the type and source of the spill were determined.

Both Skaggs and Miullo said they were unhappy about the delay in notification.

THE DENVER POST Page 2B Thursday, March 23, 1989

Flats officials failed to tell safety group of leak

By Alan Gottlieb
Denver Post Staff Writer

Officials at Rocky Flats nuclear weapons plant failed to inform a federal nuclear safety committee about a potentially dangerous chemical spill that occurred at the plant a week before the panel held hearings in Denver on March 1.

The committee chairman said Wednesday that he didn't learn of the spill until a Denver citizens' group called him last week.

"I'm surprised that it wasn't mentioned while we were in Denver, because obviously environmental concerns with the plant are major issues, which need to be aired and discussed," said John Ahearne, head of the Advisory Committee on Nuclear Facility Safety.

Chromic acid, a carcinogenic and toxic chemical, overflowed from a vat Feb. 22, spilling into the plant's wastewater treatment system. From there, it was diverted into holding ponds and spray-irrigated onto fallow fields. None of the chemical left plant boundaries.

Ahearne's committee met in Denver to hear presentations on Rocky Flats safety. The year-old, 14-member panel, which is appointed by and reports to the Energy Department secretary, is charged with looking into a wide range of safety issues at the nation's problem-plagued weapons plants.

But during lengthy presentations by Energy Department plant manager Earl Whiteman and contractor Rockwell International president Dominick Sanchini, the spill was not mentioned.

On March 1, the day of the hearings, Rockwell notified the Colorado Department of Health and the federal Environmental Protection Agency of the spill. Notification was delayed for several days because Rockwell officials weren't sure what chemical had leaked or in what quantity.

"It was stupid on our part not to tell the committee," admitted Rockwell spokesman Ed Heintz. But he said it was not a deliberate omission.

Energy Department spokeswoman Anna Bachicha said the committee wasn't told of the leak because the investigation still was in its early stages, and the Energy Department lacked sufficient information on what had happened.

Whatever the reason, Ahearne found the omission troubling. "As was obvious from the hearings and from some criticisms we've heard in the past, there is legitimate concern about plant contractors reporting incidents in a timely fashion. The communication of problems seems to be a lot slower than one would like."

Wed., March 29, 1989, Denver, Colo., Rocky Mountain News—15

Flats spill violated no laws, but may spur tighter rules

By JANET DAY
News Environmental Writer

A chemical spill last month at the Rocky Flats nuclear weapons plant violated no state hazardous-waste laws, but could prompt stricter regulation of the plant, environmental officials said last night.

Nearly a week elapsed between the Feb. 22 spill and notification of state and federal health agencies, but officials with those agencies told the Rocky Flats Monitoring Council that plant officials acted as promptly as they could.

Hexavalent chromium, a highly toxic metal, spilled out of a rinse tank when a workman left a hose running all night. The tank overflowed, as did several barrier systems, causing diluted amounts of the metal to seep under the building, into a sump and then into the sewage system.

Plant officials didn't immediately link the overflowing tank with the sewage system problems because they initially thought the spill had been contained in the building. Plant officials have yet to find the leak where the chromium-tainted water seeped beneath the building into the sump pump.

"There was no violation of hazardous-waste laws when you put in perspective the sequence of events," said Fred Dowsett of the Colorado Department of Health. "Something got into their system, and they tried to back-track to the cause of the problem. Putting events together took some time."

Hazardous-waste laws require notification of state officials within 24 hours of a toxic spill.

Officials with the Environmental Protection Agency will be tightening criteria for wastewater permits as a result of the spill, said Nat Miullo of the agency's Denver office.

The day after the spill, before the chromium was identified, the wastewater was sprayed onto a field surrounding the plant. The remaining tainted water is being stored in a pond.

Flats tests missed spill of toxic acid

By BILL SCANLON
Camera Staff Writer

WESTMINSTER — When the Rocky Flats cafeteria serves guacamole, the water flowing to the plant's sanitary treatment facility turns greenish.

So, when water treatment operators saw a greenish tint to the water late last month, they did the routine tests, but didn't jump to the conclusion that it was a dangerous toxic spill, a plant spokesman told the Rocky Flats Environmental Monitoring Council on Tuesday night.

It was dangerous, though — approximately 30 pounds of highly toxic chromic acid, about 4 1/2 pounds of which made its way to holding ponds and to nearby fields. For a while, Broomfield officials feared for the safety of their drinking water because those holding ponds sometimes are released into Walnut Creek, which flows into Great Western Reservoir.

A careless employee in Building 444 left water flowing in a tank containing the acid overnight Feb. 22-23. When he returned in the morning, some 2,000 gallons of water had overflowed the tank and a containment safety tank and had flooded the floor, which had a seemingly waterproof concrete berm perimeter. But some of the water leaked through undetected holes in the concrete and into drain pipes that service the sanitary water treatment plant, said Terry Healy, Rocky Flats nuclear weapons plant spokesman.

The plant is about eight miles south of Boulder.

The spill was cleaned up and the manager of the chromic acid lab never told his supervisor. So for five days no one at the plant made the connection between the greenish water and the chromic acid spill.

A series of tests finally made that connection — at 4

(See FLATS, Page 11A)

(From Page 1A)

p.m. Feb. 28. Rocky Flats officials informed the Colorado Department of Health the next day and the Environmental Protection Agency the day after that. But they didn't tell a national blue ribbon safety monitoring panel that happened to be touring the plant on March 1.

EPA and state Health Department officials Tuesday night told Monitoring Council members that Rocky Flats officials reported the incident soon enough — considering that they didn't know what they had until Feb. 28.

And the health officials said the chromic acid is so diluted by now that it cannot harm the public. As it flowed into the treatment facility, it had one reading as high as 13 parts per million. It's now at less than .05 parts per million — the standard beyond which there can be adverse health effects if someone drank two liters of the contaminated water every day for 70 years.

But some Monitoring Council members believe Rocky Flats needs better communication about even seemingly contained spills. And they believe that Rocky Flats once again harmed its credibility with the public by being less than forthright about the accident.

"We had to bring up that chromic acid is a carcinogen," said Council member Niels Schonbeck, a chemist. "No, I don't think this is going to have a health impact. But you don't want to be blase about any kind of environmental release."

Healy acknowledged that there ought to be a better alarm system at the plant to alert supervisors to hoses left on overnight. And he said there ought to be a better reporting system so that the whole plant knows about a spill that overflows two tanks.

In the days since the spill, Rocky Flats has installed a liner in the concrete berm, has refitted pipe so the waste from Building 444 goes to the process waste plant instead of the wastewater plant and is considering lining all the plant's berms with plastic.

Health study of Flats' neighbors waste of money, says DU biologist

By Pat McGraw
Denver Post Staff Writer

It would be a waste of money to study Rocky Flat's impact on the health of its neighbors, a biologist who has monitored workers there for a decade said Tuesday.

Bill Brandom, a University of Denver specialist in chromosomes, said employees of the nuclear weapons plant are proper subjects of additional inquiry about their work and their health.

But to extend such scrutiny to developing residential areas around the plant 16 miles northwest of Denver would be "scientifically unsound" and create more anxiety than it's worth, Brandom told a Regis College audience Tuesday.

Brandom was a member of a panel in one of the first sessions of the college's fourth annual Forum on the Nuclear Age under way through Thursday.

Because of limits on research funding available, inquiries should focus on Rocky Flats' 20,000 workers, he said. He also said a worker at the plant, which manufactures nuclear bomb triggers, is reassigned from "hot" areas after his plutonium level reaches about 40,000 times that normally encountered in the general population. Given medical evidence already generated, the Rocky Flats standards are "pretty close to where they should be," he maintained.

Ken Lichtenstein, a physician at Rose Medical Center and a member of Physicians for Social Responsibility, said he agreed with Brandom about research priorities, but he also noted a variety of flaws in studies of residents of areas near nuclear plants.

"Half of the studies say there is no more cancer" among residents, and the other half say there is, Lichtenstein said. And studies of nuclear workers typically address only deaths, not cases in which the worker survives with a chronic work-related disease, he noted.

The forum will reconvene in the college's Science Amphitheater at 3:30 p.m. today and Thursday. Sessions are free and public.

EPA may toughen testing of water discharges

By Alan Gottlieb
Denver Post Staff Writer

WESTMINSTER — The federal Environmental Protection Agency is considering stricter monitoring of water discharges at the Rocky Flats nuclear weapons plant.

The plant's permit under the Clean Water Act expires later this year, and EPA officials want to test for a wider range of toxic chemicals and radioactive materials, according to agency official Nat Miullo.

Miullo told the Rocky Flats Environmental Monitoring Council Tuesday that a recent spill of chromic acid at the plant, while not a public health threat, "precipitates a need to tighten controls."

He said that the agency could double to about 20 the number of materials monitored.

Also, water can be tested at the point of discharge from the plant's waste-water treatment system instead of from retention ponds. That would allow the agency to gauge more accurately the quantities of chemicals being released, Miullo said.

Council members criticized plant management for failing to identify the material as chromic acid more quickly after the Feb. 22 spill. It took investigators five days to determine the nature of the spill.

Council member George Fedoronko, deputy mayor of Arvada, questioned why officials failed to connect an acid spill in a production building with the subsequent appearance of a green liquid in the treatment system.

Terry Healy, who is heading up plant contractor Rockwell International's investigation of the incident, acknowledged that the connection wasn't made until a laboratory test revealed that the substance was chromic acid.

to: Terry Healy

Flats seeks solution to tainted water

Plant must drain pond without polluting reservoir

By MARLYS DURAN
Rocky Mountain News Staff Writer

Rocky Flats officials are looking for a way to empty chromium-tainted water from a retention pond without polluting a reservoir that supplies Broomfield's drinking water, a spokesman for the plant said yesterday.

Broomfield officials have demanded that water in the pond not be released into Great Western Reservoir, even though the amount of chromium has dropped to a level considered safe by the Environmental Protection Agency.

The pond, on the east side of the Rocky Flats site, became contaminated in late February after chromic acid, including hexavalent chromium — a highly toxic metal used in plating operations — overflowed from a holding tank into the plant's wastewater treatment system.

"Even if you have diluted the chromium to get it below drinking-water standards, it remains above historical standards," City Manager George Di Ciero said in a letter to Rocky Flats officials last month.

"To preserve public confidence in the drinking-water supply, every effort must be taken to be sure that the reservoir remains above suspicion," the letter said.

The reservoir, at West 112th Avenue and Alkire Street in Jefferson County, is east of Rocky Flats, which manufactures triggers for nuclear weapons.

Broomfield spokeswoman Rosann Doran said no chromium has turned up in Great Western reservoir.

Flats spokesman Patrick Etchart said plant engineers "are going to cooperate with Broomfield."

Water that collects in the pond is released periodically into Walnut Creek, which flows into the reservoir, so that the pond remains low enough to catch and hold runoff water from major rainstorms, Etchart said.

But water hasn't been released since chromium was found in the pond, and the pond now is about half full, he said.

"We're approaching the spring rain season. We want to reach a resolution to this issue," he said.

One option being considered is a suggestion by Broomfield officials that the tainted water be pumped north to Upper Church Creek, which would dump it into a retention lake at the Jefferson County Airport.

Broomfield fights release from Flats ponds into reservoir

Saturday, April 8, 1989

By Alan Goldfish
Denver Post Staff Writer

Broomfield officials don't want any more water released into the city's reservoir from retention ponds at the Rocky Flats nuclear weapons plant.

A February accident at the plant in which a small quantity of chromic acid — a toxic, carcinogenic chemical — spilled into the Rocky Flats wastewater treatment system and from there into holding ponds has raised concerns from Broomfield officials.

Rocky Flats occasionally releases water from its retention ponds into north Walnut Creek. The water flows from there into Great Western Reservoir, Broomfield's main source of drinking water.

Even when the chromic acid problem is resolved, Broomfield doesn't want Rocky Flats water in the reservoir, city spokeswoman Roseann Doran stressed. "City council's position is that we don't want anything ever released again from Rocky Flats into Great Western Reservoir."

Since the acid spill, engineers at Rocky Flats have not released any water from holding pond B-5, the outermost in a series of retention pools. Small quantities of chromic acid have been detected in that pond, but those levels are below federal drinking water limits.

But the pond now is holding 12 million gallons, about half its capacity, and engineers want to release some water soon.

According to Ed Heintz, a spokesman for Rockwell International, the Rocky Flats contractor, water is trapped in pond B-5 by an earthen dam. While plant engineers say the situation isn't dangerous, "they don't like it to get as full as it is now, because earthen dams have a higher rate of failure than other types."

Broomfield officials, worried that the recent incident might shake public confidence in drinking water supplies, have told the plant to send its wastewater elsewhere.

Engineers at Rocky Flats are studying the possibility of diverting water from the pond into Upper Church Ditch, which would take it into Upper Church Lake, located on the grounds of Jefferson County Airport.

Heintz said this option requires further study, and that the plant would have to buy piping and pumps.

"There are also questions of which bureaucracies would be involved in granting permission to do this," he said.

All this will take time. And plant officials worry that spring run-off will cause the pond to fill up even more while the current situation is debated.

TO: Terry Rhea

Flats pumps tainted water to private site

Jeffco airport pond to get 12 million gallons

By JANET DAY
News Environmental Writer

Officials of the Rocky Flats nuclear weapons plant yesterday began pumping 12 million gallons of contaminated wastewater into a private pond at the Jefferson County airport rather than dump it into Great Western Reservoir.

A spill in late February tainted the plant's wastewater with toxic chromium. Some of the water was used to irrigate nearby fields before the contamination was identified; the rest was stored in a pond at the weapons plant.

Water from the pond is routinely discharged into Great Western, but Broomfield officials objected to the chromium-laced water. Great Western provides the majority of the city's drinking water.

The water now contains levels of chromium considered safe by federal officials.

"This is a perceived problem rather than a real environmental problem," said Nat Miullo of the Environmental Protection Agency. "We're seeing chrome levels at far below drinking-water standards.

"The water could have been released into Broomfield's drinking-water sources without any health impacts, but since Broomfield does not choose to accept the water, Rocky Flats has accommodated their wishes," Miullo said.

Nearly 5,000 feet of 6-inch pipe will carry the water to Upper Church Creek, which drains into a pond at the airport, where the water will stay until it is used for irrigation and dust control, or simply evaporates.

Draining the pond is expected to take up to four weeks, said Pat Etchart, plant spokesman. Pumping started yesterday, but the water isn't likely to reach the airport pond until today.

Jeff Kraft
Communications
Bldg. 111

Flats diverting tainted water

By BILL SCANLON
Camera Staff Writer

The Rocky Flats nuclear weapons plant on Monday began diverting water containing minute traces of chromic acid around Great Western Reservoir, source of Broomfield's drinking water.

The water is safe, say Rocky Flats officials. But plant health officers and Broomfield officials agreed to divert the water to allay public concerns.

The water is being pumped through a pipe to Upper Church Ditch along the plant's northern boundary. That ditch flows into a pond at the Jefferson County Airport that is not used for anything, said Rocky Flats spokesman Dennis Hurtt.

The diversion will be complete in three or four weeks.

On Feb. 22, a Rocky Flats employee forgot to turn off the water flowing into a tank containing about 30 pounds of the acid. The toxic water overflowed several safety vessels and made its way to the sanitary water treatment plant, say plant spokesmen.

From there, it was treated and discharged into Pond B-3. That water was spray-irrigated onto nearby fields — the only way to keep the pond from overflowing.

Some of that water made its way to Pond B-5, which regularly is released into a creek that flows to Great Western Reservoir.

But water hadn't been released from B-5 since the occurrence, say plant officials.

Tests show that the traces of acid mixed with the 14 million gallons of water in B-5 add up to .02 parts of chromium per million, below the federal drinking water standards of .05 chromium per million.

Critics lambasted Rocky Flats for taking six days to make the connection between the overflowed tank and the contaminated water and for allowing the spill to work its way to the main sewage lines.

Since the spill, Rocky Flats employees have refitted pipe so waste from Building 444 goes to the process waste plant, not the sanitary wastewater plant. Supervisors have been told to report even minor spills to the top managers.

Rocky Flats-Broomfield Water
KCNC, Channel 4, Denver
10pm
4/5/89

Bob Palmer, anchor: News 4 has learned that Broomfield officials are worried about the future quality of their water supply because of a chromic acid leak at Rocky Flats more than a month ago. Luann Akin learned of this story tonight and she joins us now from the newsroom. Luann, what exactly do we know?

Akin: A rather complicated story, Bob. That chromic acid spill was in a building at Rocky Flats back on February 22nd. Now, some of the acid got into Rocky Flats' own waste water system. It was treated and released into a holding pond. Water from that pond is routinely spray irrigated onto the grasslands around Rocky Flats. And it's side effects of that irrigation that have led to Broomfield's concern. Some of that runoff has gotten into another holding pond that frequently feeds Great Western reservoir. That's Broomfield's primary water supply. Now, Broomfield has ordered Rocky Flats to suspend those routine releases of water because of the higher than normal levels of chromic acid. The State Health Department talked to us tonight. They say the chromic acid levels in that holding pond are right at the EPA's limits. A Rocky Flats official told us the levels are below EPA limits. Broomfield officials say either way, those chromic acid levels are well above normal and they don't like it. Rocky Flats is withholding releases from that holding pond, but they say they don't want to put too much strain on an earthen dam that keeps the water in the pond back. So both sides are looking at it, both sides are working on a solution. Rocky Flats is considering some of its options at this point, but as yet, we don't know what those options will be. Bob?

Palmer: Okay, thank you Luann. Now, we don't want to worry anyone in Broomfield. There's nothing wrong with the water there at this time.

Akin: Absolutely. Only a concern at this point and both sides are looking hard at the situation.

(end)

RESPONSE TO INQUIRY

COPIES TO: D. Sanchini
A. Whiteman
P. Currier
J. McNett
B. Wozniak
G. Ideker
W. Weston
C. Bader
D. Ferrera
G. Meyers
J. Erfurdt
E. Heintz

ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT

ROCKWELL APPROVAL_____
DOE APPROVAL_____

THE FOLLOWING INFORMATION SHOULD BE USED AS A GUIDELINE WHEN ANSWERING MEDIA OR PUBLIC INQUIRIES. REFER ALL INQUIRIES TO COMMUNICATIONS -- x2882.

SUBJECT: Pond B-5 Diversion (Chromic Acid) DATE: April 21, 1989

RESPONSE:

The City of Broomfield and the Rocky Flats Plant have agreed on a plan to divert water from a holding pond at Rocky Flats so that it does not flow into Great Western Reservoir.

The water, which meets Environmental Protection Agency (EPA) drinking water standards, will be diverted to another retention pond located at the Jefferson County Airport.

The approximately 14 million gallons of water in Pond B-5, a 100-year flood control pond in the plant's buffer zone, has been extensively sampled by Rocky Flats personnel, and by the City of Broomfield and the Colorado Department of Health. The sampling confirmed that the water in the pond meets EPA drinking water standards and does not pose any risk to public health.

The extensive sampling was initiated following an unplanned release on plantsite of chromic acid, used in plating operations at Rocky Flats. A preliminary investigation indicated that the chromic acid was released from Building 444 in late February (Feb. 22-23) when a plating bath tank overflowed.

Some of the material entered the plant's sanitary treatment system. Water treated in the sanitary treatment plant is eventually discharged to a holding pond on plantsite before it is spray irrigated on native grasses in the plant's buffer zone. Current estimates are that approximately 30 pounds of chromium entered the sanitary treatment plant, and that approximately 5 pounds of the material was released to Pond B-3.

The water is spray irrigated from Pond B-3 per requirements of an EPA National Pollutant Discharge Elimination System (NPDES) permit. Some run-off from the spray irrigation entered Pond B-5, where early sampling indicated the presence of chromium at levels near EPA drinking water standards. (It is estimated that a maximum of 2 pounds of chromium reached Pond B-5.)

(more)

Pond B-5 Diversion (Chromic Acid)--Page 2

Since the unplanned release, extensive water and soil sampling has been conducted in the holding ponds and on soils which were spray irrigated. Leachable chromium concentrations in the soils were less than 0.1 ppm (parts per million) and do not indicate any environmental impact. Recent water samples from the holding ponds are in the range of 0.02 ppm or less, well below EPA drinking water standards of 0.05 ppm.

Following the unplanned release of chromic acid, investigations were initiated. Appropriate regulatory agencies also were notified and given preliminary reports, including the Colorado Department of Health, the EPA, and the EPA's National Response Center.

Various options and treatment alternatives were reviewed and evaluated before it was decided to divert the water to the airport pond. The water will be pumped from Pond B-5 to the Upper Church Ditch, which flows into the airport pond. The diversion is expected to begin on (April 24) and will take approximately three to four weeks to complete.

The release of water from Pond B-5 was considered prudent because adequate capacity must be maintained in the pond to collect run-off for sampling, and to contain a 100-year flood. Water in the pond had not been released since Jan. 31-Feb. 2 and spring run-off was contributing to elevated water levels in the pond. (NOTE: Pond B-5, an earthen dam constructed in 1980, was never intended for long-term retention of water, but only as a flood-control dam to hold water for a short period of time.)

Additional information concerning the precise circumstances surrounding the unplanned release of the chromic acid--and appropriate corrective actions to prevent a recurrence--will be provided when the current investigations are completed.

IF ASKED: Several options were considered before it was decided to divert the water around Great Western. Among those were additional treatment of the water. Additional treatment of the water was not considered technically feasible within available timeframes, particularly considering that the water currently meets federal drinking water standards. Although the water could have been released to Great Western without any health impact, Rocky Flats wanted to honor Broomfield's request that the water not be discharged to the reservoir.

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ROCKWELL INTERNATIONAL
ROCKY FLATS PLANT

- The Rocky Flats Plant has reached agreement with the City of Broomfield on a plan to divert water from a holding pond at Rocky Flats around Great Western Reservoir.

- The water, which meets Environmental Protection Agency (EPA) drinking water standards, will be diverted to another pond located at the Jefferson County Airport.

- The approximately 14 million gallons of water in Pond B-5 has been extensively sampled by plant personnel, by the City of Broomfield, and the Colorado Department of Health (CDH). The sampling confirmed that the water in the pond meets EPA drinking water standards and does not pose any risk to public health.

- Water has been in Pond B-5 since a chromic acid solution, used in plating operations at Rocky Flats, was inadvertently released February 22-23 from Building 444 when a plating bath tank overflowed.

  - Some of the chromic acid solution entered the Sanitary Treatment Plant where it was treated and discharged to another holding pond, Pond B-3. Water in Pond B-3 is spray irrigated on native grasses in the plant's buffer zone per requirements of an EPA National Pollutant Discharge Elimination System permit. Some run-off from the spray irrigation activities was collected in Pond B-5.

  - As a result, the plant initiated an extensive sampling program to determine concentrations of chromium in soil and water. Soil samples collected where the water was spray irrigated indicated leachable chromium concentrations less than 0.1 ppm (parts per million). This level does not indicate any threat to public health or the environment.

  - Recent water samples taken from Pond B-5 indicate chromium concentrations in the range of 0.02 ppm, well below federal drinking water standards of 0.05 ppm.

- The City of Broomfield has requested that Rocky Flats divert the water around Great Western Reservoir. Plant and city personnel worked closely to evaluate the possible options before agreeing to divert the water to the airport holding pond. The water will be pumped from Pond B-5 to the Upper Church Ditch, which flows into the airport pond.

- The diversion began April 24 and will take approximately three to four weeks to complete.

- Appropriate regulatory agencies have been notified and agreed to the diversion. Among those were CDH, EPA, the Jefferson County Airport Authority, and the Denver Water Board.

APPENDIX C

Soil and Water Samples

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM SAMPLES
STATUS (4/30/89)
WATERS

SAMPLE ID	SAMPLE DATE		RESULTS mg/l	
995 EFF	2-20-89			
995 INF	2-28-89			
B-3	3-01-89	2 samples	0.008 - 0.12	Hex. Cr
B-3 EFF	3-01-89		0.19	
B-3 W	3-01-89		0.13	
B-5 EFF	3-01-89		0.07	
B-5 W	3-01-89		0.08	
C-2 EFF	3-01-89		0.06	
C-2 W	3-01-89		<0.05	
N SPRAY FIELD 2	3-01-89		<0.05	
N SPRAY FIELD 1	3-01-89		0.08	
S SPRAY FIELD	3-01-89		<0.05	
C-2 EFF	3-01-89		<0.02	Hex. Cr
SPRAY IRRIG. FIELDS	3-01-89	3 samples	0.04 - 0.07	Hex. Cr.
995 EFF	3-02-89			
995 EFF	3-03-89			
STORM DRAIN PIT	3-03-89		11	
B-4 INF	3-06-89		0.010	
B-5 INF	3-06-89		0.027	
B-5 SED	3-06-89		12 ug/g	
B-5	3-06-89	2 samples	0.06 + 0.07	Hex. Cr.
B-3	3-06-89		0.029	
A-5 INF	3-06-89		0.22	
A-4 INF	3-06-89		<0.010	
995-EFF	3-07-89			
995-EFF	3-08-89			
B5 NORTH	3-09-89			
B5 SOUTH	3-09-89			
B5 WEST	3-09-89			
B5 DAM N	3-09-89			
B5 DAM S	3-09-89			
C1 POND	3-09-89		0.010	
C2 POND	3-09-89		0.010	
INTERLAND FILL	3-09-89			
STORM DRAIN EAST OF LAND FILL	3-09-89			
444 SUMP	3-09-89			

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE		RESULTS mg/l		
444 SUMP	3-09-89				
B5 NORTH	3-09-89				
N SPRAY	3-09-89				
995-EFF	3-09-89				
444 FOUNDATION DRAIN	3-09-89				
995-EFF	3-10-89		<0.010		
C2 POND W	3-10-89		0.010	R	
C2 POND E	3-10-89		<0.010	R	
B5 POND W	3-10-89		0.024	R	
B5 POND WEST SED	3-10-89				
B5 POND SOUTH SED	3-10-89				
B5 POND S	3-10-89		0.044	R	
B5 POND N	3-10-89		0.050	R	
B5 DAM S	3-10-89		0.048	R	
WALNUT & INDIANA	3-10-89		0.010	R	
B5 NORTH DAM	3-10-89		0.060	R	
444 FOUNDATION DRAIN	3-10-89				
B-5	3-10-89	5 samples	0.03 - 0.07	Hex. Cr	
C-1	3-10-89		<0.010	Hex. Cr	
C-2 East	3-10-89	2 samples	0.03 - 0.07	Hex. Cr	
A-3 I	3-10-89		<0.010	Hex. Cr	
995-E	3-10-89		<0.010	Hex. Cr	
WALNUT & INDIANA	3-10-89		<0.010	Hex. Cr	
C1 POND	3-10-89				
A-3	3-10-89		<0.010		
A-3 INF	3-10-89		<0.01	Hex. Cr.	
B5 NORTH	3-11-89		0.038		
B5 NORTH	3-12-89		0.050		
995 E COMP	3-13-89		<0.010		
995 EFF	3-13-89		0.016		
B5 DAM S	3-13-89		0.051		
B5 DAM N	3-13-89		0.043		
B5 WEST	3-13-89		0.027		
B5 SOUTH	3-13-89		0.034		
995 EFF	3-13-89				
WALNUT & INDIANA	3-13-89		<0.010		
444 FOUND	3-13-89		7.0		
B5 WEST 1	3-14-89		1.13	STD	
B5 WEST 2	3-14-89		0.030		
B5 WEST 3	3-14-89		<0.010	FB	
B5 SOUTH 1	3-14-89		0.070	STD	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
B5 SOUTH 2	3-14-89	0.028	
B5 NORTH 1	3-14-89	0.226	STD
B5 NORTH 2	3-14-89	0.035	
B5 DAM N	3-14-89	0.030	
B5 DAM S	3-14-89	0.031	
444 FOUND	3-14-89	6.6	
995 EFF	3-15-89	0.016	
B5 COMP 1	3-15-89	<0.010	FB
B5 COMP 2	3-15-89	0.035	
444 DRAINS	3-15-89	7.4	
C-2	3-16-89	<0.010	
WOMAN & INDIANA	3-16-89	<0.010	
A-3	3-16-89	0.011	
A-4	3-16-89	<0.010	
B-5	3-16-89	0.032	
444 DRAINS	3-16-89	9.0	
995 EFF	3-16-89	0.010	
124 RAW	3-17-89	<0.010	
A4 POND	3-17-89	<0.010	
B5 POND	3-17-89	<0.010	FB
B5 DAM	3-17-89	0.026	
B5 NORTH	3-17-89	0.031	
B3 POND	3-17-89	<0.010	
C2 DAM	3-17-89	<0.010	
C2 WEST	3-17-89	<0.010	
WOMAN & INDIANA	3-17-89	<0.010	
995 E	3-17-89	<0.010	
444 DRAIN	3-17-89	8.0	
A-4	3-18-89	<0.010	
B-3	3-18-89	0.014	
C-2 DAM	3-18-89	<0.010	
C-2 W	3-18-89	0.012	
B-5 DAM	3-18-89	0.032	
B-5 N	3-18-89	0.025	
B-5 W	3-18-89	<0.010	FB
WOMAN & INDIANA	3-18-89	<0.010	
A-4	3-19-89	<0.010	
B-3	3-19-89	<0.010	
B-5	3-19-89	<0.010	FB
B-5 N	3-19-89	0.032	
B-5 DAM	3-19-89	0.028	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
C-2 DAM	3-19-89	<0.010	
C-2 W	3-19-89	<0.010	
WOMAN & INDIANA	3-19-89	<0.010	
A-4	3-20-89	<0.010	
B-3	3-20-89	<0.010	
B-5	3-20-89	<0.010	FB
B-5 N	3-20-89	0.032	
B-5 DAM	3-20-89	0.030	
C-2 DAM	3-20-89	0.014	
C-2 W	3-20-89	<0.010	
WOMAN & INDIANA	3-20-89	<0.010	
B-5 PROFILE 1	3-20-89	<0.010	FB
B-5 PROFILE 2	3-20-89	0.024	
B-5 PROFILE 3	3-20-89	0.032	
B-5 PROFILE 4	3-20-89	0.037	
B-5 PROFILE 5	3-20-89	0.027	
B-5 PROFILE 6	3-20-89	0.028	
B-5 PROFILE 7	3-20-89	0.032	
B-5 PROFILE 8	3-20-89	<0.010	FB
B-5 PROFILE 9	3-20-89	0.024	
B-5 PROFILE 10	3-20-89	0.039	
B-5 PROFILE 11	3-20-89	0.040	
995 E COMP	3-20-89	0.011	
995 E	3-20-89	<0.010	
A-4	3-21-89	0.015	
B-3	3-21-89	<0.010	
B-5	3-21-89	<0.010	FB
B-5 DAM	3-21-89	0.026	
B-5 N	3-21-89	0.031	
C-2 DAM	3-21-89	0.010	
C-2 W	3-21-89	0.011	
WOMAN & INDIANA	3-21-89	<0.010	
124 RAW	3-21-89	0.015	
995 E	3-21-89	<0.010	
Westminster Split:			
C-2 BLANK	3-21-89	<0.010	FB
C-2 DAM	3-21-89	<0.010	
C-2 INF	3-21-89	<0.010	
444 DRAIN	3-21-89	5.0	
A-4	3-22-89	<0.010	
B-3	3-22-89	<0.010	
B-5	3-22-89	<0.010	FB
B-5 DAM	3-22-89	0.027	
B-5 N	3-22-89	0.026	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
C-2 DAM	3-22-89	<0.010	
C-2 W	3-22-89	<0.010	
WOMAN & INDIANA	3-22-89	<0.010	
995 E	3-22-89	<0.010	
B-5 DAM	3-22-89	0.010	Hex. Cr
A-4	3-23-89	<0.010	
B-3	3-23-89	<0.010	
B-5	3-23-89	<0.010	FB
B-5 DAM	3-23-89	0.025	
B-5 N	3-23-89	0.024	
C-2 DAM	3-23-89	<0.010	
C-2 W	3-23-89	<0.010	
WOMAN & INDIANA	3-23-89	<0.010	
995 E	3-23-89	<0.010	
A-4	3-24-89	<0.010	
B-3	3-24-89	<0.010	
B-5	3-24-89	<0.010	FB
B-5 DAM	3-24-89	0.021	
B-5 N	3-24-89	0.025	
C-2 DAM	3-24-89	<0.010	
C-2 W	3-24-89	<0.010	
WOMAN & INDIANA	3-24-89	<0.010	
A-4	3-25-89	0.011	
B-3	3-25-89	<0.010	
B-5	3-25-89	<0.010	FB
B-5 DAM	3-25-89	0.024	
B-5 N	3-25-89	0.017	
C-2 DAM	3-25-89	<0.010	
C-2 W	3-25-89	<0.010	
WOMAN & INDIANA	3-25-89	<0.010	
995E Comp.	3-25-89 / 3-26-89	<0.010	
A-4	3-26-89	<0.010	
B-3	3-26-89	<0.010	
B-5	3-26-89	<0.010	FB
B-5 DAM	3-26-89	0.027	
B-5 N	3-26-89	0.023	
C-2 DAM	3-26-89	<0.010	
C-2 W	3-26-89	<0.010	
WOMAN & INDIANA	3-26-89	<0.010	
A-4	3-27-89	<0.010	
B-3	3-27-89	<0.010	
B-5	3-27-89	<0.010	FB

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
B-5 DAM	3-27-89	0.023	
C-2 DAM	3-27-89	0.022	
C-2 W	3-27-89	<0.010	
WOMAN & INDIANA	3-27-89	<0.010	
995E	3-27-89	<0.010	
444 DRAIN	3-27-89	5.3	
A-4	3-28-89	<0.010	
B-3	3-28-89	<0.010	
B-5	3-28-89	<0.010	FB
B-5 DAM	3-28-89	0.021	
B-5 N	3-28-89	0.022	
C-2 DAM	3-28-89	<0.010	
C-2 W	3-28-89	<0.010	
WOMAN & INDIANA	3-28-89	<0.010	
995E	3-28-89	<0.010	
444 DRAIN	3-28-89	6.0	
A-4	3-29-89	0.013	(duplicate <0.010)
B-3	3-29-89	<0.010	
B-5	3-29-89	<0.010	FB
B-5 DAM	3-29-89	0.020	
B-5 N	3-29-89	0.023	
C-2 DAM	3-29-89	<0.010	
C-2 W	3-29-89	<0.010	
WOMAN & INDIANA	3-29-89	0.025	- sample being rerun 3/31/89
WOMAN & INDIANA (rerun)	3-29-89	<0.010	
995E	3-29-89	<0.010	
444 DRAIN	3-29-89	6.6	
A-4	3-30-89	<0.010	
B-3	3-30-89	<0.010	
B-5	3-30-89	<0.010	FB
B-5 DAM	3-30-89	0.019	
B-5 N	3-30-89	0.017	
C-2	3-30-89	<0.010	
C-2 W	3-30-89	<0.010	
WOMAN CREEK	3-30-89	<0.010	
995E	3-30-89	<0.010	
B-5	3-30-89	<0.010	Hex. Cr
A-4	3-31-89	<0.010	
B-3	3-31-89	0.014	
B-5	3-31-89	<0.010	FB

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
B-5 DAM	3-31-89	0.026	
B-5 N	3-31-89	0.026	
C-2 DAM	3-31-89	0.011	
C-2 W	3-31-89	<0.010	
WOMAN CREEK	3-31-89	<0.010	
995E	3-31-89	<0.010	
A-4	4-01-89	<0.010	
B-5	4-01-89	<0.010	FB
B-5 DAM	4-01-89	0.026	
B-5 N	4-01-89	0.022	
C-2	4-01-89	<0.010	
WOMAN CREEK	4-01-89	<0.010	
995E Wkend comp.	4-01-89	<0.010	
A-4	4-02-89	<0.010	
B-5	4-02-89	<0.010	FB
B-5 DAM	4-02-89	0.021	
B-5 N	4-02-89	0.020	
C-2	4-02-89	<0.010	
WOMAN CREEK	4-02-89	<0.010	
A-4	4-03-89	<0.010	
B-5	4-03-89	<0.010	FB
B-5 DAM	4-03-89	0.026	
B-5 N	4-03-89	0.018	
C-2	4-03-89	<0.010	
WOMAN CREEK	4-03-89	<0.010	
995E	4-03-89	<0.010	
A-4	4-04-89	<0.010	
B-5	4-04-89	<0.010	FB
B-5 DAM	4-04-89	0.026	
B-5 N	4-04-89	0.018	
C-2	4-04-89	<0.010	
WOMAN CREEK	4-04-89	<0.010	
995E	4-04-89	<0.010	
A-4	4-05-89	<0.010	
B-5	4-05-89	<0.010	FB
B-5 DAM	4-05-89	0.020	
B-5 N	4-05-89	0.017	
C-2	4-05-89	sample w/next batch	
WOMAN CREEK	4-05-89	<0.010	
995E	4-05-89	<0.010	
C-2	4-05-89	<0.010	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
444 DRAIN	4-05-89	7.3	
444 DRAIN4-05-89	4-05-89	7.1	
A-4	4-06-89	<0.010	
B-5	4-06-89	<0.010	FB
B-5 DAM	4-06-89	0.016	
B-5 N	4-06-89	0.013	
C-2	4-06-89	<0.010	
WOMAN CREEK	4-06-89	<0.010	
995E	4-06-89	<0.010	
A-4	4-07-89	<0.010	
B-5	4-07-89	<0.010	FB
B-5 DAM	4-07-89	0.026*	
B-5 N	4-07-89	0.032*	
C-2	4-07-89	<0.010	
WOMAN CREEK	4-07-89	<0.010	
995E	4-07-89	<0.010	

* Samples had visually more debris and sediment than in previous days samples which may account for higher results.

A-4	4-08-89	<0.010	
B-5	4-08-89	<0.010	FB
B-5 DAM	4-08-89	0.020	
B-5 N	4-08-89	0.016	
C-2	4-08-89	<0.010	
WOMAN CREEK	4-08-89	<0.010	
995-E WKEND COMP	4-08/09-89	<0.010	
A-4	4-09-89	<0.010	
B-5	4-09-89	<0.010	FB
B-5 DAM	4-09-89	0.017	
B-5 N	4-09-89	0.017	
C-2	4-09-89	<0.010	
WOMAN CREEK	4-09-89	<0.010	
B-5 I	4-10-89	0.020	
A-4	4-10-89	<0.010	
B-5	4-10-89	<0.010	FB
B-5 DAM	4-10-89	0.018	
B-5 N	4-10-89	0.019	
C-2	4-10-89	<0.010	
WOMAN CREEK	4-10-89	<0.010	
995-E	4-10-89	<0.010	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
A-4	4-11-89	<0.010	
B-5	4-11-89	<0.010	FB
B-5 DAM	4-11-89	0.023	
B-5 N	4-11-89	0.021	
C-2	4-11-89	<0.010	
WOMAN CREEK	4-11-89	0.017	
DUP	4-11-89	0.012	
995-E	4-11-89	<0.010	
B-5	4-11-89	0.010	Hex. Cr
A-4 E	4-12-89	0.028	
B-5	4-12-89	0.019	FB
B-5 DAM	4-12-89	0.021	
B-5 N	4-12-89	0.021	
C-2	4-12-89	<0.010	
WOMAN CREEK	4-12-89	<0.010	
WALNUT & INDIANA	4-12-89	<0.010	
995-E	4-12-89	<0.010	
A-4 E	4-13-89	0.016	
B-5	4-13-89	<0.010	FB
B-5 DAM	4-13-89	0.020	
B-5 N	4-13-89	0.024	
C-2	4-13-89	0.015	
WOMAN CREEK	4-13-89	<0.010	
WALNUT & INDIANA	4-13-89	0.022	
995 EFF	4-13-89	<0.010	
A-4 E	4-14-89	<0.010	
B-5	4-14-89	<0.010	FB
B-5 DAM	4-14-89	0.032	
B-5 N	4-14-89	0.022	
C-2	4-14-89	<0.010	
WOMAN CREEK	4-14-89	<0.010	
WALNUT & INDIANA	4-14-89	0.017	
995 E	4-14-89	<0.010	
A-4 E	4-15-89	0.014	
B-5	4-15-89	<0.010	FB
B-5 DAM	4-15-89	0.019	
B-5 N	4-15-89	0.032	
C-2	4-15-89	<0.010	
WOMAN CREEK	4-15-89	<0.010	
WALNUT & INDIANA	4-15-89	0.040	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
A-4 E	4-16-89	0.014	
B-5	4-16-89	0.010	FB
B-5 DAM	4-16-89	0.016	
B-5 N	4-16-89	0.020	
WOMAN CREEK	4-16-89	0.010	
WALNUT & INDIANA	4-16-89	1.77 *	
C-2 E	4-16-89	0.012	
995 E WKEND COMP	4-15/16-89	<0.010	

* Sample had unknown flake; possibly from hood where sample prepared; sample is being redigested and rerun starting 4/19/89.

WALNUT & INDIANA	4-17-89	<0.010	R **
B-5	4-17-89	<0.010	FB
B-5 DAM	4-17-89	0.034	
B-5 N	4-17-89	0.025	
WOMAN CREEK	4-17-89	<0.010	
WALNUT & INDIANA	4-17-89	<0.010	
B-5 INF	4-17-89	0.014	
A-4 EFF	4-17-89	0.012	
C-2 EFF	4-17-89	0.010	
995 E	4-17-89	<0.010	

** Rerun of above sample of 4-16-89 date, (first result 1.77 mg/l Total Cr.)

A-4E	4-18-89	0.011	
B-5 DAM	4-18-89	0.020	
B-5 N	4-18-89	0.018	
B-5	4-18-89	<0.010	FB
WOMAN CREEK	4-18-89	0.011	
WALNUT & INDIANA	4-18-89	0.013	
C-2 E	4-18-89	<0.010	
B-5 DAM	4-19-89	0.020	
B-5 N	4-19-89	0.017	
B-5	4-19-89	0.011	FB
WOMAN CREEK	4-19-89	<0.010	
WALNUT & INDIANA	4-19-89	0.014	
995 E	4-19-89	<0.010	
C-2 E	4-19-89	<0.010	
B-5 DAM	4-20-89	0.017	
B-5 N	4-20-89	0.015	
B-5	4-20-89	<0.010	FB
WOMAN CREEK	4-20-89	<0.010	
995 E	4-20-89	<0.010	
C-2E	4-20-89	<0.010	

FB = Field Blank
Std = Standard
R = Rerun

TOTAL HEXAVALENT AND CHROMIUM RESULTS

SAMPLE ID	SAMPLE DATE	RESULTS mg/l	
995E	4-21-89	<0.010	
B-5 DAM	4-21-89	0.012	
B-5 N	4-21-89	0.013	
B-5	4-21-89	<0.010	FB
WOMAN CREEK	4-21-89	<0.010	
C-2E	4-21-89	<0.010	
B-5 DAM	4-22-89	0.016	
B-5 N	4-22-89	0.018	
B-5	4-22-89	<0.010	FB
WOMAN CREEK	4-22-89	<0.010	
995E Wkend comp.	4-22/23-89	<0.010	
B-5 DAM	4-23-89	0.015	
B-5 N	4-23-89	0.015	
B-5	4-23-89	<0.010	FB
WOMAN CREEK	4-23-89	<0.010	
B-5 I	4-24-89	0.018	
995E	4-24-89	<0.010	
B-5 1st Draw	4-24-89	0.017	
B-5 I	4-24-89	0.016	
Ditch at Boundary	4-24-89	0.016	
B-5 Discharge	4-24-89	0.016	
B-5 Discharge	4-25-89	0.016	
995E	4-25-89	<0.010	
B-5 Discharge	4-26-89	0.022	
995E	4-26-89	0.010	
dup. of 995E	4-26-89	<0.010	
B-5 Discharge	4-27-89	0.015	
995E	4-27-89	0.013	
B-5 Discharge	4-28-89	0.014	
995E	4-28-89	0.015	
Upper Church Lake	4-28-89	0.027	
B-5 Discharge	4-29-89	0.017	
B-5 Discharge	4-30-89	0.023	

EP TOXICITY TOTAL CHROMIUM
CONCENTRATIONS (MG/L) IN SOILS

Location	Sample Designation	Depth Below Ground Surface	Sample Date	Extract Concentration (mg/l)	Comments
Background					
	2	1"	03/09/89	0.019	
	5	6"	03/10/89	<0.010	
	15	1"	03/11/89	0.023	
	16	6"	03/11/89	0.020	
Slope South of Building 444					
	17	1"	03/13/89	0.014	
	18	6"	03/13/89	0.012	
	19	1"	03/13/89	<0.010	
	20	6"	03/13/89	0.011	
North Spray Field					
	13	1"	03/11/89	0.020	
	14	6"	03/11/89	0.036	
	1	1"	03/09/89	0.012	
	6	6"	03/10/89	<0.010	
	28	1"	03/15/89	0.013	
	30D	1"	03/15/89	<0.010	Field Duplicate
	29	6"	03/15/89	<0.010	
South Spray Field					
	11	1"	03/11/89	0.021	
	12	6"	03/11/89	0.033	

EP TOXICITY TOTAL CHROMIUM
CONCENTRATIONS (MG/L) IN SOILS (CONTINUED)

Location	Sample Designation	Depth Below Ground Surface	Sample Date	Extract Concentration (mg/l)	Comments
South Spray Field (continued)					
	9	1"	03/11/89	0.082	
	10	6"	03/11/89	0.018	
	3	1"	03/09/89	<0.010	
	7	6"	03/10/89	<0.010	
	4	1"	03/09/89	<0.010	
	8	6"	03/10/89	<0.010	
	31	1"	03/16/89	0.012	
	32	1"	03/16/89	Data Not Yet Available	
	33	1"	03/16/89	0.024	
	34	1"	03/16/89	0.014	
	34D	1"		0.012	Lab Duplicate
Slope North of South Spray Field					
	26	1"	03/15/89	<0.010	
	27	6"	03/15/89	0.013	
Slope South of South Spray Field					
	24	1"	03/15/89	0.013	
	25	6"	03/15/89	0.023	
	21	1"	03/15/89	0.029	
	23D	1"	03/15/89	0.019	Field Duplicate
	22	6"	03/15/89	0.018	

APPENDIX D

Medical Report

MEDICAL TOXICOLOGY PARTNERSHIP

A partnership consisting of Professional Corporations

Daniel T. Teitelbaum, M.D., P.C.
Daniel A. Goldstein, M.D., P.C.

726 E. 16th Avenue, Suite 302
Denver, Colorado 80203
(303) 894-0667
FAX (303) 830-8876

April 7, 1989

Dr. Joseph Fuhrman
Medical Director
Rocky Flats Plant
P.O. Box 464
Golden, CO 80402-0464

Dear Dr. Fuhrman:

We have now completed our assessment of the individuals whom you were kind enough to send to Accord Medical Centers for evaluation. These individuals were as follows: [redacted]

All of these individuals were interviewed and examined at Accord Medical Centers on March 20, 1989. As part of their workup, a history was obtained, a clinical examination performed, pulmonary function tests were carried out, and urine chromium excretion was determined.

The following were the results of the examination:

1) [redacted] Pulmonary function tests normal; chromium less than 1 mcg/L. The clinical examination revealed only an upper respiratory infection and no other abnormality.

2) [redacted] The clinical examination revealed bilateral staining of the feet above the sole and onto the instep with a yellow stain, quite characteristic of chromates. Other than the foot staining, no dermatitis was noted. No other abnormality was found. Pulmonary function tests were normal. Urine chromium was less than 1 mcg/L.

3) [redacted] On clinical examination, no abnormalities were found. The pulmonary function studies were normal. The urine chromium was less than 1 mcg/L.

4) [redacted] On clinical examination, the patient was found to have respiratory irritation. A chest x-ray

examination revealed prominent pulmonary tract outflow, consistent with pulmonary valvular stenosis. Pulmonary function tests were normal. Urine chromium was less than 1 mcg/L.

[redacted] No abnormalities were found on clinical examination. No laboratory tests were performed.

[redacted] There were no abnormalities on clinical examination. The pulmonary function tests were normal. Urine chromium result was less than 1 mcg/L.

[redacted] On clinical examination, chrome sores were found. Sensitization to chromates was suspected. Pulmonary function tests were normal. Urine chromium was less than 1 mcg/L.

[redacted] No significant findings were made on clinical examination. Pulmonary function tests were normal. Urine chromium was less than 1 mcg/L.

[redacted] Evidence of pulmonary irritation and irritation of the soles of the feet was found. The chest x-ray examination was normal. Pulmonary function tests were normal. Urine chromium was less than 1 mcg/L.

[redacted] No abnormalities are found on physical examination. Pulmonary function tests are normal. The urine chromium was not performed.

Based upon this set of physical examinations and laboratory work, it is my opinion that the workers referred to Accord Medical Centers did suffer short-term exposure to chromic acid when they walked through the chromic acid spill, or handled materials which came from that area. Fortunately, only two workers continue to show abnormality as a result of that exposure.

The history indicates that in addition to the exposure in February, there were at least two prior exposures which were of concern to the workers.

Because chromic acid and chromates are both sensitizers and carcinogens, this type of exposure may carry a significant risk for the future. Sensitization to chromates is particularly troublesome because of the widespread use of chromates in processes such as leather tanning and paper production. Thus, the opportunity for contact with chromates is widespread and sensitization can be very troublesome.

Because of the carcinogenic nature of chromic acid, every effort to avoid any further contact with this material on the part of these individuals is needed.

Thank you very much for referring this group of workers to Accord Medical Centers for evaluation.

Sincerely yours,

DANIEL THAU TEITELBAUM, M.D., P.C.
by

DANIEL T. TEITELBAUM, M.D.
PRESIDENT

/pj

cc: [redacted]

APPENDIX E

Summary of Corrective Action Plan

CHROMIC ACID INCIDENT
CORRECTIVE ACTION PLAN

TABLE OF CONTENTS

1.0 INTRODUCTION

2.0 SCOPE

3.0 BLDG. 444 PLATING OPERATIONS CORRECTIVE ACTIONS

3.1 Bldg. 444 Administrative Corrective Actions

3.1.1 Plating Operations Startup Checklist

3.1.2 Operational Safety Analysis

3.1.3 Foundry Operating Procedures

3.1.4 Alarm Response Procedure

3.1.5 Plating Operations Waste Transfer Procedure

3.1.6 Spill Reporting Training

3.1.7 Visually Secure Lab at End of Shift

3.1.8 Dual Management in Plating Lab

3.2 Bldg. 444 Facility Corrective Actions

3.2.1 Waste Tank Secondary Containment Repair

3.2.2 Leak Detection for Secondary Containment

3.2.3 Cross Connection of Cyanide and Acid Waste Tank Systems

3.2.4 Automatic Water Shutoff Valves

3.2.5 Plating Bath Level Control Repairs

3.2.6 Plating Operations Control Systems Repairs

3.2.7 Plating Operations Alarm Systems Repairs

3.2.8 Bldg. 444 Roof Repair

4.0 PLANTWIDE CORRECTIVE ACTIONS

4.1 Plantwide Administrative Corrective Actions

4.1.1 Notification to Employees Regarding Spill Reporting

4.1.2 Spill Reporting Procedures

4.1.3 Hazardous Chemical Training

4.1.4 Building Manager Training

4.1.5 Review of MWO Backlog for Safety-Related Work

4.1.6 Review of OSAs

4.1.7 Laboratory End-of-Shift Inspection

4.1.8 Manufacturing Technology Development Operating Procedures

4.1.9 Process Technology Development Operating Procedures

4.1.10 Analytical Screening for Sewage Treatment Plant

4.1.11 Retention Pond Contingency Action Plan

4.1.12 Spill Response Oversight

4.1.13 Plant Rule for Spill Avoidance & Reporting

4.2 Plantwide Facility Corrective Actions

4.2.1 General Operational Corrective Actions

4.2.1.1 Monitoring Critical Alarms

4.2.1.2 Reliable Level Sensors

4.2.2 Tank Systems Containing Hazardous Substances Corrective Actions

4.2.2.1 Preliminary Tank System Evaluation

4.2.2.2 Tank System Secondary Containment Procedure

4.2.2.3 Assessment of RCRA Permitted Tank Systems

4.2.2.4 Management Plan for Hazardous Substance Tank Systems

4.2.3 Sewage Treatment Plant (STP) Corrective Actions

4.2.3.1 Assessment of Hazardous Influents to STP

4.2.3.2 Detention Pond Dam Upgrades

4.2.3.3 STP Influent/Effluent Treatment/Diversion Evaluation

4.2.3.4 Real-Time Analysis at Sewage Treatment Plant

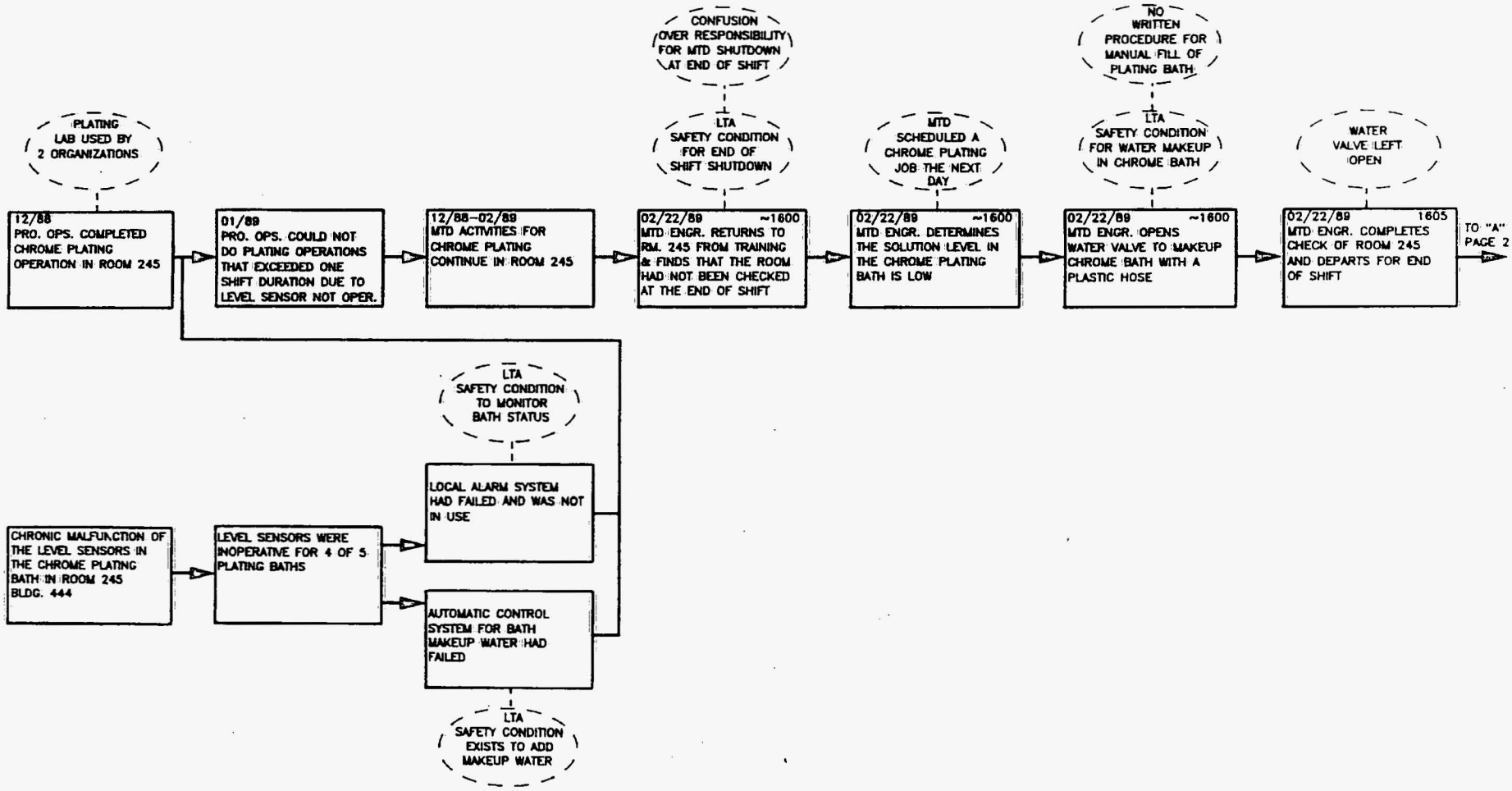
5.0 SUMMARY OF ROM COSTS FOR CORRECTIVE ACTIONS

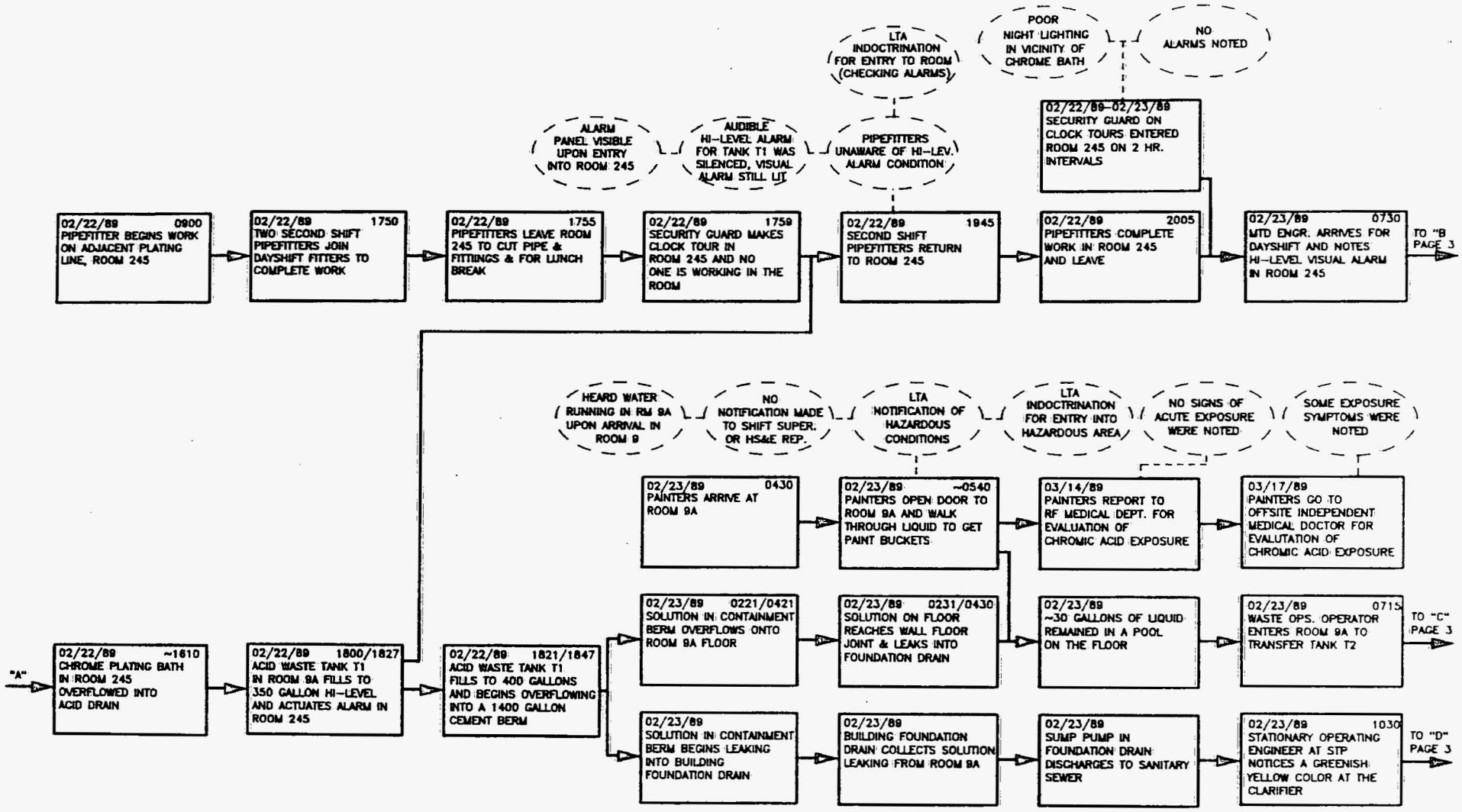
6.0 OVERALL SCHEDULES FOR CORRECTIVE ACTIONS

APPENDIX F

Events and Causal Factors Chart

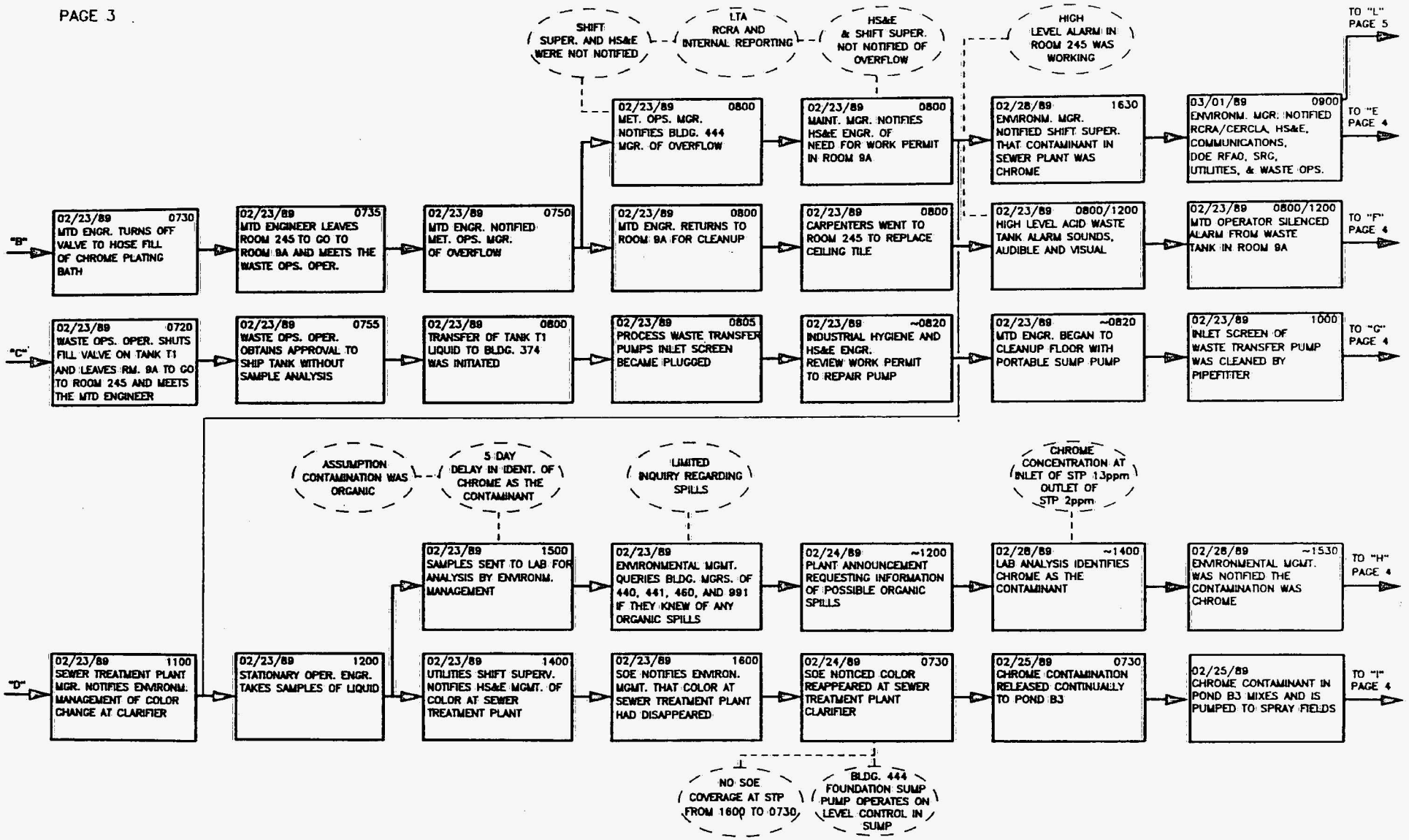
CHROMIC ACID INCIDENT
EVENTS & CAUSAL FACTORS CHART

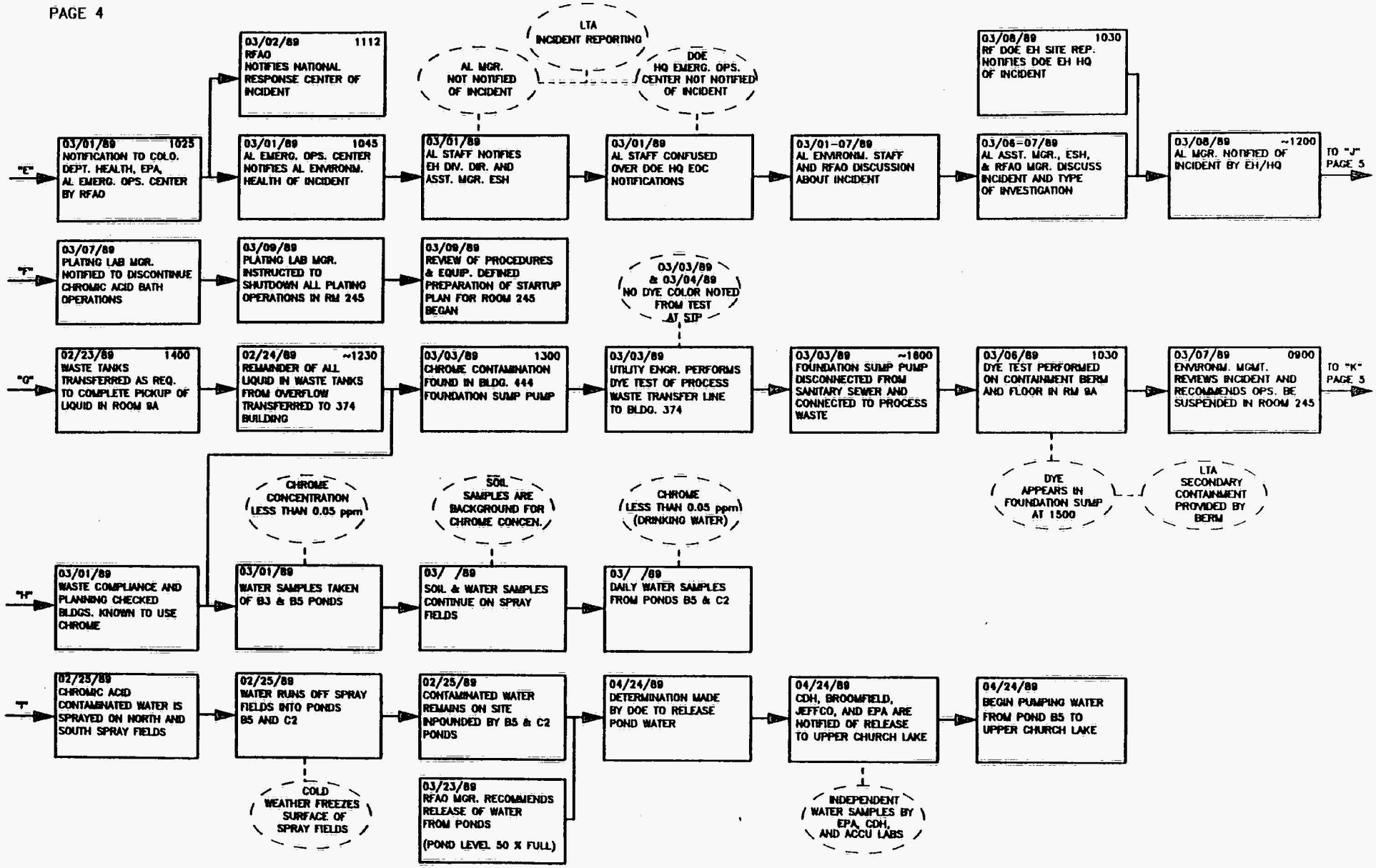



"A"
02/22/89 ~1610
CHROME PLATING BATH IN ROOM 245 OVERFLOWED INTO ACID DRAIN
02/22/89 0900
PIPEFITTER BEGINS WORK ON ADJACENT PLATING LINE, ROOM 245
02/22/89 1750
TWO SECOND SHIFT PIPEFITTERS JOIN DAYSHIFT FITTERS TO COMPLETE WORK
02/22/89 1755
PIPEFITTERS LEAVE ROOM 245 TO CUT PIPE & FITTINGS & FOR LUNCH BREAK
02/22/89 1759
SECURITY GUARD MAKES CLOCK TOUR IN ROOM 245 AND NO ONE IS WORKING IN THE ROOM
ALARM PANEL VISIBLE UPON ENTRY INTO ROOM 245
AUDIBLE HI-LEVEL ALARM FOR TANK T1 WAS SILENCED, VISUAL ALARM STILL LIT
LTA INDOCTRINATION FOR ENTRY TO ROOM (CHECKING ALARMS)
PIPEFITTERS UNAWARE OF HI-LEV. ALARM CONDITION
02/22/89 1945
SECOND SHIFT PIPEFITTERS RETURN TO ROOM 245
POOR NIGHT LIGHTING IN VICINITY OF CHROME BATH
NO ALARMS NOTED
02/22/89-02/23/89
SECURITY GUARD ON CLOCK TOURS ENTERED ROOM 245 ON 2 HR. INTERVALS
02/22/89 2005
PIPEFITTERS COMPLETE WORK IN ROOM 245 AND LEAVE
02/23/89 0730
MTD ENGR. ARRIVES FOR DAYSHIFT AND NOTES HI-LEVEL VISUAL ALARM IN ROOM 245
TO "B" PAGE 3
02/22/89 1800/1827
ACID WASTE TANK T1 IN ROOM 9A FILLS TO 350 GALLON HI-LEVEL AND ACTUATES ALARM IN ROOM 245
02/22/89 1821/1847
ACID WASTE TANK T1 FILLS TO 400 GALLONS AND BEGINS OVERFLOWING INTO A 1400 GALLON CEMENT BERM
02/23/89 0221/0421
SOLUTION IN CONTAINMENT BERM OVERFLOWS ONTO ROOM 9A FLOOR
02/23/89
SOLUTION IN CONTAINMENT BERM BEGINS LEAKING INTO BUILDING FOUNDATION DRAIN
02/23/89 0231/0430
SOLUTION ON FLOOR REACHES WALL FLOOR JOINT & LEAKS INTO FOUNDATION DRAIN
02/23/89
BUILDING FOUNDATION DRAIN COLLECTS SOLUTION LEAKING FROM ROOM 9A
02/23/89 0430
PAINTERS ARRIVE AT ROOM 9A
HEARD WATER RUNNING IN RM 9A UPON ARRIVAL IN ROOM 9
NO NOTIFICATION MADE TO SHIFT SUPER. OR HS&E REP.
02/23/89 ~0540
PAINTERS OPEN DOOR TO ROOM 9A AND WALK THROUGH LIQUID TO GET PAINT BUCKETS
LTA NOTIFICATION OF HAZARDOUS CONDITIONS
LTA INDOCTRINATION FOR ENTRY INTO HAZARDOUS AREA
02/23/89
~30 GALLONS OF LIQUID REMAINED IN A POOL ON THE FLOOR
02/23/89
SUMP PUMP IN FOUNDATION DRAIN DISCHARGES TO SANITARY SEWER
03/14/89
PAINTERS REPORT TO RF MEDICAL DEPT. FOR EVALUATION OF CHROMIC ACID EXPOSURE
NO SIGNS OF ACUTE EXPOSURE WERE NOTED
SOME EXPOSURE SYMPTOMS WERE NOTED
03/17/89
PAINTERS GO TO OFFSITE INDEPENDENT MEDICAL DOCTOR FOR EVALUATION OF CHROMIC ACID EXPOSURE
02/23/89 0715
WASTE OPS. OPERATOR ENTERS ROOM 9A TO TRANSFER TANK T2
TO "C" PAGE 3
02/23/89 1030
STATIONARY OPERATING ENGINEER AT STP NOTICES A GREENISH YELLOW COLOR AT THE CLARIFIER
TO "D" PAGE 3

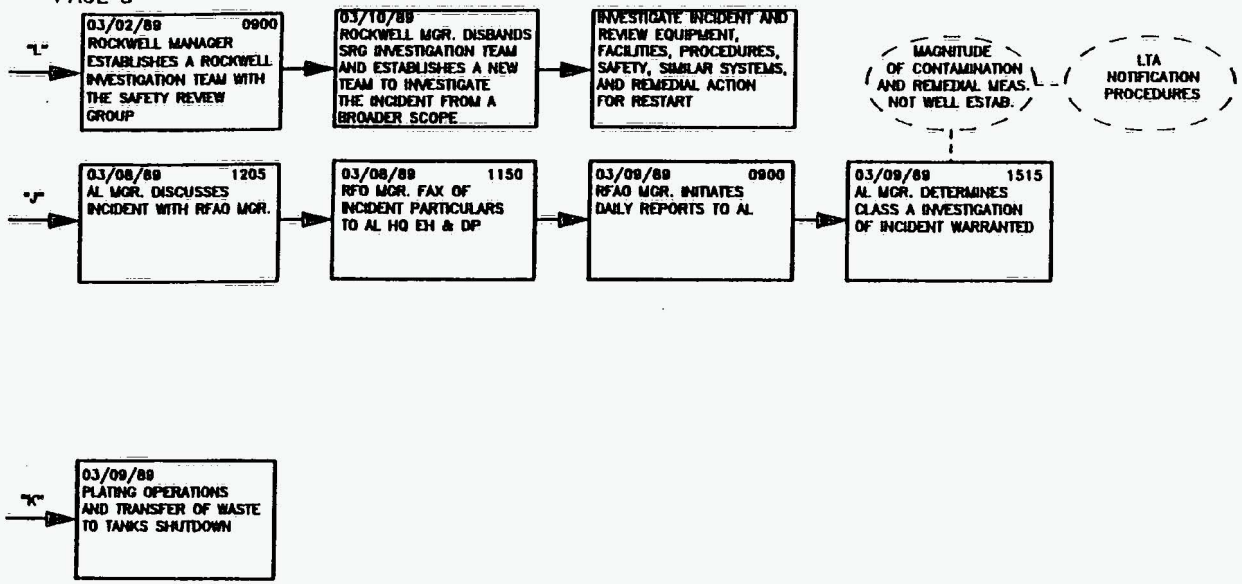
200

PAGE 3

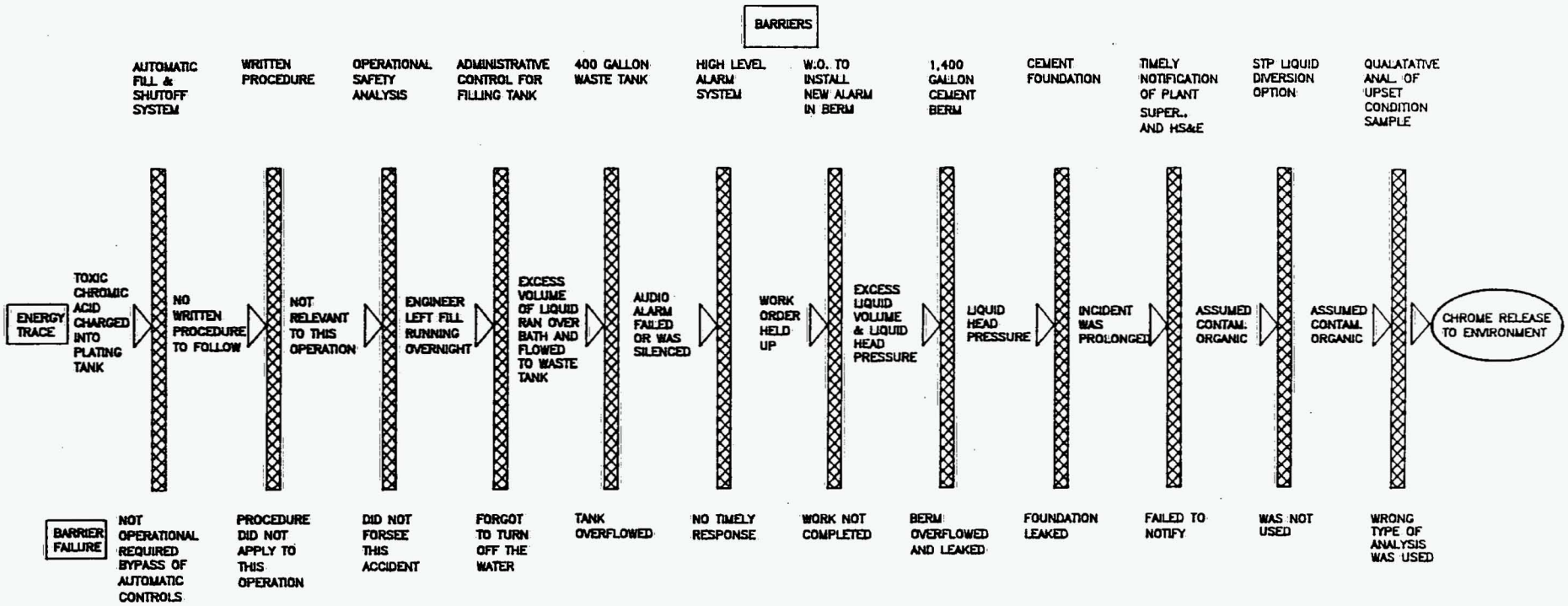

"B"
02/23/89 0730 MTD ENGR. TURNS OFF VALVE TO HOSE FILL OF CHROME PLATING BATH
02/23/89 0735 MTD ENGINEER LEAVES ROOM 245 TO GO TO ROOM 9A AND MEETS THE WASTE OPS. OPER.
02/23/89 0750 MTD ENGR. NOTIFIED MET. OPS. MGR. OF OVERFLOW
SHIFT SUPER. AND HS&E WERE NOT NOTIFIED
02/23/89 0800 MET. OPS. MGR. NOTIFIES BLDG. 444 MGR. OF OVERFLOW
LTA RCRA AND INTERNAL REPORTING
HS&E & SHIFT SUPER. NOT NOTIFIED OF OVERFLOW
02/23/89 0800 MAINT. MGR. NOTIFIES HS&E ENGR. OF NEED FOR WORK PERMIT IN ROOM 9A
HIGH LEVEL ALARM IN ROOM 245 WAS WORKING
02/28/89 1630 ENVIRONM. MGR. NOTIFIED SHIFT SUPER. THAT CONTAMINANT IN SEWER PLANT WAS CHROME
03/01/89 0900 ENVIRONM. MGR. NOTIFIED RCRA/CERCLA, HS&E, COMMUNICATIONS, DOE RFAO, SRG, UTILITIES, & WASTE OPS.
TO "L" PAGE 5
TO "E" PAGE 4
"C"
02/23/89 0720 WASTE OPS. OPER. SHUTS FILL VALVE ON TANK T1 AND LEAVES RM. 9A TO GO TO ROOM 245 AND MEETS THE MTD ENGINEER
02/23/89 0755 WASTE OPS. OPER. OBTAINS APPROVAL TO SHIP TANK WITHOUT SAMPLE ANALYSIS
02/23/89 0800 TRANSFER OF TANK T1 LIQUID TO BLDG. 374 WAS INITIATED
02/23/89 0800 MTD ENGR. RETURNS TO ROOM 9A FOR CLEANUP
02/23/89 0805 PROCESS WASTE TRANSFER PUMPS INLET SCREEN BECAME PLUGGED
02/23/89 0800 CARPENTERS WENT TO ROOM 245 TO REPLACE CEILING TILE
02/23/89 ~0820 INDUSTRIAL HYGIENE AND HS&E ENGR. REVIEW WORK PERMIT TO REPAIR PUMP
02/23/89 0800/1200 HIGH LEVEL ACID WASTE TANK ALARM SOUNDS, AUDIBLE AND VISUAL
02/23/89 0800/1200 MTD OPERATOR SILENCED ALARM FROM WASTE TANK IN ROOM 9A
TO "F" PAGE 4
02/23/89 ~0820 MTD ENGR. BEGAN TO CLEANUP FLOOR WITH PORTABLE SUMP PUMP
02/23/89 1000 INLET SCREEN OF WASTE TRANSFER PUMP WAS CLEANED BY PIPEFITTER
TO "G" PAGE 4
"D"
02/23/89 1100 SEWER TREATMENT PLANT MGR. NOTIFIES ENVIRONM. MANAGEMENT OF COLOR CHANGE AT CLARIFIER
02/23/89 1200 STATIONARY OPER. ENGR. TAKES SAMPLES OF LIQUID
ASSUMPTION CONTAMINATION WAS ORGANIC
5 DAY DELAY IN IDENT. OF CHROME AS THE CONTAMINANT
02/23/89 1500 SAMPLES SENT TO LAB FOR ANALYSIS BY ENVIRONM. MANAGEMENT
02/23/89 1400 UTILITIES SHIFT SUPERV. NOTIFIES HS&E MGMT. OF COLOR AT SEWER TREATMENT PLANT
LIMITED INQUIRY REGARDING SPILLS
02/23/89 ENVIRONMENTAL MGMT. QUERIES BLDG. MGRS. OF 440, 441, 460, AND 991 IF THEY KNEW OF ANY ORGANIC SPILLS
02/23/89 1600 SOE NOTIFIES ENVIRON. MGMT. THAT COLOR AT SEWER TREATMENT PLANT HAD DISAPPEARED
NO SOE COVERAGE AT STP FROM 1600 TO 0730
BLDG. 444 FOUNDATION SUMP PUMP OPERATES ON LEVEL CONTROL IN SUMP
02/24/89 ~1200 PLANT ANNOUNCEMENT REQUESTING INFORMATION OF POSSIBLE ORGANIC SPILLS
02/24/89 0730 SOE NOTICED COLOR REAPPEARED AT SEWER TREATMENT PLANT CLARIFIER
CHROME CONCENTRATION AT INLET OF STP 13ppm OUTLET OF STP 2ppm
02/28/89 ~1400 LAB ANALYSIS IDENTIFIES CHROME AS THE CONTAMINANT
02/25/89 0730 CHROME CONTAMINATION RELEASED CONTINUALLY TO POND B3
02/28/89 ~1530 ENVIRONMENTAL MGMT. WAS NOTIFIED THE CONTAMINATION WAS CHROME
TO "H" PAGE 4
02/25/89 CHROME CONTAMINANT IN POND B3 MIXES AND IS PUMPED TO SPRAY FIELDS
TO "I" PAGE 4


"E"
03/01/89 1025
NOTIFICATION TO COLO. DEPT. HEALTH, EPA, AL EMERG. OPS. CENTER BY RFAO
03/02/89 1112
RFAO NOTIFIES NATIONAL RESPONSE CENTER OF INCIDENT
03/01/89 1045
AL EMERG. OPS. CENTER NOTIFIES AL ENVIRONM. HEALTH OF INCIDENT
AL MGR. NOT NOTIFIED OF INCIDENT
LTA INCIDENT REPORTING
DOE HQ EMERG. OPS. CENTER NOT NOTIFIED OF INCIDENT
03/01/89
AL STAFF NOTIFIES EH DIV. DIR. AND ASST. MGR. ESH
03/01/89
AL STAFF CONFUSED OVER DOE HQ EOC NOTIFICATIONS
03/01-07/89
AL ENVIRONM. STAFF AND RFAO DISCUSSION ABOUT INCIDENT
03/06-07/89
AL ASST. MGR., ESH, & RFAO MGR. DISCUSS INCIDENT AND TYPE OF INVESTIGATION
03/08/89 1030
RF DOE EH SITE REP. NOTIFIES DOE EH HQ OF INCIDENT
03/08/89 ~1200
AL MGR. NOTIFIED OF INCIDENT BY EH/HQ
TO "J" PAGE 5
"F"
03/07/89
PLATING LAB MGR. NOTIFIED TO DISCONTINUE CHROMIC ACID BATH OPERATIONS
03/09/89
PLATING LAB MGR. INSTRUCTED TO SHUTDOWN ALL PLATING OPERATIONS IN RM 245
03/09/89
REVIEW OF PROCEDURES & EQUIP. DEFINED PREPARATION OF STARTUP PLAN FOR ROOM 245 BEGAN
"G"
02/23/89 1400
WASTE TANKS TRANSFERRED AS REQ. TO COMPLETE PICKUP OF LIQUID IN ROOM 9A
02/24/89 ~1230
REMAINDER OF ALL LIQUID IN WASTE TANKS FROM OVERFLOW TRANSFERRED TO 374 BUILDING
03/03/89 1300
CHROME CONTAMINATION FOUND IN BLDG. 444 FOUNDATION SUMP PUMP
03/03/89 & 03/04/89
NO DYE COLOR NOTED FROM TEST AT SIP
03/03/89
UTILITY ENGR. PERFORMS DYE TEST OF PROCESS WASTE TRANSFER LINE TO BLDG. 374
03/03/89 ~1800
FOUNDATION SUMP PUMP DISCONNECTED FROM SANITARY SEWER AND CONNECTED TO PROCESS WASTE
03/06/89 1030
DYE TEST PERFORMED ON CONTAINMENT BERM AND FLOOR IN RM 9A
DYE APPEARS IN FOUNDATION SUMP AT 1500
LTA SECONDARY CONTAINMENT PROVIDED BY BERM
03/07/89 0900
ENVIRONM. MGMT. REVIEWS INCIDENT AND RECOMMENDS OPS. BE SUSPENDED IN ROOM 245
TO "K" PAGE 5
"H"
03/01/89
WASTE COMPLIANCE AND PLANNING CHECKED BLDGS. KNOWN TO USE CHROME
CHROME CONCENTRATION LESS THAN 0.05 ppm
03/01/89
WATER SAMPLES TAKEN OF B3 & B5 PONDS
SOIL SAMPLES ARE BACKGROUND FOR CHROME CONCEN.
03/ /89
SOIL & WATER SAMPLES CONTINUE ON SPRAY FIELDS
CHROME LESS THAN 0.05 ppm (DRINKING WATER)
03/ /89
DAILY WATER SAMPLES FROM PONDS B5 & C2
"I"
02/25/89
CHROMIC ACID CONTAMINATED WATER IS SPRAYED ON NORTH AND SOUTH SPRAY FIELDS
02/25/89
WATER RUNS OFF SPRAY FIELDS INTO PONDS B5 AND C2
COLD WEATHER FREEZES SURFACE OF SPRAY FIELDS
02/25/89
CONTAMINATED WATER REMAINS ON SITE INPOUNDED BY B5 & C2 PONDS
03/23/89
RFAO MGR. RECOMMENDS RELEASE OF WATER FROM PONDS
(POND LEVEL 50 % FULL)
04/24/89
DETERMINATION MADE BY DOE TO RELEASE POND WATER
04/24/89
CDH, BROOMFIELD, JEFFCO, AND EPA ARE NOTIFIED OF RELEASE TO UPPER CHURCH LAKE
INDEPENDENT WATER SAMPLES BY EPA, CDH, AND ACCU LABS
04/24/89
BEGIN PUMPING WATER FROM POND B5 TO UPPER CHURCH LAKE

PAGE 5


"L"
03/02/89 0900
ROCKWELL MANAGER ESTABLISHES A ROCKWELL INVESTIGATION TEAM WITH THE SAFETY REVIEW GROUP
03/10/89
ROCKWELL MGR. DISBANDS SRG INVESTIGATION TEAM AND ESTABLISHES A NEW TEAM TO INVESTIGATE THE INCIDENT FROM A BROADER SCOPE
INVESTIGATE INCIDENT AND REVIEW EQUIPMENT, FACILITIES, PROCEDURES, SAFETY, SIMILAR SYSTEMS, AND REMEDIAL ACTION FOR RESTART
MAGNITUDE OF CONTAMINATION AND REMEDIAL MEAS. NOT WELL ESTAB.
LTA NOTIFICATION PROCEDURES
"J"
03/08/89 1205
AL MGR. DISCUSSES INCIDENT WITH RFAO MGR.
03/08/89 1150
RFO MGR. FAX OF INCIDENT PARTICULARS TO AL HQ EH & DP
03/09/89 0900
RFAO MGR. INITIATES DAILY REPORTS TO AL
03/09/89 1515
AL MGR. DETERMINES CLASS A INVESTIGATION OF INCIDENT WARRANTED
"K"
03/09/89
PLATING OPERATIONS AND TRANSFER OF WASTE TO TANKS SHUTDOWN

APPENDIX G

Energy Trace and Barrier Failure Analysis

CHROMIC ACID INCIDENT
ENERGY TRACE AND BARRIER FAILURE ANALYSIS