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Mr. John Kieling
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Dear Mr. Kieling:

Subject: Incident Involving Treatability Study Residues at Los Alamos National Laboratory (LANL) Chemistry and Metallurgy Research (CMR) Building, Technical Area 3

The purpose of this letter is to provide you with additional information regarding the subject incident that occurred at the CMR building on June 25, 1999. As I indicated in my August 4, 1999 letter to you, the University of California, the Department of Energy's management and operations contractor for LANL, was conducting an internal Type-B investigation of the glove box incident in its entirety. A copy of the final report is enclosed for your review.

Should you have any questions or require additional clarification, please contact me at (505) 665-5042 or Jack Ellvinger at (505) 667-0633.

Sincerely,

H. L. "Jody" Plum
Office of Environment

LAAME:3JP-126

Enclosure

cc
See page 2

TR

5592

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Chemistry and Metallurgy Research (CMR) Facility Room 4064 Glovebox Incident Investigative Report

Prepared by the

CMR Incident Investigation Team

Los Alamos National Laboratory

September 10, 1999

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CMR Incident Investigation Team Signatures

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Executive Summary

On June 25, 1999, a glovebox in the Wing 4 basement of the Chemistry and Metallurgy Research (CMR) facility overpressurized, bursting a glove and releasing high levels of technetium-99 (Tc-99) contaminants into Room 4064. Since Room 4064 was unoccupied at the time of the incident and Tc-99 poses only a minimal threat to health or the environment, the incident did not result in injuries, personal exposures/contaminations, or reportable releases. The principal impact of the incident consisted of the cleanup and decontamination efforts required to return Room 4064 to an operable condition.

On the day of the incident, Laboratory personnel were reducing the volume of approximately five liters of liquid waste by evaporation. The liquid waste was highly contaminated with Tc-99. The waste also contained water, ammonium ions, nitrates, hydrogen peroxide, sulfates, potassium, fluorides and small quantities of various metals. Resource Conservation and Recovery Act (RCRA) metals in excess of regulatory limits were also discovered after the incident. The evaporative process involved placing the five liters of liquid waste into three separate trays located on hotplates inside two gloveboxes. The liquids were then heated to approximately 80 degrees C, with the intention of reducing the liquid content to facilitate collection and disposal of the solid residues. The evaporative process was initiated on June 15, 1999; approximately 35 liters of similar waste had already been evaporated prior to the June 25 incident.

Evidence indicates that while the research team was out of the room taking a lunch break, a rapid but non-explosive reaction occurred in one of the gloveboxes. The high levels of ammonium nitrate present in the waste, aided by trace metals that could act as catalysts, apparently reacted and released large volumes of gas into the glovebox. The high level of gas, combined with impaired glovebox ventilation flow paths, resulted in a pressurized glovebox. The pressurization of the glovebox, combined with a fatigued glovebox glove, resulted in the rupture of the glove. Contamination was spread through the breached glove at the time of the incident and probably for several more hours before the hot plates were shut off.

Although the incident did not represent a serious threat to employee safety or the environment, the weaknesses identified during the investigation point to significant barriers to effective implementation of Integrated Safety Management—both at the CMR facility and the Laboratory. Principal concerns identified include:

1. Work performed outside of established review and approval processes.
2. Lack of adequate review and authorization prior to accepting work at the Laboratory.
3. Unreliable engineering and activity controls in the CMR Wing 4 basement.
4. Inability of personnel to remotely shut off equipment involved in hazardous operations.
5. Lack of work re-analysis (i.e., change control) when unanticipated hazards are identified during the conduct of work.
6. An assumption that controls are effective without adequate verification of their effectiveness.
7. Paper controls (e.g., USQDs, Hazard Control Plans, Work Authorization Packages) did not equate to safe operations and may have lessened the sense of personal responsibility for safety by both the employees and line management.

1.0 Introduction

1.1 Background

On June 25, 1999, at approximately 1245, a glovebox glove ruptured in Wing 4, Room 4064, of the Chemistry and Metallurgy Research (CMR) facility. The rupture, which was caused by pressurization of the glovebox, resulted in widespread technetium-99 (Tc-99) contamination of the floor, equipment, and most surfaces within the room. No personnel were in Room 4064 at the time the rupture occurred. No injuries, personnel exposures, or personnel contamination resulted from this incident.

On June 29, 1999, the Acting Director for Nuclear Materials Technology (NMT) Division appointed two teams to investigate the incident and the incident response. The CMR Incident Investigation Team was composed of 10 professionals in the fields of environmental science, occupational health and safety, hazardous materials, biology/chemistry, chemical and mechanical engineering, nuclear and radiochemistry, safety management, industrial hygiene, and medical technology radiochemistry. The team, which included independent staff and line management from the Laboratory as well as observers from the DOE Los Alamos Area Office (DOE-LAAO), began its investigation on June 30, 1999. Laboratory experts in ventilation, explosives, and radiological protection also served as consultants to the team. The CMR Incident Investigation Team members are listed in Appendix B.

1.2 Scope of Investigation

The scope of the team was to perform a "DOE Type-B like" investigation of the incident. The team was asked to focus on work control and authorization, as well as the status of facility systems to support safe operations. Only those facility systems directly or indirectly involved in the incident were evaluated by the team. Several issues discovered by the team but not directly related to the incident, such as potential Resource Conservation and Recovery Act (RCRA) violations and fire protection deficiencies, are identified in this report. They were not, however, analyzed in detail due to scope and time constraints.

The team conducted interviews with all employees directly involved in the incident and their management. (See Appendix D.) Other personnel with knowledge of the facility, the operations involved, or relevant expertise were also interviewed. Documents dating from the proposal for the work in 1996 through the date of the incident were reviewed and walkdowns of the incident location, including inspections and testing of the equipment involved, were conducted. Lastly, chemical analyses were performed on the materials involved in the incident and post-incident residues.

Event and causal factor charting was conducted to analyze the facts and identify root causes. (See Appendix F.) Recommendations were based on this analysis.

1.3 Facility Description

The CMR facility was designed and constructed in 1952 to house research and experimental facilities for analytical chemistry, plutonium processing, uranium chemistry and metallurgy, and other support functions. Current programmatic activities are predominantly analytical chemistry, supporting major experimental programs at the Laboratory and within the Department of Energy (DOE) complex.

Uranium process chemistry activities are currently performed in Wing 4, Wing 5, and Wing 9 of the CMR facility. One of these activities involved treatability studies on highly enriched uranium (HEU) contaminated mixed waste from the Portsmouth Gaseous Diffusion Plant (PORTS). The bulk of this activity was being performed in radiologically controlled basement areas in Wing 4: Rooms 4062, 4064, and 4066. Most of the operations were performed in three gloveboxes, three radiological fume hoods, and on the bench-tops in Room 4064.

The air inlets and exhaust air outlets of the gloveboxes in Room 4064 are locally equipped with HEPA filters. The exhaust from these boxes then passes through a HEPA filtered exhaust fan system located in basement Room 4023. The exhaust for this system then passes into the Wing 4 laboratory exhaust system.

Two main exhaust fans service the laboratory areas (including the basement) in Wing 4. The exhaust fans, filters, and plenums are located in the exhaust filter towers at the west end of the wing. The Wing 4 filter towers are equipped with roughing filters rather than HEPA filters.

The CMR Facility Management group (NMT-13) is responsible for the main ventilation system. The local glovebox exhaust system is the responsibility of the Actinide Chemistry group (NMT-2). The purpose of the main ventilation system and the local exhaust systems is to provide airflow such that a cascade of differential pressures causes air to flow from areas of least to highest probable contamination, thus limiting the spread of contamination.

2.0 Accident Description, Emergency Response, and Follow-up Actions

2.1 Accident Description

Prior to the glovebox incident that occurred on June 25, 1999, the NMT-2 PORTS treatability study team had been slowly evaporating three trays of Tc-99 contaminated solutions on three standard hot plates in two gloveboxes in Room 4064. The solutions were byproducts from recently completed studies on mixed waste from PORTS. The solutions had a pH between 8 and 9 and included water, ammonium ions, nitrates, hydrogen peroxide, sulfates, potassium, fluorides, and transition elements such as copper, zinc, nickel, iron, and technetium. After the incident, the solutions were also found to contain RCRA regulated metals such as arsenic, chromium, and selenium. The intent of the team was to reduce the volume of the solutions by evaporation, dry any solid residues, and then properly discard the residues as potentially mixed waste (MW).

The team maintained the temperatures of the solutions at approximately 80 degrees centigrade (C) to prevent boil-over and ensured that a liquid level was maintained in the trays to prevent formation of dry solids. The operation was continually attended except during lunch breaks, and the hot plates were turned off at the end of the day. When unattended, the glovebox gloves were tied outside the gloveboxes to prevent them from contacting the hot plates.

On June 25, 1999, the team was performing the evaporation process as usual on the last of approximately 40 liters (L) of the Tc-99 contaminated solution. After performing their usual checks, the team went to lunch at 1145. At approximately 1240, one of the team members returned from lunch and, while waiting for the other team members to return, proceeded to a computer in Room 4062, which is adjacent to Room 4064. As the team member walked to the computer, he glanced into Room 4064 (the entrance to Room 4064 is covered with a yellow laser safety curtain). Noting nothing unusual (i.e., glovebox gloves protruding out of the boxes), the team member started the computer. Two to three minutes later, the team member heard a popping noise coming from Room 4064, and he rolled his chair to the room's entrance to see what had happened. Looking through the yellow curtain, he saw what he assumed was brown smoke coming from one of the gloveboxes. The team member then evacuated the area and contacted his team leader. Power to the gloveboxes was not disconnected; therefore, the hot plates were still on and the evaporation process continued.

2.2 Emergency Response

At 1253 that afternoon, the NMT-2 team leader informed the CMR operations center of the problem. Shortly thereafter, CMR, NMT, and Laboratory emergency response was initiated and Wing 4 was evacuated of all personnel.

Due to uncertainty as to the contents of the solutions and concerns about the possible presence of nitrogen oxide gases (NO_x), Performance Assurance, Safety, and Training

(NMT-10) personnel were contacted to obtain acid respirator cartridges prior to any entry into the Wing 4 basement areas.

At 1320, a CMR employee who was standing near the main floor entrance to Wing 4, smelled NO_x gas (this employee had experience working with NO_x gas). Another CMR employee in the same area also smelled an unusual odor.

Between 1400 and 1430, first responders in the PORTS work area, wearing acid suits, anti-contamination clothing, and self-contained breathing apparatus, looked around the laser curtain and noted that a low-lying white haze had filled Room 4064 (this haze also cleared during this time period). Later, the responders found that the left glove in the upper-middle set of gloves in one of the gloveboxes had "blown off." Response personnel subsequently plugged this glove port.

Between 1300 and 1600, facility personnel attempted to shut off the hot plates in the gloveboxes in Room 4064. However, due to a lack of adequate engineering drawings and knowledge of the Wing 4 electrical distribution system, the source of the power could not be determined. Eventually, facility personnel physically located the breaker panel for the glovebox power, and at approximately 1630 the hot plates were shut off.

At approximately 1930, NMT-2 and ESH-1 personnel entered Room 4064 and found that the floor, equipment, and surfaces in the room were highly contaminated with Tc-99. Survey results showed beta activity levels on the floor, surfaces, and equipment within the room from several thousand to greater than 2,000,000 disintegrations per minute (dpm). Responders also found that slurry from the three hot plates had splattered over the inside surfaces of the gloveboxes.

For further details regarding emergency response actions, refer to the report from the Laboratory team investigating emergency response issues.

2.3 Follow-up Actions

On June 29, 1999, the Acting NMT Division Director suspended all process work in Wing 4 of the CMR facility. All operations with radioactive materials within this wing were terminated. Work authorized to continue in Wing 4 included the following:

1. Work to decontaminate Rooms 4062, 4064, and 4066.
2. Work necessary to relocate essential operations out of Wing 4.
3. Work needed to support the accident investigation teams.
4. Essential maintenance work needed for worker safety or maintenance of the authorization basis for the facility.

5. Maintenance, testing, and operations in support of security.

Also on June 29, 1999, as previously noted, the Acting NMT Division Director appointed two teams to investigate the incident and the incident response.

3.0 Incident Facts

3.1 1996 To 1997: Initial Work Preparations

As part of the uranium enrichment operations at the Portsmouth Gaseous Diffusion Plant (PORTS) in Ohio, some highly enriched uranium (HEU) materials generated at the facility were classified as mixed waste (MW). The PORTS waste materials essentially consisted of reaction byproducts from the gaseous diffusion process. Much of the uranium feed material used in this process was reclaimed or recycled from processed reactor fuel. The chemical processes for purifying recycled uranium leave trace amounts of transuranic elements (e.g., neptunium and plutonium) and fission products (mainly technetium-99). Although the radiological impact of these impurities is generally negligible in terms of health, other routine chemical processes tend to concentrate the impurities in the uranium product or in reaction byproducts. (Note: for details regarding the properties of uranium and the enrichment process, see the *Department of Energy (DOE) Health Physics Manual of Good Practices at Uranium Facilities*, commonly referred to as the uranium good practices manual.)

Because PORTS did not have the capability to process the generated wastes, Lockheed Martin Energy Systems, Inc. (LMES)—the contractor for PORTS at the time the wastes were generated—issued a call for proposals to process the materials. This processing essentially involved recovering the HEU and separating any RCRA materials to facilitate disposal of the wastes.

In March 1996, the Laboratory's Environmental Systems and Waste Characterization group (CST-7) received the PORTS proposal call from LMES. The CST-7 uranium chemistry technical staff member (TL1) was interested in the PORTS proposal because the work was related to a project he was involved in at the CMR facility. This project was the proposed Uranium Line for Special Separation Science of Enriched Scrap (ULISSES), a project still in the development/construction phase. TL1 subsequently discussed the PORTS proposal with a staff member (SM1) from the Laboratory's Materials Research and Processing Science Group (MST-5) who also worked on uranium chemistry in the CMR facility. TL1 and SM1 then began plans to perform the LMES work in the CMR facility as a collaborative effort between CST-7 and MST-5. TL1 informed his CST-7 group leader that he was interested in the PORTS proposal, and the group leader told TL1 to proceed with plans to procure the work.

From March to April 1996, TL1 and SM1 discussed the PORTS proposal call with LMES personnel. The proposal specified that processing was to be performed on four PORTS waste streams:

- *X-710.* The X-710 waste was generated in the X-710 uranium analysis laboratory as a result of analytical operations.

- *Oil Leak Gunk.* The oil leak gunk was generated in the X-326 facility as a result of a lubrication oil leak into the process waste stream that occurred in 1973.

- *Freon Degrader.* The freon degrader waste was generated in the X-326 facility, originating from the freon degrader system.

- *Filter Ash.* The filter ash waste was generated in the PORTS fluorination systems. (NMT-2 management later decided that filter ash processing would not be performed.)

Approximately 100 kilograms (kgs) of waste was to be processed, nearly all of which contained HEU and RCRA materials according to LMES personnel. It was the intent of LMES that the Laboratory recover and return the HEU, separate and properly discard the RCRA materials. LMES considered the CMR facility to be a favorable location to perform the work, principally because of the physical security the facility could provide for the handling of the HEU in the PORTS wastes.

Between May and July 1996, TL1 and SM1 engaged the Laboratory's Hazardous and Solid Waste group (ESH-19) in discussions on how the PORTS MW could be sent to the Laboratory and then processed. Because the Laboratory did not have a permit to "treat" the PORTS MW, it was decided that the work could be performed under a New Mexico Environmental Department (NMED) "treatability study." Generally, the purpose of a "treatability study" is to allow research, without a RCRA permit, for a limited time (one year) on relatively small quantities of materials from a hazardous waste stream. The intent of such research is to determine possible treatment methods to destroy/remove RCRA materials so that eventually, under an approved permit, the hazardous waste stream can be processed. A treatability study is not generally intended to allow processing of large amounts of hazardous waste without a permit. Neither TL1 nor SM1 had ever performed work under a treatability study.

In July 1996, after the decision was made to perform the PORTS work under a treatability study, LMES, with input from TL1, SM1, and ESH-19, developed a Statement of Work (SOW) for the project. The SOW, which contained a general description of the project, was approved in September 1996 by LMES, DOE-Oak Ridge, the Laboratory's Business Division, and DOE-Albuquerque. The total cost for the PORTS treatability study, including RCRA residue disposal, was estimated to be $315,000.

Also during July 1996, LMES provided TL1 with PORTS elemental analysis data, which included the amounts of HEU and the types and amounts of RCRA constituents in the PORTS waste materials. The analysis data showed that the RCRA materials included arsenic, chromium, silver, lead, and selenium, and that the oil leak gunk and freon degrader waste streams contained relatively high levels of Tc-99. As noted in the uranium good practices manual, gaseous diffusion reaction byproducts are likely to have a high Tc-99 content. However, TL1 and SM1 had not read the uranium good practices manual, did not understand that gaseous diffusion reaction byproducts were likely to have a high Tc-99 content, had not recognized the high Tc-99 content listed in the PORTS elemental analysis data, and were not specifically informed by LMES personnel of the

high Tc-99 content in the PORTS waste. TL1 and SM1 thus assumed, at this point, that the PORTS wastes contained only trace quantities of Tc-99 or other radionuclides.

In August 1996, TL1 and SM1 sent ESH-19 a formal "Notice of Intent" to conduct a treatability study. LMES personnel visited the CMR facility to review the areas where the work was to be performed.

In early September 1996, SM1 prepared a Laboratory Environment, Safety, and Health Identification (ESH-ID) for the proposed treatability study. The ESH-ID listed the work as a continuation of the existing ULISSES project. The ESH-ID stated: "The purpose of this ESH-ID is addressing issues concerning the treatability study of the ULISSES project." As mentioned previously, TL1 considered the PORTS proposal call issued by LMES to be related to the ULISSES project, but the treatability study was not done in the ULISSES line. The treatability study was new work in the CMR facility for processing PORTS waste. Additional problems with the ESH-ID included the following:

1. The purpose, type, and scope of work were not completed and the specified location of the work was incorrect. The ESH-ID indicated that the work would be performed in Wing 9 instead of in Wing 4 and Wing 5 laboratory areas.

2. The ESH-ID contained contradictory information about the generation of liquid effluents. In the section on waste generation, the ESH-ID stated that the project would not generate airborne emissions or liquid effluents/wastes, but a later section of the ESH-ID stated that aqueous solutions from the study would be discarded via the CMR liquid waste line to the Laboratory's waste treatment facility (TA-50). This latter statement indicates that TL1 and SM1 were aware that the project involved generating and discarding liquid effluents.

3. The ESH-ID listed uranium (U)-233, U-235, plutonium (Pu)-238, Pu-239, and Pu-242 as possible fissionable materials contained in the waste, but did not list the principal alpha and beta emitters in PORTS waste: U-234 and Tc-99. These materials were included in the elemental analysis data on the PORTS waste materials, which LMES provided to TL1, but the PORTS elemental analysis was neither provided nor requested for the ESH-ID process.

4. The ESH-ID stated that the project would not involve non-radiological hazardous materials such as chemicals, metals or metal compounds, reactive compounds, or strong oxidizers. This statement was made despite the fact that the treatability study would involve acids; bases; nitrates; hydrogen peroxide; sulfates; potassium; fluorides; transition metals such as copper, zinc, nickel, iron, and technetium; and possibly organics. The ESH-ID did not address the use of these materials and their possible interactions under various conditions, such as heating or agitation.

5. The ESH-ID requires a description of isotopes involved, the chemical forms, amounts, storage, use, and types of operations with fissionable materials. However, this section of the ESH-ID simply states, "U235."

Twelve Laboratory professionals in the fields of environment, safety, health, and industrial hygiene were asked to review the ESH-ID prepared by SM1. (The industrial hygienist did not respond). None of the 11 reviewers made any significant comments regarding the adequacy of the ESH-ID other than several standard statements such as perform a USQD screen before starting work, and involve radiological protection personnel in future discussion of this project.

Later in September 1996, the Laboratory sent formal notifications of intent to perform the treatability study to DOE-LAAO, who in turn sent it to the NMED. These formal notifications stated, "These technologies will treat the waste to reduce the health and safety concerns associated with mixed waste by separating the radionuclides for recovery and reuse, thereby making the secondary residue from these treatment processes more amenable for subsequent treatment, storage, and disposal."

The notifications included the process descriptions for the treatability studies that would be performed on the PORTS waste streams. The process descriptions for the oil leak gunk and freon degrader wastes discussed recovery methods for HEU and the disposal of associated secondary residues. However, no mention was made of the Tc-99 content in the wastes, and little detail was provided on the methods that would be used to treat the waste for RCRA metals or how these materials would be destroyed or otherwise removed from the waste streams.

The process descriptions also stated, "Because the CMR Building contains filter towers with HEPA filters, there is virtually no chance that hazardous or radioactive air emissions could occur from this treatment process. In addition, the gloveboxes contain a separate HEPA filtration system." The filter towers in Wing 4 of the CMR building where TL1 and SM1 planned to perform the bulk of the work do not have HEPA filters. The gloveboxes in the basement of Wing 4 have a local HEPA system, but originally TL1 and SM1 planned to perform much of the work in the radiological fume hoods in this basement. Not all of these fume hoods are equipped with local HEPA filtration.

In November 1996, the NMED approved the treatability study of approximately 100 kgs of PORTS MW at the Laboratory. The NMED granted the Laboratory one year to perform the study, and TL1 and SM1 understood that the clock was to start the day the PORTS waste samples arrived at the CMR facility.

Up to this point, Laboratory line management (other than the team leader) had no involvement in planning the work to process the approximately 100 kgs of PORTS MW at the Laboratory. Laboratory line management had neither discussed the proposal with LMES, ESH-19, DOE, or the NMED nor been involved in developing, reviewing, and approving the SOW for the study. Laboratory line management had not seen the PORTS elemental analysis data provided by LMES, reviewed the ESH-ID for the project, or seen

the process descriptions for the treatability studies to be performed on the PORTS waste streams. Lastly, there was no Laboratory line management involvement in preparing, reviewing, or approving the formal "Notice of Intent" sent by TL1 and SM1 to ESH-19 in August 1996, or in preparing, reviewing, or approving the formal notifications of intent sent to DOE-LAAO and the NMED in late September.

In late 1996, the Laboratory's Nuclear Materials and Stockpile Management (NMSM) office, which keeps track of the special nuclear material (SNM) used or stored at the Laboratory, became aware of the treatability study and the fact that it involved shipments of SNM (HEU). Any shipments of SNM to the Laboratory must be approved by the NMSM office.

3.2 1997 To 1998: Final Work Preparations and CMR Stand-down

In January 1997, NMSM requested authorization from the DOE Albuquerque Office (DOE-AL) for the Laboratory to receive approximately 90 kgs of PORTS residues in one hundred and eleven 55-gallon shipping drums. The request stated that all recovered HEU would be returned to PORTS and that all secondary residues would be sent either to PORTS or to a solid waste disposal contractor (Envirocare). The request further stated that all liquid effluent was expected to meet the waste acceptance criteria (WAC) for disposal via the CMR radioactive waste line to TA-50 (radioactive WAC for TA-50 is 0.5μCi/L and below RCRA limits). This latter statement was based on TL1's assumption that the HEU in the samples would be successfully recovered. The request made no mention of the Tc-99 content in the samples and how it would be handled. DOE-AL reviewed the request and granted authorization for the Laboratory to receive the shipments.

Following DOE-AL approval to receive the shipment, the CMR facility management staff began preparing an Unreviewed Safety Question Determination (USQD) and What-If hazard analysis for the work. These documents were completed in August 1997. The USQD for the work was "negative," indicating that the project was within the bounds of the existing CMR facility authorization basis. The USQD noted that "trace" quantities of Tc-99 on the order of 1 pCi/gram of material were expected in the PORTS residues. This figure was based on TL1's assumptions. The PORTS elemental analysis data indicated the Tc-99 content in the oil leak gunk and freon degrader waste samples ranged from 1.76E7 to 4.65E8 pCi/gram of sample.

The What-If analysis was largely derived from an existing What-If analysis for the ULISSES project. Neither the USQD nor the What-If analysis contained specific details regarding possible interactions between the materials associated with the project under various conditions or the possible impacts of these interactions on engineering controls (e.g., glovebox ventilation; HEPA filters). In addition, neither the USQD nor the What-If analysis stated that work would be performed in enclosures that did not provide HEPA filtration (i.e., radiological hoods in the Wing 4 basement). Lastly, no mention was made in these analyses of the directional airflow requirements in the radiological areas where

the work was to be performed. After the incident, positive air flow from Room 4064 to adjacent uncontaminated areas was noted by the Incident Investigation Team. Interviews with facility personnel, including the HVAC system engineer, indicate that directional airflow problems in the CMR facility basement were long standing, well recognized, and not considered correctable.

On August 25, 1997, the first shipment of 20 drums arrived at CMR, which started the clock for the one-year study granted by NMED. Also on this date, both the USQD and the What-If analysis for the work were approved. TL1 signed the "Management Concurrence" block of the USQD, and the CMR facility manager also signed the approval form. No other Laboratory line management was involved in preparing, reviewing, or approving the USQD. The What-If analysis was, however, approved by TL1, CST-7 line management, and MST-5 line management.

On September 2, 1997, all operations were suspended at the CMR facility due to several incidents (not related to the PORTS work) involving lack of adequate hazard review, performance of unauthorized work, poor conduct of operations, violations of procedures, and failure to stop work when problems were encountered. Before normal operations could be resumed, all CMR activities, including the PORTS treatability study, were to be reviewed and formally authorized, with corrective actions implemented facility-wide to prevent related future occurrences. Shortly after the CMR facility stand-down began, TL1 and ESH-19 became concerned that a stand-down period of four to six months would seriously affect the Laboratory's ability to complete the PORTS treatability study within the one-year time period. TL1 and ESH-19 sent DOE-LAAO a letter, which was sent on to the NMED, that gave the status of the CMR stand-down and the Laboratory's intentions regarding the PORTS residues. The letter stated that the residues would be properly stored at CMR until operations were allowed to resume. The letter proposed delaying the start date for the one-year time limit until the resumption of CMR operations and the treatability study. The letter essentially stated that unless informed otherwise, the Laboratory would assume that the NMED found this delay acceptable. When NMED did not formally respond to the letter, the Laboratory, TL1, and ESH-19 assumed the delay in the start date was "authorized."

During the early phases of the CMR stand-down, TL1 began preparing a work authorization package (WAP) for the treatability study. A WAP was required by all activity owners at the CMR facility before normal operations could resume, and the WAPs were to be assembled by the activity owners, with assistance from CMR facility management and support personnel. Shortly after TL1 began preparing the PORTS WAP, CST-7 line management asked MST-5 line management to take responsibility for the PORTS work at CMR. The request was made because the work was being performed in spaces owned by MST-5. MST-5 management was located in the CMR facility and the MST-5 group leader was familiar with the CMR work resumption process. MST-5 management agreed to take responsibility for the PORTS work. TL1 remained a CST-7 group member.

Through the WAP, activity owners were required to formally define the scope of the work, identify all hazards in the work, and list all controls for the hazards. The PORT WAP included the USQD and What-If analyses, as well as facility, activity, radiation protection, and waste generation guides and checklists and operating procedures. Problems with the PORTS WAP included the following:

1. It did not include or reference the PORTS elemental analysis data.

2. The facility and activity equipment checklist requirements for the basement areas in Wing 4 where the work was to be performed (Rooms 4062, 4064, 4066, and 4068) did not list the local radiological exhaust system that serviced the gloveboxes in Room 4064, where the gloveboxes and radiological hoods were located. In addition, neither of these checklists specified expectations regarding verification and maintenance of proper directional airflow (from least contaminated to most contaminated) in these radiological areas. (Note: Correct airflow into the radiological hoods in Room 4064 was maintained throughout the PORTS work; however, proper directional airflow in the basement radiological laboratories in Wing 4 was not maintained.)

3. The radiation protection checklists for these areas did not list U-234, the principal alpha emitter within the HEU, or Tc-99, the principal beta emitter. The only isotope listed was U-235. The checklists also stated that the PORTS work required no air sampling, air monitoring, or personnel contamination monitoring, despite the potential for loose contamination from the U-234, U-235, and Tc-99. Alpha contamination monitors, an alpha continuous air monitor (CAM), and fixed head air sample units were already in Room 4064 at the time the checklist was prepared and were left inside as a precaution.

4. The WAP specified that the final products and waste generated by the PORTS study would be the recovered HEU, solid mixed waste, low level waste (LLW), and aqueous LLW solutions. The HEU was to be returned to PORTS, the RCRA materials sent to Envirocare, the LLW waste discarded at the Laboratory, and the solutions poured down the radioactive waste drain to TA-50. Based on the belief that the HEU would be recovered, TL1 assumed the solutions would easily meet the WAC for TA-50 and could therefore be poured down the drain. However, TL1 was not aware of the high Tc-99 content in the oil leak gunk and freon degrader waste streams and the possible difficulties in handling liquids contaminated with this radionuclide.

5. The PORTS procedures included in the WAP had included the steps necessary to perform the treatability studies, but the procedures were not complete. They did not contain the specific precautions/hold points and/or associated actions for unusual or unexpected conditions or problems, and they did not address the Tc-99 content in the waste streams

6. The WAP included a hazard control plan (HCP) prepared by MST-5. The HCP contained several "boiler plate" statements regarding hazards and controls and had the same general deficiencies as noted previously for the ESH-ID, USQD, and What-If analysis.

An independent verification (IV) team reviewed the WAP for completeness and spot-verified that adequate controls were in place for the hazards associated with the activity. Because the WAP did not include or reference the PORTS elemental analysis data or discuss the actual Tc-99 content in the waste, the IV team was unaware that PORTS samples contained non-uranium beta emitters and that adequate engineering and administrative controls were not in place to address the Tc-99 content in the waste streams.

3.3 1998: Final Work Authorization and Beginning of PORTS Treatability Studies

In January 1998, the resumption process was completed for the PORTS study. MST-5 line management authorized restart of the activity, but TL1 did not re-start the PORTS study because a WAP for a uranium chemistry project also needed to be completed.

In February 1998, the NMT Division took over management responsibility for the CMR facility. The MST-5 group in the CMR facility became the Material Science and Processing group (NMT-11). The NMT-11 group leader, now responsible for the PORTS treatability study, and TL1 developed a memorandum of understanding (MOU) between LMES and the Laboratory regarding the final disposition of the HEU in the PORTS wastes. Shortly after the MOU was approved by LMES, the NMT-11 group leader, and TL1, NMT Division re-assigned responsibility for the PORTS study to the Actinide Process Chemistry group (NMT-2). NMT-2 performs the majority of its work at the Laboratory's Plutonium Processing and Handling Facility (TA-55). At this time, TL1 was still assigned to the CST-7 group and the PORTS study had still not resumed because of delays in completing the uranium chemistry WAP.

In March 1998, NMT-2 line management, now responsible for the PORTS study, decided to walk-down the PORTS and uranium chemistry WAPs and become familiar with these processes before allowing work to resume. During the review, NMT-2 management found that the PORTS procedures were very different from those used at TA-55. However, NMT-2 management decided that the procedures were adequate, though in need of future revision.

NMT-2 management did not review the adequacy of the facility/activity engineering controls during their walk-down of the PORTS areas because it was assumed that CMR facility management was "taking care" of the glovebox and building ventilation systems. NMT-2 management did not know they were responsible for the local exhaust fan system for the gloveboxes in Room 4064. Because of this confusion of ownership, there was no maintenance program for this local system. NMT-2 management was also unaware of the directional airflow problems in the Wing 4 basement radiological areas.

No significant changes ever were made to the PORTS WAP other than re-formatting uranium chemistry procedures to NMT-2 standards.

On March 16, 1998, the CMR facility implemented a new quality assurance procedure as a result of problems encountered during the stand-down. This procedure, CMR-QA-15, CMR Activity Approval Process, provided CMR personnel with guidelines for obtaining the review and authorization of new or changed activities in the CMR facility. The procedure considered a "new activity" any activity not covered by a current approved WAP and/or not described in the current CMR authorization basis (AB). This included physical changes in laboratory operations in the CMR facility. A "changed activity" was considered to be any change that introduced new or different hazardous/radioactive materials, changes significant enough to cause a revision to an existing procedure, changes not covered in the current AB, or changes in the physical location of a process in the facility.

The CMR Activity Approval Process for a "new activity" required that a USQD be performed for any new or changed systems, structures, or components within the CMR facility boundary to determine whether the new/changed activity would be within the bounds of the CMR AB. The Activity Approval Process also required the completion of an associated hazard assessment/review to (1) identify and document conditions that had the potential to harm personnel, property, the public, or the environment, and (2) define the controls that would mitigate or prevent potential harm. The Activity Approval Process did not discuss the necessary review and approval for any changed or newly identified hazards in an existing activity. TL1 was trained (required reading) on the new CMR Activity Approval Process instituted at the facility.

On June 1, 1998, TL1 joined NMT-2 as the team leader for the PORTS treatability study. Three days later, the treatability study began with work on the X-710 waste stream. Because the NMED had not formally responded to the request for a delay in the start of the one-year time clock for the treatability study, TL1 assumed June 4, 1998, to be the start day for the work.

In late July 1998, processing of the X-710 waste stream was completed. The PORTS team successfully recovered the HEU from the X-710 waste stream. All liquid effluents were collected in carboys for RCRA analysis. Work then began in a Room 4064 fume hood to open the first sample containers of freon degrader waste.

On August 5, 1998, an incident occurred in Room 4064 that involved personnel and area contamination. One of the PORTS team members became contaminated with a beta emitter while opening a PORTS container of freon degrader waste. Through response to this incident, it was discovered that the team member and a small area in the room were contaminated with Tc-99. TL1 realized that these newly opened PORTS wastes were highly contaminated with Tc-99.

NMT-2 and NMT-13 subsequently stood down the PORTS work. Through investigation into the incident, it was discovered that the PORTS elemental analysis showed the oil

leak gunk and freon degrader wastes were highly contaminated with Tc-99. Reviews of the uranium good practices manual also indicated that these levels of Tc-99 should have been anticipated. As a result of the incident, Tc-99 subject matter experts (SMEs) at the Laboratory and a health physicist (HP) were asked to review the PORTS processes and procedures. NMT-2 management also reviewed the processes for PORTS work.

As a result of the NMT-2 management review, TL1 was required to postulate the Tc-99 material balance in the PORTS wastes, but no other significant actions were required. This was in part based on a decision to wait until a new CMR Radiological Control Policy was implemented before making any broad changes.

In mid-October 1998, the stand-down on PORTS work was lifted and the treatability study resumed as authorized by the October 15, 1998, Package for Resumption of Work in Rooms 4062/64/66. (The original NMED one-year time limit for the PORTS treatability study had expired on August 25, 1998, but work continued based on the assumption that the start date for the one-year clock had been moved to June 4, 1998.)

Principal changes made to the PORTS process, which were incorporated into the WAP, included the following:

1. Radiological control guidance for the Tc-99 (e.g., using beta-gamma survey instruments) was included in accordance with the recommendations of the HP.

2. The procedures were modified to keep track of the Tc-99 throughout the treatability process in accordance with the recommendations of the Tc-99 SMEs.

3. PORTS work was moved from the radiological hoods into the three gloveboxes in Room 4064.

4. An NMT-2 Housekeeping Plan for the PORTS areas was issued.

Although Room 4064 contained both gloveboxes and radiological hoods, TL1 and SM1 had planned to perform most of their work (all if possible) in the hoods or on bench-tops. The hoods were not provided with HEPA filters. The plans to use the non-HEPA filtered hoods were based on the assumption that the only radiological hazard was from the U-235. When it was decided to move the bulk of the treatability study operations into the HEPA filtered gloveboxes in Room 4064, no new reviews were performed of the specific hazards involved with this move. In addition, there were no new formal reviews (i.e., USQD) on the impacts this move would have on the engineering controls in the Wing 4 basement—namely, the glovebox systems, the local exhaust fan system, and the associated HEPA filters.

Although the PORTS procedures were modified to keep track of the Tc-99, no path forward was developed to address the handling of solutions that were now highly contaminated with Tc-99. It had become clear that the high Tc-99 content would prevent the solutions from meeting the WAC for TA-50.

In October 1998, the NMT-2 group leader was asked to take a special assignment, which eventually became permanent. During this transition period, the NMT-2 deputy group leader was unofficially the acting NMT-2 group leader from November 1998 until January 1999, when he was officially designated the acting group leader. During this time, NMT-2 had approximately 100 full-time employees and contractors, most of whom worked at TA-55.

In November 1998, the team began noticing the formation of white "fumes" in the east glovebox where they were performing uranium precipitation work in Room 4064. At the same time, they noticed a drop in the magnahelic gauge reading on the glovebox. This gauge measured the differential pressure (dp) between the glovebox and Room 4064. Normally, the gauge read from 0.5 to 1.0 inches of water (inches), but when the fumes began forming, the gauge reading began dropping below 0.7 inches. TL1 and the team periodically adjusted the air inlet valves for the glovebox (located upstream of the inlet HEPA filter on the box) to maintain a "normal" reading on the gauge.

Beginning in November 1998, the team dramatically stepped up the pace of their operations to meet the assumed NMED deadline of June 4, 1999. Because of the increased volume of work, more problems were observed with the magnahelic gauge readings on the east glovebox in Room 4064. In addition, with the RCRA metal precipitate work being performed in the west glovebox, Tc-99 contaminated solutions began to pile up. This was because the solutions did not meet the WAC for TA-50 and could not be poured down the radioactive waste drain. At this point, TL1 and one of the technicians (TEC1) decided they needed a method for handling Tc-99 contaminated solutions.

In December 1998, TL1 and TEC1 studied the literature for a solution to the Tc-99 problem. They found data that described a Tc-99 precipitation process using ferrous ammonium sulfate (FAS). Because the research appeared promising, TEC1 began small-scale experiments using the FAS process on the Tc-99 contaminated solutions. Although the treated solutions still did not meet the WAC for release to TA-50, the small-scale results appeared promising and TL1 decided to try the FAS process on a large scale. No written procedures or change control analysis (e.g., USQD) were developed for the process.

3.4 January to June 1999: PORTS Treatability Studies Continue

In early January 1999, TL1 and the team continued to have problems with the magnahelic gauge reading on the east glovebox. Because they could no longer adjust the inlet air valve on the box to achieve a "normal reading," they replaced the outlet HEPA filter on the box. At the same time, they changed the outlet HEPA filters for the west glovebox in the room. After the HEPA filters were replaced, PORTS work continued at a rapid pace to meet the June 4, 1999, deadline.

TL1 and the team noted the accumulation of a white powder on the surfaces of the old filter for the east glovebox. Ammonium hydroxide and nitric acid were among the

chemicals used in this glovebox for precipitating HEU. TL1 assumed that ammonia and nitric acid vapors associated with the use of these chemicals combined to form white ammonium nitrate fumes and that these fumes condensed as a white powder on the HEPA filter. None of the PORTS hazard analyses, or any other PORTS documentation, had ever addressed the formation of ammonium nitrate and the possibility that this material could clog glovebox filter media. In addition, the CMR activity approval process did not address newly identified or changed *hazards* associated with an existing activity. TL1 did not inform NMT-2 or CMR facility management of the problem or develop any formal precautions to either mitigate or prevent its recurrence.

Also in January 1999, TL1 and the team began large scale FAS treatment on the Tc-99 contaminated solutions in the west glovebox in Room 4064. The team found that even after repeated treatments with FAS, the solutions still contained high levels of Tc-99 and did not meet the WAC for TA-50. However, the team continued the FAS treatment of the solutions, hoping to obtain better results.

The FAS process, which was not described or analyzed in the PORTS treatability study WAP, constituted a change as defined in the CMR Activity Approval Process. TL1 did not inform NMT-2 or CMR facility management about the new proposed process and did not submit the new process for review and authorization as required by CMR-QA-15. There was no line or facility management involvement in planning, reviewing, approving, and executing the FAS process.

The FAS process was not described in the NMED-approved treatability study. TL1 believed that all RCRA metals had been removed from the liquid effluents during the RCRA, hydroxide precipitate process. However, TL1 had no analytical data indicating that the RCRA metals had been removed from the freon degrader waste during the hydroxide process. Based on his knowledge of the hydroxide process, TL1 assumed that all RCRA metals had also been similarly removed from the Tc-99 contaminated, freon degrader effluent solutions. TL1 did not notify or obtain approval from ESH-19 or the Waste Management and Environmental Compliance group (NMT-7) before beginning FAS treatment of the liquid effluents.

In February, the Laboratory's Air Quality group (ESH-17) informed CMR facility management that a measurable release of Tc-99 had occurred from an exhaust stack for Wing 4 of the facility. The release (later found to be well below any regulatory limits) was traced to a calcining operation of uranium oxide solid residues that the PORTS team was performing in a furnace in one of the non-HEPA filtered hoods in Room 4064. TL1 performed the 900-degree C calcining in this hood because he assumed that no Tc-99 was present in the solid uranium oxide compounds. The original process descriptions for this work stated, "there is virtually no chance that radioactive emissions could occur from this treatment process." The ESH-ID for this work stated there would be no airborne emissions.

In late February 1999, NMT Division management required that all CMR residents complete a required reading of the basic requirements in the CMR Activity Approval

Process. These basic requirements stated that all new or changed activities required review and authorization. TL1 and the team completed this required reading.

When TL1 moved the furnace into the west glovebox for the calcining operation, he became concerned about the possibility of fire in the outlet HEPA filter. He therefore decided to install fire screens on the upstream side of the outlet HEPA filters in gloveboxes in Room 4064. TL1 did not inform NMT-2 management about the need for the fire screens.

TL1 prepared radiological and safe work permits (RWP and SWP) for the installation of the fire screens. In the SWP, TL1 stated, "The purpose of this special work permit is to provide directions and ensure appropriate review and approval for attaching fire screens over glovebox HEPA filters." TL1 included a description of the work to be performed and listed the identified hazards for the work as ionizing radiation, radioactive contamination, and airborne release of radioactive material. The RWP was listed as a special control for the work. TL1 submitted the SWP for review and approval to the NMT-13 area work supervisor (AWS) for Wing 4.

Not included in the SWP was a description of why the fire screens were necessary (i.e., because of the fire danger to the filters from the calcining work) or the effect the new installation would have on the operation of the glovebox magnahelic gauges. The low-pressure-sides of the gauges were connected just upstream of the outlet HEPA filters. In this way, the gauges measured the dp between the boxes and the room. After the screens were installed, the gauges would measure the dp between the narrow space between the screens and the outlet HEPA filters. With the screen completely clean, this arrangement should have made little difference in the ability of the gauges to measure the dp of the boxes. However, if the screens became partially or completely plugged, the gauges would not provide an accurate measurement of the dp between the boxes and the room.

Because the SWP did not include the reason why the fire screens were necessary or the potential impacts of the screens on the gauge readings, the Wing 4 AWS was not aware of any unusual problems associated with the installation. In addition, the AWS did not adequately inquire into why the screens were necessary or what problems the installation might pose. Believing the installation of the fire screens would make the glovebox operation safer, the AWS approved the SWP on March 3, 1999. The SWP was also reviewed and approved on this date by a NMT-10 representative at CMR. The CMR facility manager then approved the SWP on March 4, 1999. A pre-job briefing was held on March 4, 1999, and the work was then performed.

Contrary to the requirements of CMR-QA-15, no additional reviews (i.e., USQD, design change package, and hazard review) were performed by NMT-2 or CMR facility management of the physical change to safety significant equipment and possible impacts on the CMR AB and facility/activity engineering controls.

After the fire screens were installed, the team noted periodic changes in the magnahelic gauge readings on the east and west gloveboxes and had to clean the screens

approximately every two weeks. The team cleaned the white powder from the screens, which was assumed to be ammonium nitrate, by "banging" the screens on the floor of the gloveboxes and then cleaning the screens with a brush.

Also in March 1999, TL1 found, through uranium dissolution and precipitation, that the amount of HEU in the freon degrader waste was nearly twice what was measured through previous PORTS and Laboratory uranium assay data for PORTS waste. Before March 1999, TL1 had limited the amount of HEU used in each glovebox and hood to 200 grams to ensure that operations were conducted well within the criticality limit of 520 grams per enclosure. TL1 had based his knowledge of the amount of HEU in each sample on the PORTS and Laboratory assays. Because the new March data suggested that nearly 400 grams of HEU had actually been present in each enclosure, TL1 reduced the amount of waste by half to stay well below the criticality limits. TL1 did not inform NMT-2 or CMR facility management of the discovery of the higher HEU content in the freon degrader waste. As a result, no formal reviews (i.e., USQD) were performed to ensure the higher HEU content was still within the bounds of the CMR AB. In addition, no reviews were performed of the specific hazards involved with the higher HEU content in the PORTS wastes.

On March 13, 1999, the NMT Division implemented NMT-AP-007, Research, Development, and Process Work Control. This new procedure defined the requirements for the use of safe operating procedures, experimental plans, and work instructions to document and authorize potentially hazardous activities associated with research, development, and process work. The requirements were applicable to all NMT Division employees who performed research and development, chemical processing and analysis, or other potentially hazardous activities not categorized as "facility work" (facility work was controlled through a different procedure). All new group-specific activities initiated on or after March 13, 1999 were required to be documented and authorized in accordance with the requirements of the new procedure. The new procedure did not, however, discuss the review and approval for any changed or newly identified hazards in an existing activity. TL1 and the team were not trained on the new NMT procedure.

Also in March 1999, a new group leader was selected for NMT-2.

In late March and early April 1999, TL1 and the team noted that the magnahelic gauges on all three boxes were reading near zero. The team also noted that cleaning the fire screens and adjusting the inlet air valves for the boxes did not significantly increase the readings. TL1 suspected that the filtration for the local glovebox exhaust fan system in Room 4023 had been clogged with ammonium nitrate. After changing the pre-filter and later the HEPA filter, the gauge readings on the boxes returned to "normal." No changes to PORTS operations were made to prevent or reduce the production and buildup of ammonium nitrate on the screens and HEPA filters. Neither NMT-2 management nor CMR facility management were aware of the ammonium nitrate problems associated with the PORTS work.

In April 1999, TL1 and the team completed processing of the freon degrader waste and began work on the oil leak gunk. Although the team had continued the FAS treatment of the Tc-99 contaminated liquid effluents that was begun in January 1999, none of the solutions met the WAC for disposal to TA-50. Because there was too much liquid to keep in the boxes, TL1 established a "threshold" beta activity level for determining when to move the liquid from the boxes to carboy containers. Liquids that did not meet the threshold (less than 50,000 dpm per 0.1 milliliter of solution) were kept in 2-liter bottles inside the east and west gloveboxes.

Up to this point, although samples had been submitted, TL1 had not received analytical data showing that the RCRA metals were successfully removed from the freon degrader liquid effluents (the ones also contaminated with Tc-99). However, TL1 assumed that the potassium hydroxide that was added to the liquids during both the RCRA precipitate and FAS processes had removed the RCRA metals. The PORTS team handled the liquids as potentially MW.

During one week in April, the PORTS team had three radiological incidents involving either skin or area contamination. NMT-10 and ESH-1 in CMR reviewed the incidents with NMT-2 management to determine corrective actions. The observations included the following:

1. Too many different operations being performed too quickly.
2. Poor housekeeping.
3. An apparent willingness to violate procedures.
4. Poor laboratory practices.

NMT-10 and ESH-1 recommended the development of a corrective action plan to address these issues. Based on this information and a growing concern over the viability of the work, NMT-2 management decided to begin "phase-out" of the treatability study and to counsel the team members regarding work practice weaknesses. NMT-2 management, in agreement with NMT-10 and ESH-1, decided to postpone the development and implementation of a corrective action plan until NMT/CMR policies regarding radiological control and temporary suspension and restart of operations were approved. At that time, approval was scheduled for mid-June, but up to mid-August, only the contamination control portion of the procedure package had been approved.

On May 4, 1999, the NMT-2 group leader, still concerned with the PORTS treatability study operation, issued a memo, with DOE-AL concurrence, that stopped the project. TL1 was informed that no new work would be performed on the PORTS samples. TL1 was told to finish what he had started and begin repackaging the remaining PORTS samples for transport back to PORTS.

In May 1999, TL1 and the team completed a small-scale study on the oil leak gunk waste stream. Also at this time, TL1 sent a sample of the freon degrader liquid effluent to the Analytical Chemistry group (NMT-1) for qualitative analysis of the RCRA metal content. (Note: As of August 23, 1999, TL1 had not received analysis results.)

On June 3, 1999, all unused/uncompleted samples were shipped back to PORTS. Of the one hundred and eleven 55-gallon drums of waste that had been shipped to the Laboratory, 64 drums were returned to PORTS; 34 of the drums containing oil leak gunk were never opened.

3.5 June 11-24, 1999: Evaporation of Liquids Performed in Room 4064 Gloveboxes

On June 11, 1999, the team voiced concerns to TL1 regarding the FAS treatment of the Tc-99 contaminated solutions. Each time the team performed the process, more solution was generated, but the beta activity in the liquids was not significantly decreasing. Based on these concerns, TL1 and the team discussed how best to proceed with the Tc-99 contaminated solutions. They decided to slowly evaporate off the liquid to reduce the volume, dry any solid residue, and then discard the residue as a solid MW. TL1 and TEC1 chose evaporation because they had previous success with this method. In 1992, the two had evaporated approximately 20L of plutonium and americium contaminated solutions in a glovebox at the Laboratory DP site. In 1995, they had evaporated approximately 4L of uranium contaminated solutions in a HEPA filtered glovebox in Wing 9 of the CMR facility. Nothing unusual was noted during those events.

On June 14, 1999, TL1 met with the team to discuss the evaporation process. TL1 stated that the Tc-99 solutions were to be poured into trays and then slowly heated on hot plates in the east and west gloveboxes. The team discussed the following precautions for the evaporation process:

1. Tie the glovebox gloves outside the boxes to prevent them from contacting the hot plates. The west box had six pairs of gloves (three upper and three lower); the east box had four pairs (two upper and two lower). Figure 3-1, a schematic of Room 4064 gloveboxes, shows the location of the hot plates.

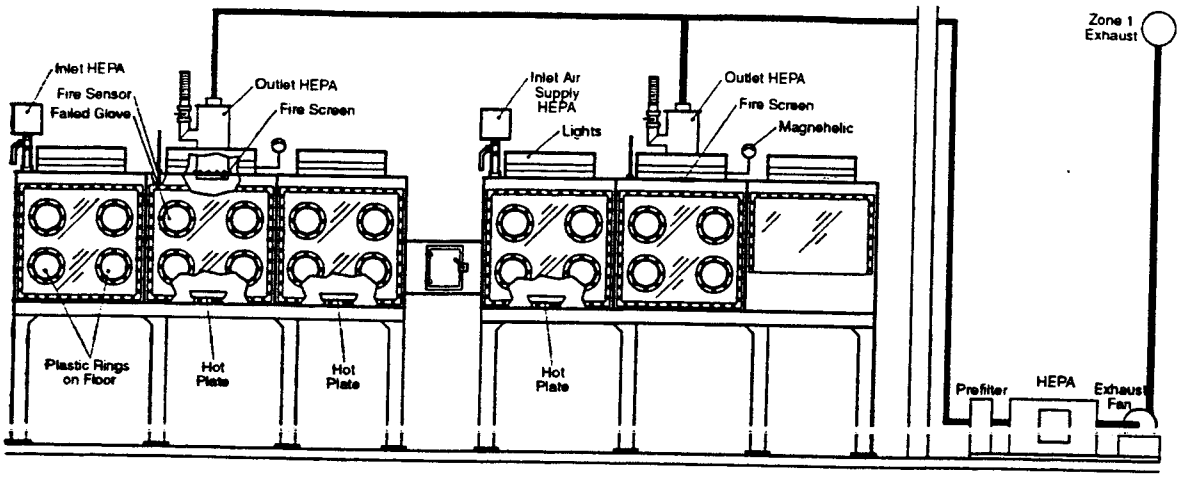


Figure 3-1. Schematic of Room 4064 Gloveboxes with Hot Plates Shown.

2. Maintain the temperature of the liquids in the trays at approximately 80 degrees C to prevent boil-over. Ensure that a liquid level is maintained in the trays to prevent evaporating to dryness.

3. Periodically remove the slurry that accumulates in the trays and set it aside in the glovebox.

4. Continually attend the process except during lunch breaks, and turn off the hot plates at close of business each day.

After the discussions on precautions, TEC1 began evaporating the Tc-99 contaminated solutions in the west glovebox. No written procedures were developed or considered necessary by TL1 for this process.

The contents of the heated liquids included water, ammonium ions, nitrates, hydrogen peroxide, sulfates, potassium, fluorides, and transition metal ions such as copper, zinc, nickel, iron, and technetium. In addition to assuming that RCRA metals were not present in the solutions because of the frequent additions of potassium hydroxide during the treatability study and FAS processes. TL1 further assumed that organics were not present. This last assumption was based on "knowledge of process" that organics were destroyed at PORTS during production of the freon degrader waste. The "freon" was burned in a fluorine gas atmosphere at 600 degrees C. Discussions with Portsmouth personnel also supported the assumption that all of the organics would be destroyed by this process. In addition, no organics were listed on the PORTS elemental analysis data for the freon degrader waste.

The evaporation process was not described or analyzed in the WAP for the PORTS treatability study and represented a change as defined in the CMR Activity Approval Process. TL1 did not inform NMT-2 or CMR facility management about the proposed process and did not submit the new process for review and authorization as required by

CMR-QA-15. There was no group level line or facility management involvement in planning, reviewing, approving, and executing the evaporation process.

No hazard review was performed to address the combination of the various chemical compounds in the solutions, their possible interactions under various conditions (e.g., heating; agitation), or the possible impacts to facility/activity engineering controls. In addition, an experimental plan was not prepared for this process as indicated by NMT-AP-007.

The evaporation process was also not described in the NMED-approved treatability study. Even though TL1 did not have analytical data for the liquids being evaporated, based on knowledge of process and prior analytical data for similar liquids, he did not notify, or obtain approval from, ESH-19 or NMT-7 prior to starting evaporative treatment of the liquid effluents.

On the morning of June 15, 1999, the team continued the process in two trays, one each in the east and west boxes. Eighteen to twenty 2L bottles of solutions had to be evaporated (the bulk of the solutions were previously transferred to carboys).

The team poured the contents of the 2L bottles into the trays and then slowly heated the liquids to approximately 80 degrees C. The team then periodically monitored the temperatures of the liquids with thermometers. At the end of each day, the team turned off the hot plates. Whenever the process was unattended during lunch or after hours, the team ensured that the glovebox gloves were tied outside the boxes and that the trays were filled with liquid. At the start of the following day, the team scraped the slurry out of the trays and placed it into large beakers within the gloveboxes. Any liquid in the large beakers was then poured back into the trays and the trays were again filled with solution. This process was repeated every day. The team evaporated approximately 2L of fluid per day per tray.

Each day of the process, the team noted a slow, continual rise in the magnahelic gauge readings (more negative) on the east and west boxes. TL1 said to expect these increased readings during the evaporative process because the outlet HEPA filters in the boxes were being wetted and therefore becoming more efficient. Each morning when the team re-started the process, they noted that the gauge readings had dropped (less negative) back to "normal."

On Friday, June 18, the team member responsible for the west box (TEC2) noted an above-normal reading on the magnahelic gauge for this box. TEC2 removed the box's fire screen, cleaned-off an accumulation of white powdery residue, and installed the screen. Noting that the gauge reading dropped, TEC2 continued his work and later informed TL1 and TEC1 about the reading. TL1 and TEC1 again stated that this reading was not unexpected. At the end of the day, the team turned off the hot plates and secured the area as usual. The trays were not checked that weekend or on the following Monday and Tuesday (June 21 and 22) due to a two-day Laboratory-wide security stand-down.

On Wednesday, June 23, when the team returned to work, they noted that the trays were nearly empty of liquid and that crystals had migrated out of the two trays and onto the hot plates in each box. They further noted that the hot plate in the west box had failed. The team then decided to use a smaller tray in the west box because of safety concerns and the possibility of leaks from the over-sized tray. The team also placed a second, 9-inch x 12-inch porcelain-lined metal tray into the west box and then continued the evaporation process in both boxes.

On June 24, the team member responsible for the east box (TEC3) noted an above-normal magnahelic gauge reading on this box during the evaporation process. TEC3 informed TEC2 of the reading and TEC2 stated that the box's fire screen should be cleaned. After cleaning the fire screen, TEC3 did not note a significant drop in the gauge reading. TEC2 then cycled the butterfly valve that was downstream of the box's outlet HEPA filter, and the team members noted a drop in the gauge reading. Work then continued in the east box.

By the end of the day on June 24, the team had evaporated all but the contents of three 2L bottles. One partially empty bottle was still in the west box; two partially empty bottles remained in the east box.

Up to this point, neither TL1 nor the team suspected that the increased concentration and various interactions of the heated compounds in the trays, combined with impaired glovebox airflow, might lead to possible problems.

3.6 June 25, 1999: Incident In West Glovebox In Room 4064

On June 25, 1999, at 0830, the team returned to work and started up the evaporative process as usual. They scraped the slurry from the trays and poured some of the liquid from the three remaining bottles. Work progressed as usual with the team monitoring the temperatures of the liquids and keeping the trays as full of solution as possible. The team noted the usual rise in magnahelic gauge readings on the two gloveboxes and that the glovebox gloves were being lightly drawn into the boxes as usual. Before breaking for lunch, the team verified that the glovebox gloves were tied outside the boxes, the temperatures of the liquids were approximately 80 degrees C, and the trays were 3/4 full.

At approximately 1240, TEC2 returned from lunch, and while waiting for the other team members to return, proceeded to a computer in Room 4062. Room 4062 is adjacent to Room 4064, and as TEC2 walked to the computer, he glanced into Room 4064 (the entrance to Room 4064 is covered with a yellow laser safety curtain). Noting nothing unusual (i.e., glovebox gloves protruding out of the boxes), TEC2 started the computer. Two to three minutes later, TEC2 heard a popping noise coming from Room 4064 and he rolled his chair to the room's entrance to see what had happened. At the entrance, TEC2 looked through the yellow curtain and saw what he assumed was brown smoke coming from the west glovebox. TEC2 then evacuated the area and contacted TL1. Power was not secured to the gloveboxes; therefore, the hot plates were still on and the evaporation process continued.

A layout of the Wing 4 basement area is shown in Figure 3-2.

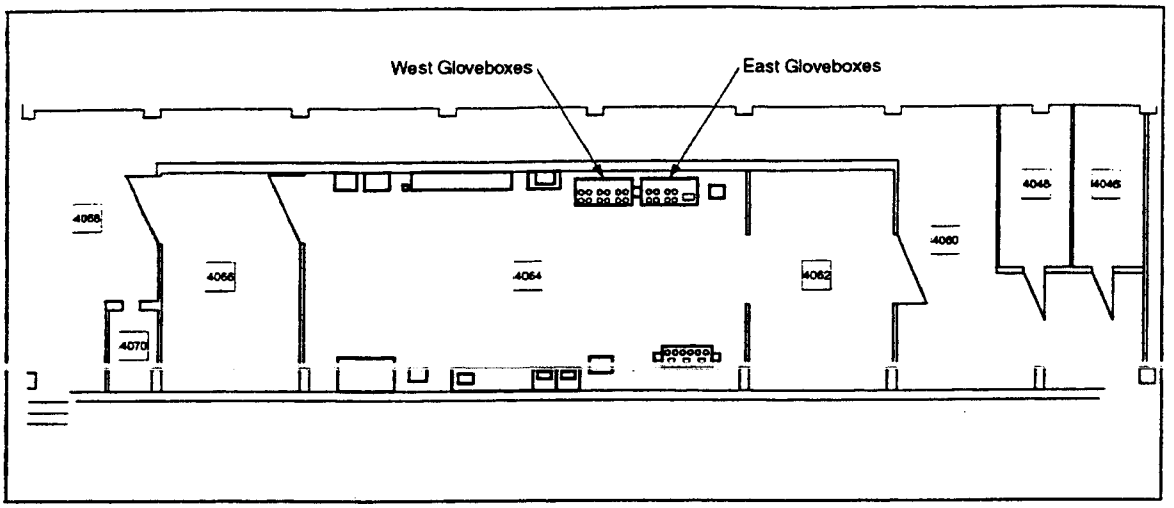


Figure 3-2. Wing 4 Basement Area

At 1253, TL1 informed the CMR operations center of the problem. Shortly thereafter, CMR, NMT, and LANL emergency response was initiated.

At 1320, a CMR employee standing near the main floor entrance to Wing 4 smelled NO_x gas (this employee had experience working with NO_x gas). Another CMR employee in the same area also smelled an unusual odor.

Between 1400 and 1430, first responders in the PORTS work area, looking past the yellow laser curtain, noted that a low-lying white haze had filled Room 4064 (this haze also cleared during this time period). Later, the responders found that the left glove in the upper-middle set of gloves in the west glovebox had "blown off." (See Figure 3-3.) Response personnel subsequently plugged this glove port (Figure 3-4).

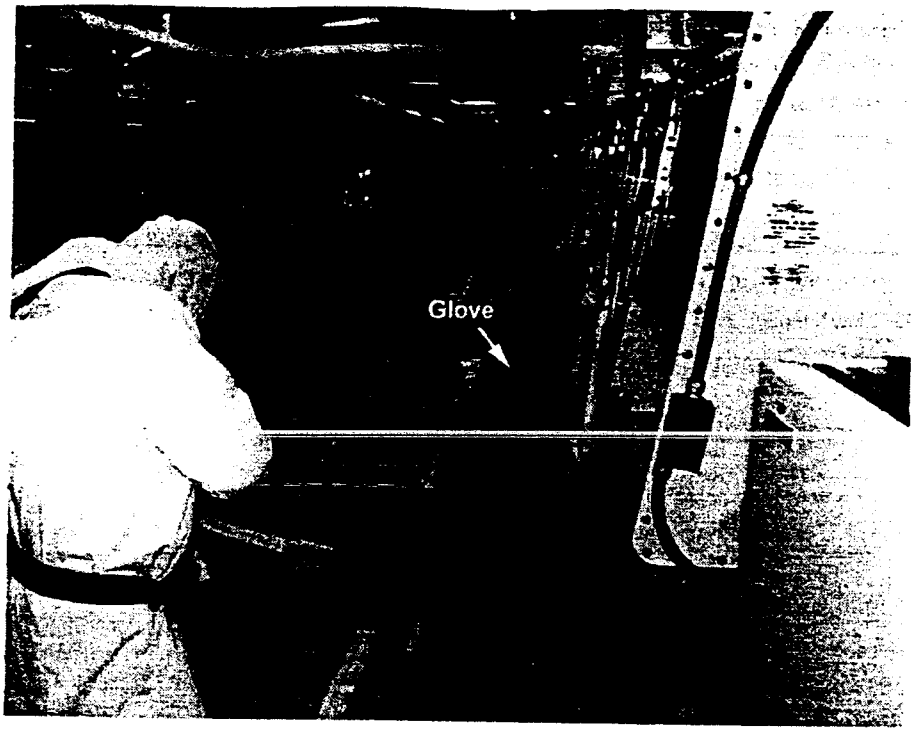


Figure 3-3. Room 4064 showing glove on floor following the incident.

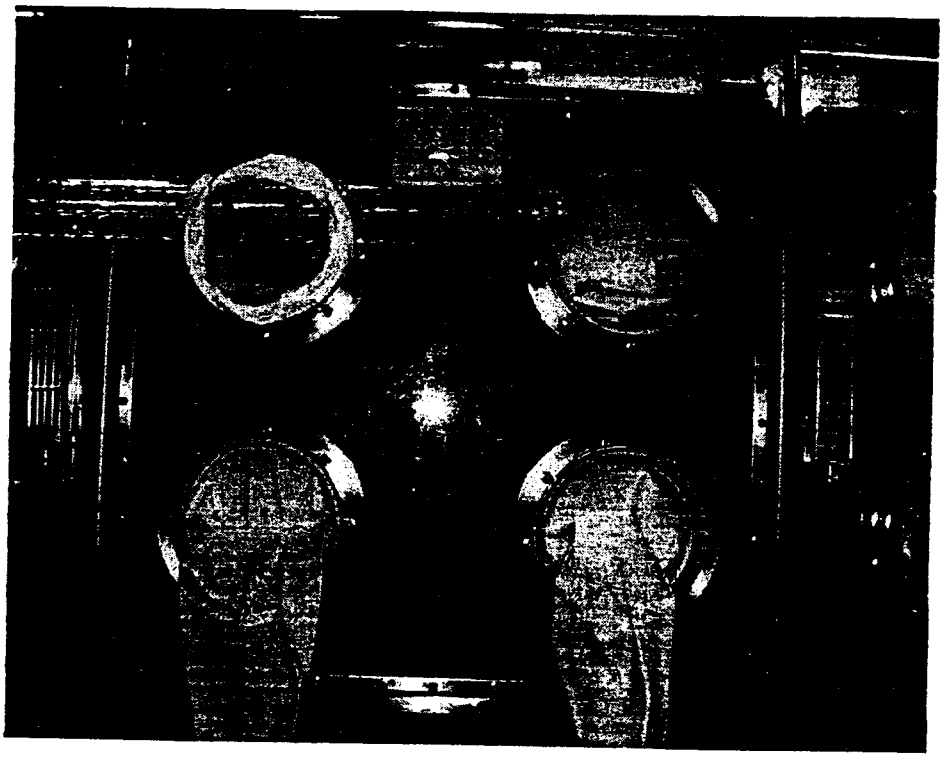


Figure 3-4. West glovebox with glove port plugged following the incident.

Between 1300 and 1600, facility personnel attempted to shut off the hot plates in the gloveboxes in Room 4064. However, due to a lack of adequate electrical drawings and knowledge of breaker locations, the source of the power could not be determined. Eventually, facility personnel physically located the breaker panel for the glovebox power, and at approximately 1630 the hot plates were shut off.

At approximately 1930, response personnel entered Room 4064 and found that the floor, equipment, and surfaces in the room were highly contaminated with Tc-99. They also found that slurry from the three hot plates had splattered all over the inside surfaces of the gloveboxes.

4.0 Post-Incident Analysis

4.1 Analysis of Solutions and Residues

Samples of the materials associated with the evaporation process were collected from the east and west gloveboxes in room 4064. Samples collected included liquid from the last 2L bottle of solution and solids from the trays, fire screens, glovebox floors, and the large beakers that contained slurry.

The liquid sample from the 2L bottle contained high levels of ammonium nitrate, parts per million (ppm) quantities of organic compounds, hydrogen peroxide, nitrite, sulfate, many transition metals including copper, nickel, zinc, Tc-99 in the form of pertechnetate (TcO_4-), and ppm amounts of uranium. The pH of the liquid was between 8 and 9. The liquid also contained some RCRA metals; two of which were present in quantities above regulatory limits: chromium at 27.9 ppm versus the limit of 5.0 ppm and selenium at 6.5 ppm versus the limit of 1.0 ppm.

Two differential thermal analysis (DTA) tests were performed on the liquid sample. A DTA test essentially consists of slowly heating a sample and observing any heat-releasing chemical reactions (exotherms) or reactions that absorb heat (endotherms). In the first DTA test, endotherms occurred as water evaporated from the sample but no exotherms were observed. In the second DTA test, the liquid was absorbed onto a piece of non-reacting zeolite ceramic to increase the surface area of the sample. No exotherms occurred when this wet sample was heated and endotherms were again observed as water evaporated from the ceramic. As heating of the remaining dry residue continued during the second DTA test, an exotherm with an approximate 20 degree-C temperature change occurred when the dry sample reached 310 degrees C.

The materials on the two fire screens were analyzed and found to have molar ratios of nitrate to ammonium ion of 1.1 and 1.0 respectively, indicating the material was essentially ammonium nitrate, with a slight enrichment of nitrate. This ratio is slightly different than the 1.2 ratio that was found in the sample liquid. The fire screen materials contained the same elements found in all other samples, indicating splattering or aerosol transport of the materials in the trays.

All samples from the trays and the floors of the gloveboxes had enrichments of nitrate ion to ammonium ion ranging from 1.4 to >48. This indicated a loss of some ammonium ion relative to the nitrate ion in the samples, possibly by formation of ammonia gas or by some other mechanism. Tc-99 was depleted relative to the other trace metals in these samples, indicating a possible loss of Tc-99 during the evaporation process. Samples in the large beakers were slightly lower in Tc-99 and showed enrichment in nitrate ion relative to ammonium ions, again probably due to a release of ammonia gas during evaporation.

Based on the collective analysis of these samples and the observations of TEC2 and other personnel before, during, and after the incident, the following is presented as the probable pressure-producing chemical reaction in the west glovebox.

It is important to note that there was no evidence of an explosive event (i.e., charring, over-turned containers, etc.).

The solutions and residues contained significant amounts of ammonium nitrate and this compound can rapidly decompose into decomposition gases such as N_2, NO_x, and water vapor. Generally, this rapid decomposition occurs at approximately 210 degrees C when the ammonium nitrate is in solid form. Although at the time of the incident, it is believed that the trays in the west glovebox were about ¾ full and the liquids were approximately 80 degrees C, the concentrated transition metals in the solutions could have catalyzed the decomposition reaction in the liquid. DTA tests of the liquid were inconclusive, however, because they only showed that dry, solid nitrate compounds would decompose. In addition, the 310 degree C initiation of the exothermic reaction noted for the sampled solution is inconsistent with the expected ammonium nitrate decomposition temperature of 210 degrees C (thus indicating that the liquid is more stable than the solid). The DTA tests were performed on the remaining solution in the 2L bottle, however, and not on the more concentrated solution that would have existed in the trays at the time of the incident.

Although the DTA test results were inconclusive, based on the following, a rapid chemical decomposition is seen as the most likely cause of glovebox pressurization.

1. TEC2 did not notice the glovebox gloves "sticking out" of the west box minutes before the incident, thus indicating that the event was not the result of a slow buildup of evaporation vapors/gases.

2. Partial clogging of fire screens and/or exhaust HEPA filters would facilitate the pressurization of the glovebox during a rapid generation of gases. It is less likely that partial clogging would prevent the release of a slow buildup of pressure. The glovebox inlet HEPA filters were examined after the incident and found relatively free from residue buildup. Although some moisture buildup (from the evaporation process) may have impeded flow through these filters, they should have served to vent pressure unless there was a rapid generation of gases in the glovebox.

3. TEC2 heard a popping sound only two to three minutes after entering Room 4062. TEC2 then saw (through a yellow plastic laser screen) brown smoke when he looked into Room 4064 immediately after hearing the popping sound. NO_x gas is brown in color.

4. Shortly after the incident, two employees at the main floor entrance to Wing 4 smelled an unusual odor. One of the employees was sure the odor was consistent with that of NO_x gas.

5. After the glove was blown off, Tc-99 contamination was released into the laboratory and evenly distributed throughout the room.

4.2 Analysis of West Glovebox and Glove

An approximate six-inch crack was found in the glass above the right, upper-middle glove port. This was the port next to the blown-off glove. No other damage was found in the glovebox.

The fire screens and outlet HEPA filters were removed from both boxes. Inspection of the fire screens in both boxes revealed that the screens were almost completely clogged with solid residues. Inspection of the HEPA filters showed that the material in the upstream side of the filters was significantly deformed and thus allowed a significant flow of air through the filter without having to pass through the filter media. (See Figures 4-1 and 4-2.)

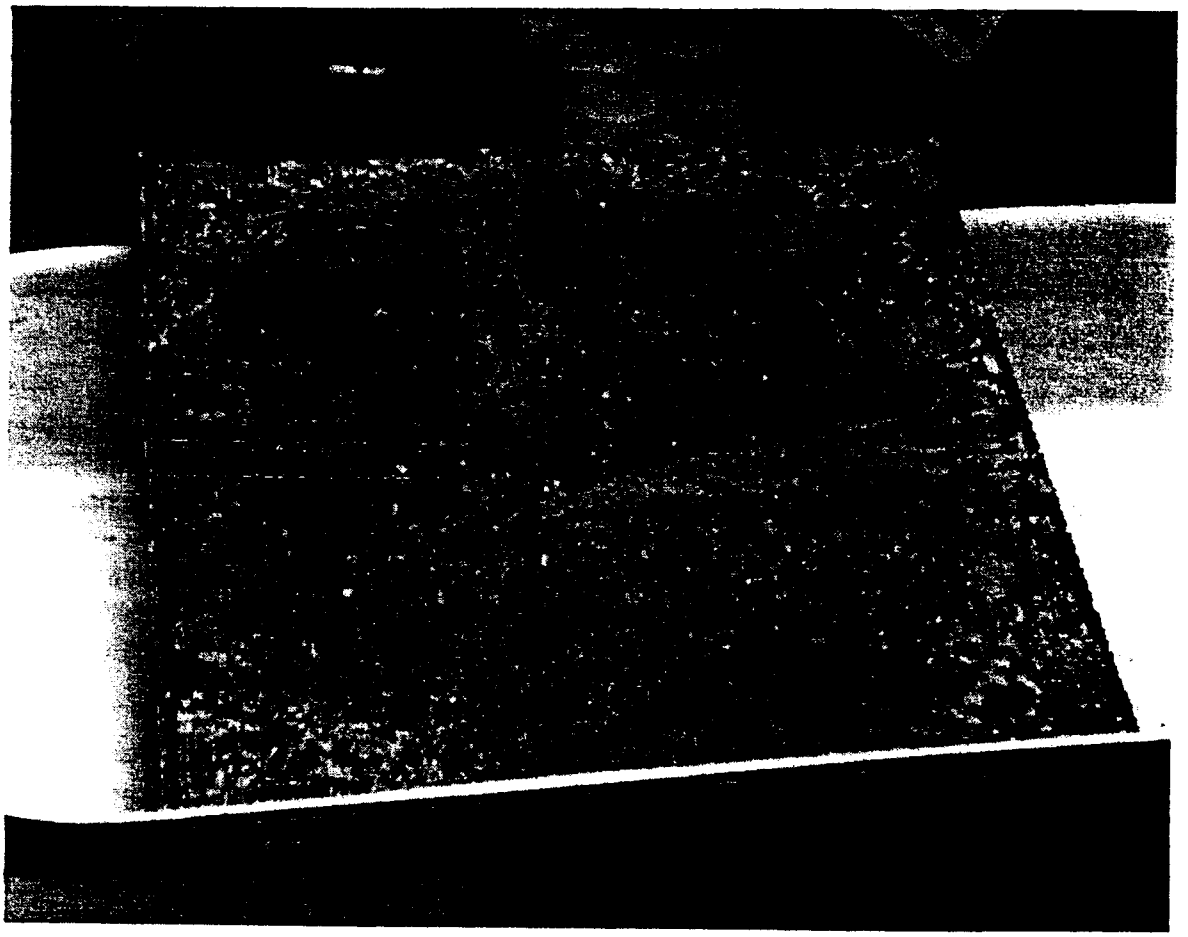


Figure 4-1. West glovebox fire screen following the incident.

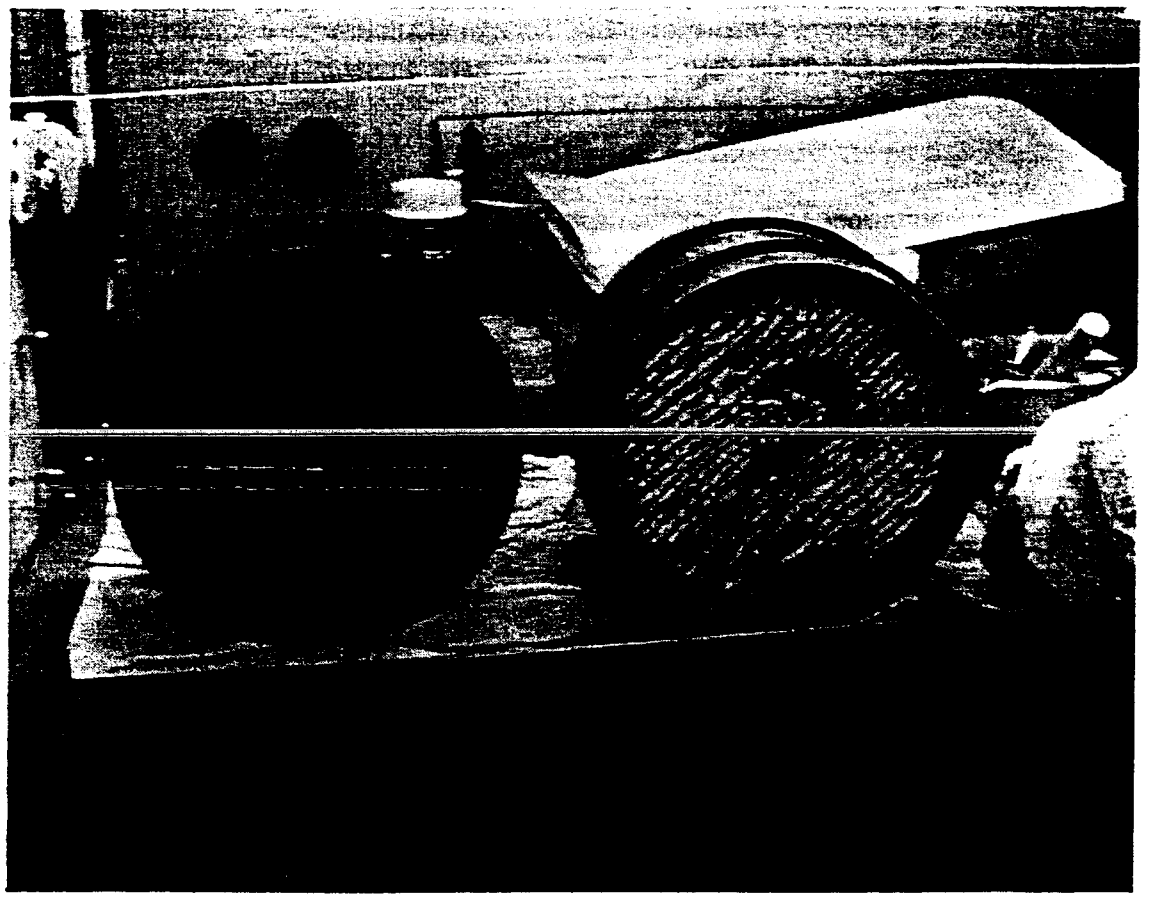


Figure 4-2. West glovebox HEPA following the incident.

The hypalon glove was manufactured by North in 1995, and had a tensile of 1900 PSI minimum. The glove was in two distinct pieces. A complete circumference rupture was located in the arm section 4 to 5 inches below the cuff where the glove was attached to the glove port. The second section had a rupture running from the arm section down to the forearm section. Dark discoloration of the white glove was noted around the inside of the cuff. The section of glove that remained in the port was white, while the section below was discolored. Manual pulling of the glove showed that it still had elasticity and was not brittle or crumbling.

Glovebox gloves have long been noted as the weakest link in a glovebox system, with the weakest portion of the glove being the arm section. Studies have shown that gloves naturally deteriorate with time and that the deterioration is accelerated by heating (as evidenced by discoloration) and frequent, stressful use.

The east and west gloveboxes were installed approximately 4-1/2 years ago. The upper gloves were also installed at that time. These gloves were rarely used and were not inspected routinely. They had never been replaced. The upper gloves were generally tied outside the boxes, particularly during the evaporation process. This tying could have

stressed the glove near the cuff where it was attached to the port. In addition, the 900 degree C calcining operation was performed in the west box below the middle glove sections. Rising heat from this operation also could have fatigued the upper set of gloves. The combination of stress from frequent tying, fatigue from heating, and then the pressurization of the box would explain the failure in the arm section of the nearly five-year old glove. (See Appendix C.)

5.0 Causal Factors

The **direct cause** of the incident was the overpressurization of a glovebox due to a rapid but non-explosive decomposition of chemical compounds while subjected to heat.

The Incident Investigation Team identified both local and systemic root causes leading to the incident.

- **Local Root Cause**—Lack of adequate line and facility management involvement in the planning, review, approval and execution of all phases of the work. (See Recommendations 1 and 6.)

- **Systemic Root Cause**—Weaknesses in the implementation of Integrated Safety Management (ISM). Multiple systems were in place to evaluate and authorize work, but they failed to ensure that all hazards, controls and responsibilities for safety were clearly identified, understood, and implemented. (See Recommendations 1, 6, 7, 18, and 20.)

Contributing causes are listed below. See Section 7 for Recommendations.

1. Inadequate group management involvement with team leaders and team activities. (See Recommendation 1.)

2. Poorly defined roles and responsibilities and training for team leaders. (See Recommendation 2.)

3. Unclear ownership of glovebox ventilation equipment. (See Recommendation 12.)

4. Poorly understood guidance for equipment and activity change control. (See Recommendations 16 and 20.)

5. Untimely change control process. (See Recommendation 16.)

6. Inadequate review and approval process for accepting work into the Laboratory. (See Recommendation 6.)

7. Lessons learned from similar occurrences not communicated. (See Recommendations 4, 5, and 18.)

8. Lack of knowledge of remote shut off locations for electrical equipment. (See Recommendation 3.)

9. Inadequate glovebox glove inspection program. (See Recommendation 14.)

10. Modifications to equipment and processes not sufficiently analyzed or authorized. (See Recommendation 10.)

11. Observed changes in equipment conditions not adequately analyzed or controlled. (See Recommendations 17 and 20.)

The following **additional issues** are not considered direct contributors to the incident. They are included either because they indicate weaknesses in overall ISM implementation or because they relate to the investigation team's charter to focus on the status of facility systems.

1. Unreliable HVAC system in the CMR basement. (See Recommendation 7.)

2. Unsealed penetrations between laboratories and adjacent rooms. Unsealed penetrations may invalidate fire wall ratings and lead to additional spread of fire, smoke, and contamination. (See Recommendation 8 and 9.)

3. Inoperable fire hose standpipe valves. (See Recommendation 15.)

6.0 Analysis and Conclusions

The incident facts are discussed below in terms of their relation to implementation of the five core functions of ISM. The five core functions of ISM are represented in Figure 6-1.

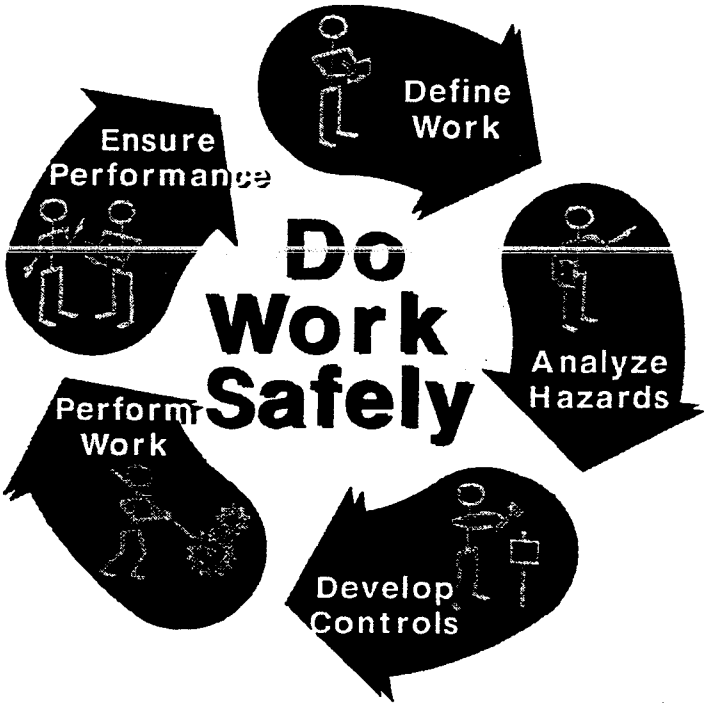


Figure 6-1. ISM five core functions.

6.1 Define the Scope of the Work

The commitment to perform the PORTS treatability study in 1996 was made without sufficient consideration or line management knowledge of the work elements and related hazards. Although MST and CST divisions shared equally in funding the study, neither organization provided effective or routine line management involvement. The CST Principal Investigator assumed day-to-day supervision of the work and remained in that position even after CST management responsibility was transferred to MST. Line management ownership was not clearly established until NMT took over CMR operations in February 1998. The PORTS team leader was not a member of NMT Division until June 1998. Although management oversight improved considerably after NMT assumed control, line management (MST, CST, and NMT) was never sufficiently aware of the specific work activities and hazards associated with the PORTS study.

- Line management was aware of the general nature of the PORTS proposal, but their approval of the PORTS contract in 1996 was neither required nor obtained. Line management approval is not required by the Laboratory procurement process.

- The Incident Investigation Team found little participation by line management in the 1996 ESH-ID process or the NMED permit approval process. Although LANL support organizations and program (NMSM) personnel were involved in the processes, no line management review or signatures were noted for either document.

- No estimate was performed of related ES&H costs (e.g., permits, waste handling, radiological monitoring equipment and support). The team estimates that these support costs easily exceeded the study's total funding of $315,000.

- RCRA mixed waste was unknowingly treated (FAS and evaporation) without a permit based on a flawed understanding of its chemical constituents and the lack of analytical data.

- Until a contamination incident occurred on August 5, 1998, Tc-99 was not identified as a significant constituent of the PORTS waste.

- The amount of HEU actually found in the samples was nearly twice that expected.

- Over 100 drums of mixed waste were accepted from PORTS, but only a fraction of this amount appeared necessary to perform the treatability study.

Changes to work activities and equipment after NMT assumed control of the PORTS project were not thoroughly discussed or reviewed with NMT-2 management. From the inception of the study, the PORTS team had nearly total control of the work, and PORTS team members were not accustomed to reviewing activities with their management. It should also be noted that NMT-2 was a large group (approximately 80 people) located in TA-55. Day-to-day involvement with the four-person PORTS project in the CMR facility was not considered practical. The NMT-2 deputy group leader often attended the weekly PORTS team meetings, however, and personally assisted in some packaging and shipping activities.

Equipment and process modifications were made without adequate review or sufficient consideration of potential hazards and impacts on existing controls. It should be noted, however, that the PORTS team leader considered the CMR change control process (CMR-QA-015, CMR Activity Approval Process) untimely. The process is primarily designed to address changes to equipment or facility apparatus, similar to the TA-55 Change Control Manual (LA-13348-M). In March 1999, an NMT procedure, Research Development and Process Control (NMT-AP-007), was issued to address work authorization for process and experimental work. The PORTS team leader was not trained on this procedure, and interviews with CMR team leaders indicate confusion regarding when to use NMT-AP-007 versus CMR-QA-015. The perception that the Activity Approval Process was cumbersome and untimely was shared by other CMR team leaders according to interviews conducted by the Incident Investigation Team. The Incident Investigation Team also found that although the timeliness of the change process had improved recently, change requests had previously not been addressed in a timely

manner. Many of the change requests working their way through the CMR change control process ranged from several months to more than a year old.

- When the decision was made to move furnace operations from the open hood into a glovebox (to reduce the chance of Tc contamination), the PORTS team leader noted that there were no fire screens in the gloveboxes to protect the HEPA filters from potential ignition sources. The PORTS team added fire screens as a safety measure, but without line management or USQD review. The modification was described in an SWP, which was reviewed and approved by CMR support and facility management. This activity should, however, have been reviewed through a USQD and reviewed and approved using CMR-QA-015. The fire screen modification adversely impacted the ability of the sensors to accurately measure glovebox pressure differential.

- Neither the PORTS team decision in early 1999 to use a ferrous ammonium sulfate process to precipitate Tc, nor the team's subsequent decision to attempt volume reduction of this sample product via hotplate evaporation, involved line or facility management review, inclusion in the CMR Activity Approval Process, or a USQD screen. However, because those were process changes based on unforeseen technical difficulties, they were not easily handled with the CMR procedure. Although NMT-AP-007 was issued during this time, it was not well communicated and neither TL1 nor his team had training or knowledge of its content. The procedure did not address re-analysis of work when new hazards are identified in existing activities.

  Specific safety responsibilities for team leaders at the Laboratory are not well defined. The Laboratory's Integrated Safety Management document recently addressed the safety role of team leaders, but their role is not clearly established in other Laboratory or CMR documents or training. In this case, the team leader's safety responsibilities were defined in his performance appraisal/job description. Those responsibilities included following the Integrated Safety Management (ISM) process and ensuring that all activities within his control were properly authorized via safe operating procedures (SOP), safe work permit (SWP), etc. The Laboratory does not require team leaders to perform safety walkarounds (team leader walkarounds are required by NMT-2 and some other organizations); team leaders are not generally provided with the same level of safety training (e.g., Dave Herbert, Safe Work Practices) as that required for line managers; and team leaders have no formal role in the performance appraisal process (though they often input appraisals for employees they supervise).

6.2 *Analyze the Hazards*

The hazards associated with the PORTS study were never well identified. Despite the various layers of hazard review—beginning with the ESH-ID in 1996 and continuing through What-if Analysis, USQD analysis, the PORTS Hazard Control Plan, and two

standdowns with associated readiness reviews—unanticipated hazards were encountered repeatedly. Although extensive processes are in place at CMR for ensuring that new work is identified and analyzed, there is essentially no guidance for analyzing new or unanticipated hazards identified during the conduct of work.

Early hazard analyses performed prior to the incident failed to identify the high levels of Tc present in the samples and significantly underestimated the amount of HEU. When these and subsequent unanticipated hazards were identified, new controls were implemented (e.g., moving operations from hoods to gloveboxes). However, no formal review (e.g., USQD) was performed to ensure that new hazards were not introduced as a result of implementing the controls.

During the conduct of their work, the PORTS team noted and informally analyzed several unanticipated process-specific hazards, such as repeatedly clogged fire screens and HEPA filters. However, these hazards were not communicated to line management, formally addressed, or addressed in SOPs.

- Several new hazards were introduced when PORTS operations were moved from hoods to gloveboxes as a control for Tc contamination. Now there was (1) a heat source (calcining furnace) directly under the glovebox gloves, (2) a potential ignition source not previously present or analyzed for the glovebox, and (3) repeated clogging of the glovebox HEPAs and fire screens as a result of the formation of ammonium nitrate during the precipitation/neutralization process.

- When the PORTS team modified their waste treatment process to add a ferrous ammonium sulfate step for precipitation of Tc, the team did not address the potential for generating additional waste stream volume. The PORTS team decided to reduce the volume of this waste stream via hot plate evaporation and then performed an informal hazard analysis in general concert with the ISM process. The hazard analysis was not documented, however, and controls were not specified in the PORTS SOPs or Hazard Control Plan. Potential hazards involved with heating, mixing, and disposal of the chemical residue were not formally addressed or uniformly understood by the PORTS team.

- After the Tc contamination event in August 1998, the PORTS team analyzed the hazards of Tc exposure to personnel, which were determined to be minimal. However, the potential for Tc contamination events and the spread of Tc to the environment were not adequately addressed. Beta hand and foot monitors were added to Room 4064, but they were used only when exiting the room. In addition, the Beta CAM initially recommended for restart was not provided based on recommendations and dose risk analysis by the Health Physics Operations group (ESH-1). The Incident Investigation Team believes that environmental and contamination hazards of Tc should have received more consideration; however, the lack of Beta monitoring provisions is not considered a contributor to the June 25, 1999 event.

6.3 Develop Controls

Necessary controls for several PORTS activities were either not identified or were insufficient due to unanticipated or inadequately understood hazards. In addition, many of the controls established for PORTS were assumed rather than ensured. Hazard analysis and control documents, such as the PORTS Hazard Control Plan and What-if analyses, repeatedly pointed to general controls (e.g., HVAC equipment maintenance, "enclosure" of processes, and checking equipment before use) without ensuring that these provisions represented reality. Many of these assumed controls were, in fact, either inadequate or ineffectively communicated and implemented. When new problems were identified, the incomplete hazard control documents were often used as the basis for further analysis. Confidence in the adequacy of these documents and the controls that they listed led to a false sense of safety. This assumption of safety may have contributed to the lack of sufficient initiative on the part of the PORTS team leader and line management to personally ensure that PORTS operations were adequately controlled.

The Incident Investigation Team noted weaknesses with assumed controls in the following areas:

Engineering Controls

- The Wing 4 HVAC is addressed in the CMR Basis for Interim Operation as a "safety significant system." The HVAC did not, however, ensure airflow from least hazardous to most hazardous areas. The Incident Investigation Team noted positive airflow from Room 4064 to adjacent non-contaminated rooms, as well as numerous unsealed penetrations to adjacent rooms where positive airflow was evident. The team was told that such positive airflows were a recurrent and long-standing problem in Wing 4 and other radiologically controlled areas in the basement of the facility. None of the many hazard analysis and restart documents reviewed by the team addressed this potential for contamination spread.

- The general exhaust from Wing 4 was not provided with HEPA protection.

- The CMR glovebox ventilation system was neither alarmed nor remotely monitored to alert personnel to potential airflow problems in the glovebox.

- The glovebox ventilation system had no preventative maintenance program. The line organization (currently NMT-2) assumed that the facility management unit (FMU) was maintaining the equipment, but the FMU considered the glovebox and its ventilation fans programmatic equipment. There was no routine program to inspect glovebox conditions (e.g., seal integrity) or airflow.

- The upper level of glovebox gloves (where the glove was breached during the incident) was original equipment (circa 1994) and was not routinely inspected for damage or degradation. It was assumed that the gloves were all right because they were not generally used. However, the gloves were routinely subjected to

heat and corrosive chemicals, as well as repeated tying. CMR POL-001 allows storage of gloves for only two years but makes no reference to how long gloves can remain in a glovebox without replacement. Investigation of the breached glove after the incident indicated discoloration consistent with degradation due to heat or other environmental factors.

- During the incident response, the CMR fire hose standpipe valves could not be opened to provide water for potential decontamination needs of the Los Alamos Fire Department. It was determined by the Incident Investigation Team that these valves had not been exercised since their installation more that 40 years ago. National Fire Codes require routine flow tests for those valves. The lack of such flow tests is a Laboratory-wide issue resulting from funding and water disposal concerns.

Procedures and Administrative Controls

Many documents identify specific controls for the PORTS study, including the PORTS Hazard Control Plan, What-if Analysis, USQD analysis, CMR Basis for Interim Operation, NMT-2 Plan for Housekeeping Standard in Rooms 4062, 4064, 4066, and 5068, and—to a lesser degree—the SOPs. However, some of these documents merely list the controls. For example, the What-if Analysis simply lists "HVAC." The PORTS Hazard Control Plan lists "Wing HVAC, negative pressure." Listed controls that require more specific actions are not generally incorporated into the SOPs. Examples of specific actions include "inspect equipment prior to use," "attended operation" (What-if Analysis), "gloveboxes will be cleaned/made orderly...on a regular basis" (NMT-2 Plan for Housekeeping Standard), and "know the location of the nearest safety shower" (PORTS Hazard Control Plan). In addition, the SOPs did not address the safe shutdown of operations as required (at TA-55) by the NMT SOP writers guide.

In the absence of updated SOPs, the PORTS team adopted informal controls to address perceived hazards associated with the hotplate evaporative process. Although these controls were reasonable, they did not include specific guidance on when to clean fire screens, replace HEPAs, and check hotplate temperature and liquid levels, or what to do in the case of an emergency (e.g., open the hotplate breaker).

6.4 Perform the Work

On the day of the incident, the work was performed within the informal controls established for the evaporation process. Prior to the incident, however, both equipment and activities were modified without using established systems for review and approval of those changes (i.e., this work was not appropriately authorized). Thus, further analysis of the work was not performed and there was limited opportunity to implement additional or modified controls that could have prevented the accident. After the glovebox was breached, worker inability to remotely de-energize the hotplates in a timely fashion contributed to additional contamination both within the glovebox and in Room 4064.

6.5 *Ensure Performance*

Feedback and improvement of the PORTS project was generally reactive. Most improvements were driven by Occurrence Reports, Radiological Incident Reports, and readiness reviews associated with stand-downs. These improvements (e.g., moving operations to gloveboxes) were not, however, adequately evaluated to ensure that new hazards did not occur as a result of the changes. Despite the multiple reviews associated with PORTS incidents and activity restarts, the adequacy of some of the most basic controls, such as room and glovebox ventilation, glovebox integrity, and revised SOPs, were never effectively addressed. In addition, related occurrences from TA-55 were not analyzed for implementation of applicable lessons learned at CMR.

NMT did, however, exhibit proactive monitoring and assessment in the form of management and support walkarounds. An NMT walkaround in April 1999 detected numerous conduct of operations deficiencies, indicating a lack of sufficient project control. Based in part on this walkaround and subsequent review, the NMT-2 group leader stopped the PORTS project on May 4, 1999. This decision limited PORTS work to project "stabilization" and waste packaging/disposal.

Three incidents involving glovebox overpressurization and contamination were previously identified at TA-55 (LANL-TA55-1994-0002, LANL-TA55-1994-0024, and LANL-TA551997-0008). No evidence exists that any of the corrective actions or lessons learned from these incidents (e.g., improved flow monitoring) were evaluated or implemented at CMR or that the PORTS team knew of those incidents.

6.6 *Integrated Safety Management (ISM) Guiding Principles*

The Laboratory has adopted eight guiding principles that provide the ISM architecture for achieving an injury free workplace (See Integrated Safety Management LA-UR-98-2837, Rev. 1). These principles are essentially the same as those found in the UC-DOE contract and are described in the ISM document as the "basis for the Los Alamos safety management system."

Eight Guiding Principles:

- Management Commitment and Worker Involvement
- Safety-Responsible Line Management
- Clear Roles
- Competence Commensurate with Responsibilities
- Balanced Priorities
- Identified Safety Standards and Requirements
- Work-Tailored Hazard Controls
- Authorized Operation

In terms of how these guiding principles were implemented in the PORTS project, the Incident Investigation Team noted some implementation weakness with nearly all eight. Three of the principles— safety responsible line management, work tailored hazard controls, and authorized operation—had significant implementation weaknesses. Their direct impacts on the incident are discussed below.

Safety-Responsible Line Management—line ownership unclear and complicated by governing documents from multiple organizations

Clear ownership for the PORTS project was not established until well after the work was accepted by the Laboratory. Line management involvement in acquiring the PORTS project and analyzing it for potential hazards was minimal

The team leader for the PORTS study directed the day-to-day activities associated with the project from its acquisition in 1996 to its termination and ongoing cleanup activities. Ownership of the project (and its funding) was originally split between MST and CST, but CST transferred PORTS oversight to MST in 1997. The PORTS team leader remained a CST employee although he supervised the work of MST employees and MST had assumed responsibility for the project. Beyond the team leader's involvement, there was little management involvement or oversight of the PORTS work until NMT took over the work in February of 1998. The PORTS team leader remained a CST employee, however, until June of 1998. Although NMT management gradually increased its involvement and oversight of the PORTS work, they had no knowledge of the activities directly leading to the incident.

Procedures governing the PORTS work after February of 1998 consisted of MST documents (PORTS Hazard Control Plan), CST documents (USQD, Emergency Plan for the CMR Building), and various NMT documents. It was not clear to the team leaders interviewed whether NMT AP-007 or CMR QA-15 was the appropriate document governing changes to activities at the CMR facility.

Work-Tailored Hazard Controls—hazards not adequately identified or understood, controls insufficiently verified and non-specific to the work.

Hazards associated with the PORTS study were poorly understood from the beginning of the project. Multiple reviews of the PORTS work failed to identify hazardous components of the waste materials, the potential for glovebox degradation, or material reactivity. When these and/or other unanticipated hazards were encountered, the work was not sufficiently re-evaluated to ensure safety.

Although some appropriate controls such as the glovebox ventilation system and the glovebox gloves were identified, the controls were insufficiently verified to ensure their effectiveness. Maintenance and surveillance activities for these controls were either informal or in some cases (e.g., glovebox booster fan) non-existent. When new controls were added to address unanticipated hazards, they were insufficiently analyzed. For example, moving activities into gloveboxes after high levels of Tc-99 were discovered in

the PORTS waste was not analyzed for its impact on the glovebox ventilation system or for the potential heat impact of a 900 degrees C furnace on the glovebox gloves.

The PORTS team periodically implemented activity level controls such as refilling evaporative pans when they were less than half full, keeping evaporative pan contents at less than 80 degrees C, and cleaning fire screens. These controls were informal, however, and implemented differently by different members of the PORTS team. These activity level controls were also not addressed in the SOPs or the Hazard Control Plan governing the work.

Authorized Operations—work accepted and "authorized" without adequate analysis of hazards and controls. The Laboratory "authorized" the PORTS waste study when the contract to perform the work was signed in September of 1996. This authorization occurred without adequate analysis or line management review. At least three problems resulted from weaknesses in the initial review and analysis.

1. Instead of accepting the minimal amount of waste needed to perform a treatability study, the Laboratory accepted all 111 drums of the PORTS waste.

2. The support costs for the study were never analyzed; ultimately, the costs far exceeded the revenue from the project ($315,000).

3. The suitability of the proposed location for the work was not formally analyzed until a USQD was performed nearly one year after the contract was signed.

Better management review (i.e., authorization) of the PORTS study could have resulted in the acceptance of significantly less waste, funding that better matched the costs, and designation of a more suitable location for performing the work.

After the CMR stand-down in September 1997, the PORTS work was authorized for restart in April 1998. The WAP, which served as the basis for the PORTS restart, contained numerous hazard/control analyses and checklists. These documents were reviewed and, in most cases signed, by appropriate management. The WAP was deficient, however, because it still failed to identify the high levels of technetium in the PORTS waste, did not adequately verify the effectiveness of controls, and did not ensure that activity level controls (Hazard Control Plan or SOPs) were tailored to the work.

The PORTS work was again reviewed and authorized in October 1998 after a two month shutdown. The shutdown resulted from a contamination incident and the resultant discovery that some of the PORTS waste contained high levels of Tc-99. As a result of the incident investigation, additional controls were identified and implemented as requirements for restart. These controls were not, however, well analyzed for their potential impact on safe operation. The principal "new control" was to move operations from open hoods into gloveboxes. This control was not analyzed as a new activity, however, and its potential impact on glovebox ventilation and gloves was not addressed.

The disposal of potentially significant volumes of technetium-contaminated residue was also not addressed prior to restart.

In addition to reviewed and documented work authorizations, some changes were also made to equipment and activities without using all established processes for review and approval of such changes (e.g., fire screen additions). Additional changes, such as waste treatment with FAS and evaporation of the liquid waste resulting from FAS treatment, were made without the knowledge of facility or group management.

Some of the FAS treatment occurred after the NMED treatability permit had expired, and chemical analyses after the incident indicate that some RCRA constituents in excess of regulatory action levels were present in the waste. Thus PORTS personnel were unknowingly treating regulated waste without the required permit.

7.0 Recommendations

Each organization assigned a corrective action should develop a corrective action plan including projected completion dates. These corrective action plans should be forwarded to AA-1 (MS G998) for documentation and tracking.

Institutional Recommendations

1. The Deputy Laboratory Director for Operations (DLDOPS) should ensure that all organizations that employ team leaders establish routine group line management interaction with the team leaders to review work activities and related environment, safety and health issues.

2. The DLDOPS should ensure that team leaders in all organizations that employ team leaders receive at least the same level of safety training and accountability for safety (e.g., performance appraisals) provided for other line managers in their organizations.

3. The DLDOPS should ensure that all Laboratory organizations performing potentially hazardous operations ensure that all workers involved in those operations know where to remotely deenergize their equipment.

4. ESH-7 should ensure that institutional lessons learned from this incident are identified and communicated throughout the Laboratory. (Also see Recommendation 20.)

5. The Quality Improvement Office (QIO) should ensure that enhancement of the Laboratory Lessons Learned program is specifically addressed in the ongoing performance assurance improvement initiative.

6. AA-3 should ensure that the contracting process for accepting work is assessed to determine whether there is adequate line management and support review prior to accepting work at the Laboratory. The assessment should also determine whether support (e.g., ES&H) costs are adequately considered before accepting work.

7. ESH should ensure that the ESH review process for new work (i.e., ESH-ID) is revised and communicated to provide assurance that ES&H issues are adequately addressed and that the new work is "authorized" by line management responsible for the work prior to its acceptance at the Laboratory.

NMT Recommendations

8. Evaluate the suitability of radiological and other hazardous work in the CMR basement given the potential for airflow from these areas to less contaminated and/or less protected areas.

9. Evaluate radiological and hazardous work areas with unsealed wall, floor or ceiling penetrations for the adequacy of contamination control measures.

10. Evaluate the impact of unsealed penetrations on the CMR fire hazard analysis (i.e., fire rated walls).

11. Review the DOE Health Physics Manual of Good Practices at Uranium Facilities and ensure that relevant information is communicated to appropriate personnel.

12. Perform a USQD for the addition of fire screens to the Room 4064 gloveboxes.

13. Consider a "backward looking" USQD for the FAS and evaporative processes and the addition of the calcining furnace into the glovebox.

14. Ensure that ownership (facility vs. programmatic) of all equipment (e.g., gloveboxes and their ventilation systems) is established and communicated, and that appropriate maintenance programs are established.

15. Ensure that ALL glovebox gloves are inspected for damage or deterioration at appropriate intervals. The need for a routine replacement interval should also be considered.

16. Repair and/or replace fire hose standpipe valves and ensure that routine maintenance and inspection programs for these valves are in place.

17. Ensure that the CMR change control process for both equipment modifications and activities is communicated and understood by CMR personnel. Current efforts to improve the timeliness of the change process are commendable and should also be communicated.

18. Develop and communicate guidance for re-analyzing work when unanticipated conditions and/or hazard changes are observed.

19. Evaluate TA-55 glovebox overpressurization incidents for corrective actions applicable to the CMR facility.

20. Ensure that lessons learned from this incident are shared with all NMT groups at CMR and TA-55 and acted on as appropriate. Lessons learned should include the following:

    a. The need for re-analyzing (and stopping if necessary) work when unanticipated hazards or ineffective controls are identified.

    b. The importance of applying the principals of ISM, in addition to any required reviews (e.g., USQDs), when performing or modifying work.

c. The importance of having a defined path forward for all materials (e.g., waste) used or generated during activities.

d. The need to ensure that operability criteria and provisions for routine maintenance exist for the controls (e.g., HVAC, gloveboxes) and that provisions are established to ensure that controls work effectively.

Appendix A—Acronyms

AB	authorization basis
AWS	area work supervisor
C	centigrade
CAM	continuous air monitor
CMR	Chemistry and Metallurgy Research
DLDOPS	Deputy Laboratory Director for Operations
DOE	Department of Energy
DOE-AL	DOE Albuquerque Office
DOE/LAAO	Department of Energy Los Alamos Area Office
dp	differential pressure
dpm	disintegrations per minute
DTA	Differential Thermal Analysis
ESH	environment, safety, and health
ESH-ID	environment, safety, and health identification
FAS	ferrous ammonium sulfate
FMU	facility management unit
HCP	hazard control plan
HEPA	high-efficiency particulate air/adsorption
HEU	highly enriched uranium
HP	health physicist
HVAC	heating, ventilation, and air conditioning
ISM	Integrated Safety Management
IV	independent verification
kgs	kilograms
L	liters
LLW	low level waste
LMES	Lockheed Martin Energy Systems, Inc.
MW	mixed waste

MOU	memorandum of understanding
NMED	New Mexico Environmental Department
NMT	Nuclear Materials Technology
NO_x	nitrous oxides (gas)
Pu	plutonium
PORTS	Portsmouth Gaseous Diffusion Plant
ppm	parts per million
QIO	Quality Improvement Office
RCRA	Resource Conservation and Recovery Act
RWP	radiation work permit
SME	subject matter expert
SNM	special nuclear materials
SOP	safe operating procedure
SOW	statement of work
SWP	safe work permit
Tc-99	technetium-99
U	uranium
ULISSES	Uranium Line for Special Separation Science of Enriched Scrap
USQD	Unreviewed Safety Question Determination
WAC	waste acceptance criteria
WAP	work authorization package
WFO	work for others

Appendix B—CMR Incident Investigation Team Members

Name	Organization	Phone	E-Mail	Mailstop
James J. Loud Incident Investigation Team Leader	AA-2 Group Leader	5-8719	jloud@lanl.gov	G783
Stephen Yarbro	NMT-2 Group Leader	7-2333	syarbro@lanl.gov	E511
Gary Peterson DOE Observer	DOE/LAAO	5-5937	gpeterson@doeal.gov	A316
Lily Reese	ESH-14	5-8767	lily-r@lanl.gov	P949
Gary W. Read	ESA-EPE Deputy Group Leader	7-5230	read@lanl.gov	J576
Moses Attrep, Jr.	CST-DO Team Leader	7-0088	mattrep@lanl.gov	J515
Alexander R. Romero	AA-2/TSM	7-0750	arr@lanl.gov	G783
Veronica P. Martinez DOE Observer	DOE/LAAO	7-4140	vmartinez@lanl.gov	A316
Zita V. Svitra	NMT-DO (CMR Upgrade)	7-7616	zsvitra@lanl.gov	G751
Marc Clay	ESH-7	5-0033	mclay@lanl.gov	K999

Appendix C—Glove Information

John Macdonald, NMT-3
Warren Steckle, MST-7

On July 29,1999, an observation visit was performed at CMR building, Wing 4 basement, west glovebox concerning an 8Y1530 glove failure. Persons present during this evaluation included Brad Schake, Barbara Stevens, Lynn Miller, and John Macdonald. The failed glove was observed in a hood, and a Radiation Work Permit (RWP) was followed while working with the glove.

Results of the Failed Glove Observation

The 8Y1530 glove was in two distinct pieces. A complete circumference rupture was located on the arm section approximately 4 to 5 inches below the cuff portion of the glove. This is shown in Figure C-1.

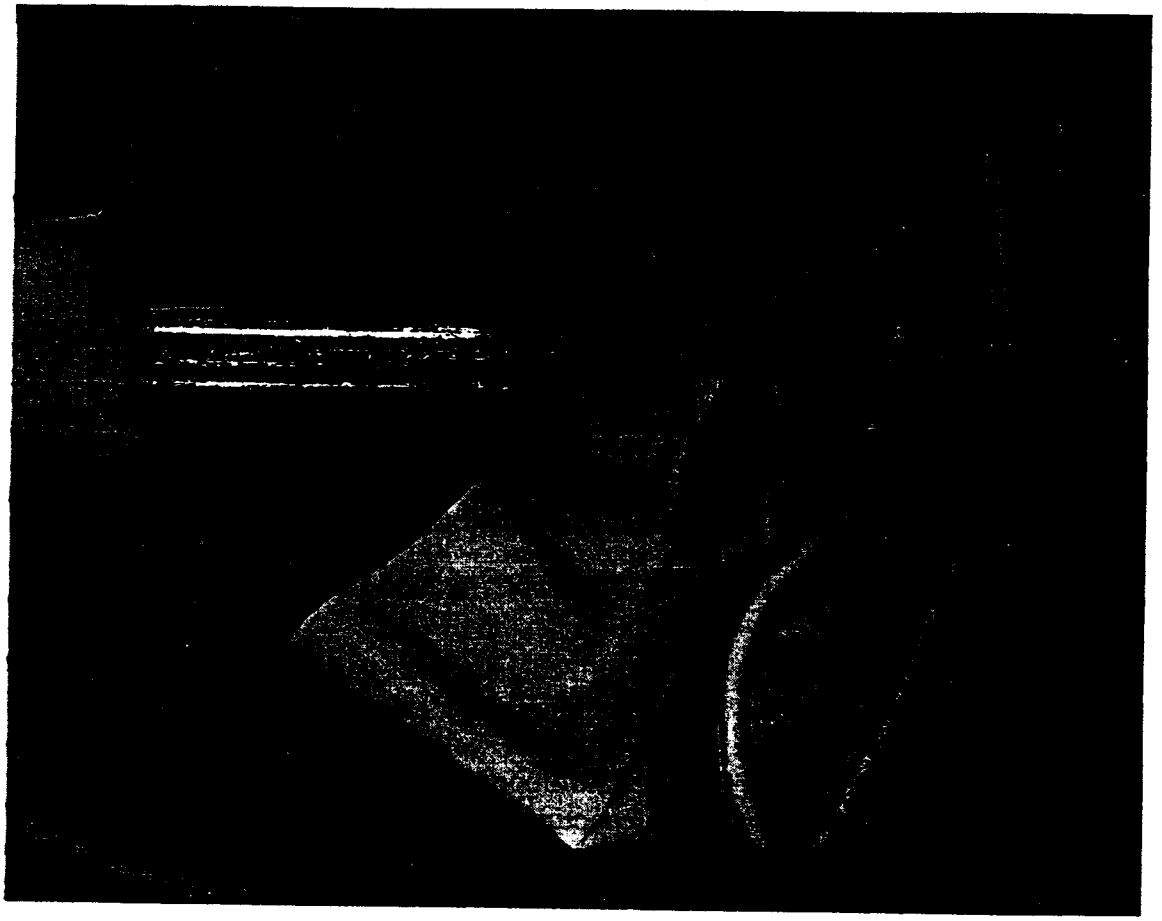


Figure C-1. Close-up of the Torn Glove Section

The second section of glove contained a rupture running from the arm section down to the forearm section of the glove. Further measurements should be taken to validate/correct estimated lengths. Discoloration of the hypalon glove was noted around the cuff sections (black discoloration); the section of the glove that was contained in the port was white while the section below the port area was discolored. Some of the discoloration can be seen in Figure C-2.

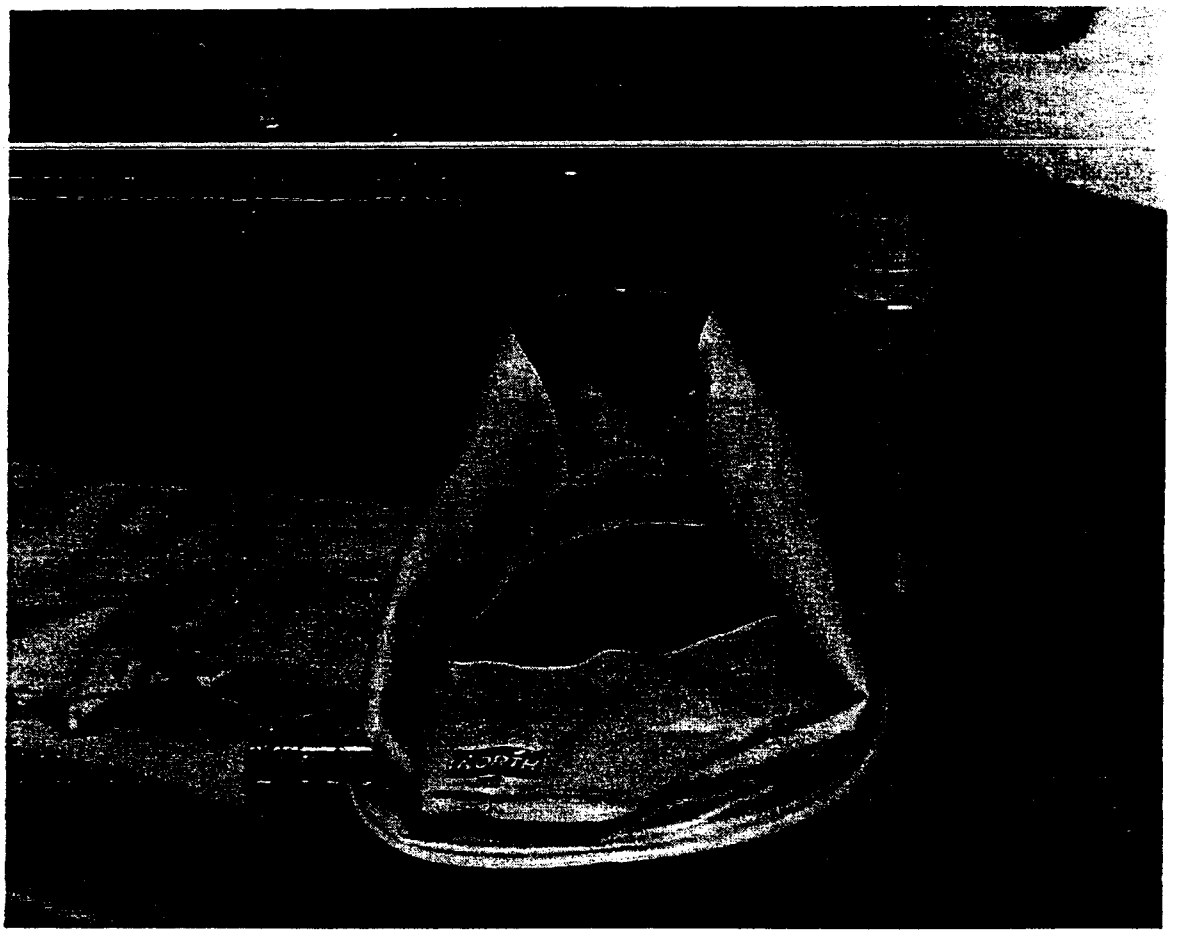


Figure C-2. Portion of the Discolored Portion of the Failed Glove

When the glove was manually pulled, it still contained elasticity and did not indicate total elasticity degradation (i.e., brittle and crumbling) as noted in aging tests performed by Warren Steckle and K.V. Wilson of MST-7. The section portion of the glove was found approximately 4 to 5 feet away from the gloveport. The glove was located on the upper row of gloveports in gloveport 3 when counting from the left to the right. Upper gloveport 4 has a crack in the glass radiating from the port. During the interviews it was reported that upper gloveport 3 and 4 and lower gloveport 1 and 2 gloves were inflated during the incident while all the other gloves remained inside the glovebox.

The process in the glovebox included two hot plates reaching temperatures of approximately 300 degrees C. Previous work in the glovebox included processes that required heating a furnace to 900 degrees C. Hypalon degrades in high temperature environments. Warren Steckle is conducting current research to attempt to quantify heat degradation with aging studies on various gloves.

The 8Y1530 glove was manufactured by North. Markings on the glove included 8Y15 Jan. 27, 95 D5216. The current specification from North cites a tensile of 1900 PSI minimum.

The weakest link in an engineered system is usually where failure occurs, and glovebox gloves have long been noted as being the weakest link in a glovebox system. Based on lead x-rays evaluation of 8YLY3030 conducted by Julio Castro, the weakest section of the glove occurs on the arm section.

The dipping process during the manufacturing of the glovebox gloves creates irregularities of surface thickness. The thinnest or weakest area of the glove is usually on the arm section of the glove. This coincides with the circular arm failure of the first section of the glove.

Appendix D—List of Interviewees

Organization	Job Title	Interview	Reason for Interview
NMT-2	PORTS/Uranium Team Leader	6/30/99, 7/15/99,7/16/99	Team Leader for PORTS Work
NMT-2	Uranium Team Technician	7/1/99	Present during the incident
NMT-13	Operations Team Leader	7/1/99	Operations Center contact for ventilation
ESH-1	Radiation Control Technician	7/2/99	Initial responder
ESH-1	Radiation Control Technician	7/2/99	Initial responder
NMT-2	Uranium Team Technician	7/6/99	Performed various PORTS operations
ESH-1	Radiation Control Technician	7/6/99	Assigned as Wing 4 RCT
NMT-2	Uranium Team Technician	7/7/99	Performed various PORTS operations
NMT-2	Deputy Group Leader	7/7/99	NMT-2 Management
ESH-19	RCRA Expert	7/9/99	RCRA Impacts
DX-2	Lab Associate	7/19/99	Potential reactions for GB pressurization
DX-2	Explosives Expert	7/19/99	Potential Reactions for GB pressurization
NMT-13	HVAC Expert	8/4/99	HVAC Impacts
NMT-2	Group Leader	6/30/99 and ongoing	NMT-2 Management
NMT-3	Glove Expert	7/29/99	Glove inspection

Appendix E—List of Documents Reviewed

Correspondence

Statement of Work (SOW): "Processing and disposal of HE mixed waste" Prepared by Lockheed Martin Energy Systems (LMES) Environmental Management & Enrichment Facilities Piketon, OH, June 1996

Letter Eugene Gillespie, Site Manager Portsmouth Site Office Oak Ridge (OR) Operations Office "Status of Recommendations for Processing HE Mixed Waste" July 11, 1996 LMES-1179-96

Letter John FitzPatrick CST-7, Mike West MST-5 to Bill Linck LMES Portsmouth "Clarification of Questions about Treatability Study" July 19, 1996 CST-7:96-001

Letter Mike West, John Fitzpatrick CST-7 to Holly Wheeler Benson ESH-19 "Notice of Intent to Conduct Treatment Study" August 22, 1996 MST-5/CST-7- CMR-001

Letter Holly Wheeler Benson ESH-19 to Jody Plum LAAO to Benito Garcia NMED "Treatability Study Notification" LAAMEP:6 OP-017 September 27, 1996

Letter Benito Garcia NMED to Jody Plum LAAO "Treatability Study Approval" November 19, 1996

Letter Jody Plum LAAO to Jim White ESH-19 "Transmittal to Approval" November 22, 1996

Hazard Analysis "What if PORTS' CMR-USQ-96-038 August 22, 1996

Letter Jack Ellinger ESH-19 to Jody Plum LAAO "Effect of CMR Standdown on Seven Treatability Studies" ESH-19:97-0251 September 16, 1996

Letter Jody Plum LAAO to Benito Garcia NMED "Effect of CMR Standdown on Treatability Studies"

Interagency Work Order No. PJT 20045 for $300K "Conduct Uranium Recovery From Waste" based on SOW July 1996

IWO No. PJT 20046 for $15K "Ship Secondary Waste to Envirocare"

SOW "Disposal of LLMW" December, 1996

Letter Earl Whiteman DOE-AL to Eugene Gillespie DOE-OR "Agreement Regarding Return of 69 cans of Gunk to Portsmouth and Return of 5 UF_6 Cylinders to LANL" May 26, 1999

Letter S.L. Yarbro LANL to John Shoemaker Bechtel-Jacobs "Notification to End Treat Study" NMT-2:FY99-089 May 4, 1999

Letter Jody Plum LAAO to James Bearzi NMED "Delay in Returning Unused Samples and Residue" LAAME 6JP-135 June 2, 1999

Letter George Werkema DOE-AL to Randy Erickson LANL "Authorization to Receive Residues from Portsmouth" April 22, 1997

Procedures and General Work Authorization Documentation

"Research, Development and Process Work Control" NMT-AP-007, R0, March 13, 1999

"CMR Activity Approval Process" CMR-QA-015, R01, March 16, 1998

"CMR Hazards Assessment/Hazard Analysis Procedure" CMR-QA-020, R00, October 31, 1997

"Radiation Protection Practices in the CMR Facility" CMR-POL-001, R04, October 31, 1996

RCRA Information Brief, "Types of RCRA Permits" DOE/EH-413/9715, September 1997

"CMR Readiness Review Plan" CMR-PLA-015, R01, February 28, 1997

"Unreviewed Safety Question Determination" CMR-QA-022, R00

"Safe Work Practices" LIR 300-00-01.0, January 16, 1998

Administrative Requirement AR 1-10, "Environment, Safety and Health Questionnaire"

"Management Evaluation Report for the Chemistry and Metallurgy (CMR) Facility Basis for Interim Operations (BIO)" Los Alamos Area Office, August 28, 1998

"Quality Management Plan Interface Working Agreement for NMT-2" April 6, 1999

North Safety Products Product Specification Catalog No. 8Y1530, "Glovebox Glove Specifications" October 12, 1998

Management Walkarounds

Management Walkaround No. NMTFRW00002486, Assessors Paul Hoover ESH-1 and Kent Sasser NMT-10, "Observed Uranium Operation in Room 4064" April 21, 1999

E-Mail Paul Hoover ESH-1 to Kent Sasser NMT-10 "Corrective Action Plan for NMT-2 Uranium Operations" April 28, 1999

Management Walkaround No. NMTFRWA00000817, Assessor Tim George NMT-9, "Walkdown on Ulissess Operations" January 16, 1998

Management Walkaround No. NMTFRWA00001293, Assessors Stephen Schreiber NMT-2 and Wayne Punjak NMT-2, "Calcination Procedure NMT2-UC-WP5-006/0" June 4, 1998

Management Walkaround No. NMTRFWA00001287, Assessors Joel Williams NMT-2, Stephen Schreiber NMT-2 and Wayne Punjak NMT-2, "Uranium Dissolution NMT11-UC-WP5-003/0" June 4, 1998

Management Walkaround No. NMTRFWA00001289, Assessors Joel Williams NMT-2, Stephen Schreiber NMT-2 and Wayne Punjak NMT-2, "Precipitation Procedure for Uranium Process Chemistry NMT2-UCWP5-005/0" June 4, 1998

Management Walkaround No. NMTRFWA00001384, Assessors Joel Williams NMT-2, John Fitzpatrick NMT-2 and Wayne Punjak NMT-2, "Waste Handling Procedures for Uranium Operations NMT11-UC-SP5-013/0" June 18, 1998

Management Walkaround No. NMTRFWA00002247, Assessors Stephen Schreiber NMT-2 and John Fitzpatrick NMT-2, "Accident/Incident Investigation, Uranium R&D Operations NMT11-UC-WP5-014/0" February 10, 1999

Management Walkaround No. NMTRFWA00002441, Assessor Eric Ernst NMT-13, "Facility Maintenance Procedures" April 4, 1999

Radiation Incident Reports (RIR)

RIR No. 98-29-4064-115, "Skin Contamination" August 8, 1998

RIR No. 99-29-4064-8, "Skin Contamination" January 15, 1999

RIR No. 99-29-4064-17, "Uranium Metal Reduction/Depleted Uranium Reaction" February 4, 1999

RIR No. 99-29-4064-67, "Area Contamination" April 16, 1999

RIR No. 99-29-4064-63, "Skin Contamination" April 16, 1999

Occurrence Reports

Occurrence Report No. ALO-LA-LANL-CMR-1998-0033, "Tc-99 Contamination Detected on the Face and Arm of an NMT-2 Employee after Working in Wing 4, Room 4064, of the CMR Facility" August 8, 1998

Occurrence Report No. ALO-LA-LANL-CMR-1999-0009, "Skin Contamination" April 16, 1999

Occurrence Report No. ALO-LA-LANL-CMR-1999-0020, "Widespread Beta Contamination in Laboratory as a Result of a Glove Coming Off Glovebox" June 25, 1999

Occurrence Report No. ALO-LA-LANL-TA-55-1997-0008, "Potential Glovebox Pressurization" January 31, 1997

Occurrence Report No. ALO-LA-LANL-TA55-1994-0024, "Actuation of Continuous Air Monitor Alarm with Personnel Contamination" July 28, 1994

Work Authorization Package for Uranium Operations

Memo to CMR Resumption File from Jon Nielsen, Review of Package, Activities for Room 9120W (ULISSES)

Memo to CMR Resumption File from John FitzPatrick, Current Status of ULISSES

Resumption Checklist

Activity Description: Uranium Process Chemistry, by D. Knobeloch, J. Nielsen, J. FitzPatrick

Personnel Qualification

Memo to Jon Neilsen from John Phillips, Designation of Jon Nielsen and Dan Knobeloch as Subject Matter Experts

Memo to John FitzPatrick as Subject Matter Expert for CMR Resumption Package

Memo to CMR Resumption File, Personnel Qualifications Uranium Process Chemistry/ULISSES

Resume of Dan Knobeloch

Resume of John FitzPatrick

Resume of Michael Martinez

Resume of Kathleen Romero

Resume of Mary Esther Lucero

Training

Memo to CMR Resumption File from John FitzPatrick, Required Training Verification that the Training Requirements are Satisfied/EDS Training Reports

Activity Location: ULISSES, Rooms and Areas of ULISSES Operations

Facility Equipment

Facility Equipment for Uranium Process Chemistry/ULISSES, Rooms and Equipment

Memo from Bob Quintana to John FitzPatrick, Facility Checklist for Confirmation of Operational Status

Facility Checklist for Confirmation of Operational Status

Checklist for Radiation Protection

Activity Equipment: Memo to CMR Resumption File, from John FitzPatrick, Verification of Readiness of Activity Specific Equipment

Support Dependency

Memo to CMR Resumption File from John Fitzpatrick, Verification of Support Dependencies

Material Introduction for Uranium Process Chemistry/ULISSES

Final Product and Required Records for Uranium Process Chemistry ULISSES

Memo to CMR Resumption File, from John FitzPatrick, Waste Generation and Verification of Readiness to Handle Waste

ISAR Authorization

Project Name Hazard Assessment

ULLISSES SOPs

List of Step by Step Procedures

Hazard ID

Uranium Chemistry Procedure for Packaging and Repackaging, NMT11-UC-WP5-001/0

Introduction and Removal of Material for Uranium Process Chemistry, NMT-11-UC-WP5-002/0

Dissolution Procedure for Uranium Process Chemistry, NMT11-UC-WP5-003/0

Ion Exchange and Extraction Chromatography Procedure for Uranium Process Chemistry, NMT11-UC-WP5-004/0

Precipitation Procedure for Uranium Process Chemistry,
NMT-2-UC-WP5-005/0

Procedure for Blending of Uranium Process Chemistry,
NMT2-UC-WP5-012/0

Calcination Procedure for Uranium Process Chemistry,
NMT2-UC-WP5-006/0

Oxidation of U Skulls land Hot Tops to U3O8,
NMT2-UC-WP5-006/0

Hydrogen Reduction Procedure for Uranium Process Chemistry,
NMT2-UC-WP5-007/0

Photolysis Procedure for Uranium Process Chemistry,
NMT11-UC-WP5-009/0

Electroreduction Procedure for Uranium Process Chemistry,
NMT11-UC-WP5-008/0

Procedure for Converting UO2 to UF4 Using Ammonium Bifluoride (NH4F-HF) or Anhydrous Hydrogen Fluoride (HF) for Uranium Process Chemistry,
NMT11-UC-WP-010/0

Memo to CMR Resumption File, from John FitzPatrick, Group Change for Uranium Chemistry Team from MST-5 to NMT-2, 3/24/98

Safe Operation Procedure, Laser Initiated Reduction of Actinide and Transition Metal Halides by Calcium Metal,
NMT11-UC-WP5-014/0

Laser Safety Note, Panic Buttons

Waste Handling Procedure for Uranium Process Chemistry,
NMT11-UC-WP5-013/0

Uranium Chemistry Procedure for Changing Glovebox Gloves,
NMT02-UC-WP5-0017/0

Memo to CMR Resumption File, from John FitzPatrick, Effective Procedure, Review of Procedures for the Uranium Process Chemistry/ULISSES

Memo to CMR Resumption File, from John FitzPatrick, Engineering Controls and Verification

Engineering Controls/Good Practices for Uranium Process Chemistry

Memo to CMR Resumption File, from John FitzPatrick, Record of Completion of WBS Training (Uranium Process Chemistry/ULISSES)

Hazards Review: Memo to CMR Resumption File, from John FitzPatrick, Hazards Review/Verification

MST-5 Resumption Approach Plan for Uranium Process Chemistry/ULISSES, (Rev.1) 12/15/97

MST Hazard Control Plan, Uranium Process Chemistry/ULISSES 12/5/97

What IF ULISSES:Process Flow Diagram Steps for ULISSES/What if Analysis

USQD

Memo to CMR Resumption File, from John FitzPatrick, ULLISES USQD

Memo to Doug Vance from Evelyn Mullen, USQD for the UF6 Inventory Reduction Project at CMR

Memo to J. Neilson from Theresa Cull, USQD for UF6 Inventory Reduction Project USQ Determination for Uranium Hexafluoride Inventory Reduction Project at CMR

Uranium Process Chemistry/ULLISSES Task Area Procedure List

Chemical Hygiene Plan, LS106-01.1

CMR Document, TRU Waste Bag Out for Certified WIPP Waste, CMR-SOP-006

CMR Document, CMR Waste Management Plan, CMR-PLA-001, R02

CMR Document, Emergency Plan for the CMR Building, CMR-PLA-003, R00

CMR Document, Radiation Protection Practices in the CMR Facility, CMR-POL-001, R04

CMR Document, CMR Policy on Normal Working Hours, CMR-POL-002, R03

Criticality Safety Review

Index for Criticality Issues in the Uranium Process Chemistry/ULISSES

Memo to Michael West, From Stuart Vessard, Preliminary Criticality Safety Evaluation of the ULISSES Operations (DRAFT) 4/17/97

Memo to John FitzPatrick from John Phillips, ESH-6 Criticality Safety Guidance for Portsmouth Treatability Studies

Memo to John FitzPatrick from R. W. Brewer, Criticality Safety Limits for the Portsmouth Treatability Study, 8/18/97

Preliminary Criticality Safety Evaluation for the ULISSES Process Wet Vacuum System

Memo to CMR Resumption File, Laser Standard Operating Procedure

Portsmouth Treatability Studies Work Authorization Package

Procedure Treatability Study #1	11/5/97
Procedure Treatability Study #2	11/6/97
Procedure Treatability Study #3	11/5/97
Procedure Treatability Study #4	11/17/97
Procedure Treatability Study #5	11/13/97
Procedure Treatability Study #6	11/13/97

Dissolution Procedure for Uranium Process Chemistry, NMT11-UC-WP5-003/0

Precipitation Procedure for Uranium Process Chemistry, NMT2-UC-WP5-005/0

Calcination Procedure for Uranium Process Chemistry, NMT-2-UC-WP5-006/0

Lockheed Martin Utility Services Analysis ID 960408-215

Lockheed Martin Utility Services Analysis ID 960408-214

Lockheed Martin Utility Services Analysis ID 960408-216

Lockheed Martin Utility Services Analysis ID 951129-037

Analysis Data Report Analysis ID 951129-037, Procedure No. SW846-8260

Analysis Data Report Analysis ID 951129-037, Procedure No. SW846-8270A

Lockheed Martin Utility Services Analysis ID 951129-038

Memo Shutting Down Operations in RMs 4062/64/66, E. Ernst to J. FitzPatrick, 8/7/98

Work Resumption Checklist for Rooms 4062/64/66

Memo to E. Ernst from Bill Zwick, Review of Materials that Planned Actions are Appropriate Upon Completion Authorization for Restart

Review by Norm Schroeder, Process to Verify Adequacy of Written Procedures

Review by Steve Costigan, Adequacy of Radcon Procedures and Monitoring Equipment for Described Tasks

Review by Steve Schreiber of Process Hazards Analysis to Verify Analysis is Adequate and Resulting Controls are adequate and in Place

Memo from John FitzPatrick, Revise Procedures to Incorporate Recommendations

Procedure Treatability Study #1 Experimental Plan, Room 4064

Procedure Treatability Study #2 Experimental Plan, Room 5068

Procedure Treatability Study #5 Experimental Plan, Room 4064

Procedure Treatability Study #6 Experimental Plan, Room 5068

Procedure Treatability Study #7 Experimental Plan, Room 5068

Memo to Portsmouth Resumption File, Table 2, Item 2, Housekeeping Standards Plan, 10/15/98

NMT-2 Plan for Housekeeping Standards in Rooms 4062, 4064, 4066, 5068

Memo to Portsmouth Resumption File, Table 2, Items 3 & 4, Decontaminate Room Post Decon Smear

Survey for Room 4064 Post Decon Smear Survey for Room 4064 HPAL Analysis Reports

Memo to Portsmouth Resumption File, Table 2, Item 5, evaluate Increased RM Frequency

Memo to Eric Ernst from Steve Costigan, CMR Rooms 4062, 4064, 4066, Corrective Actions

Memo to Portsmouth Resumption File, Table 2, Item 6, Postulate Material Balance for Technetium

ES&H Analytical Services Data Summary Report, 9/15/95

ES&H Analytical Services Data Summary Report, 1/17/96

Memo to Portsmouth Resumption File, Table 2, Item 7, Implement Process Modifications to Appropriately Handle Technetium 8/15/98

Memo to Portsmouth Resumption File, Table 2, Item 8, Query Shipper on Nature and Packaging of Sample 10/15/98

Smear Data and Sketches on Packaging of Individual Cans of Material

Memo to Portsmouth Resumption File, Table 2, Item 9, RCT Assistance Required for Opening of Samples in a Hood, 10/15/98

Memo to Portsmouth Resumption File, Table 2, Item 10, Beta CAM Installation, 10/15/98

Appendix, Rejection of Need for Beta CAM

Worksheet for Determining Air Monitoring Requirements

Memo to Portsmouth Resumption File, Table 2, Item 11, Develop Powder Containment Methods for Container Opening, 10/15/98

Tc Incident Restart Checklist and Resumption Plan

Memo To John Phillips From Johnny Harper, Assignment Of Line Manager For Portsmouth Treatability Studies

CMR Resumption Checklist

Activity Description: Portsmouth Treatability Studies 10/24/97

Personnel Qualification

Resume for Brad Schake

Resume for Michael Martinez

Memo to John FitzPatrick from Johnny Harper, Designation Of John R. Fitzpatrick as Subject Matter Expert

Memo To CMR Resumption File From John Fitzpatrick, Personnel Qualifications for Portsmouth Treatability Studies, Qualified Personnel To Perform Work On The PTS

Resume Of John Fitzpatrick, 8/7/95

Training

Memo To CMR Resumption File From John Fitzpatrick, Required Reading

Verification that Training Requirements Are Satisfied/EDS Training Reports

Activity Locations for Ports Treatability Studies

Facility Equipment for Ports Treatability Studies

Memo To John Fitzpatrick from John Quintana, Facility Confirmation Of Operational Status Of CMR Activity

Facility Checklist for Confirmation Of Operational Status, Attachment 3, Checklist For RAD Protection

Memo to CMR Resumption File from John Fitzpatrick, Verification Of Readiness Of

Activity Specific Equipment for Ports Treatability Studies

Verification of Support DependenciesSupport/Dependencies For Portsmouth Treatability Studies

Material Introduction for Ports Treatability Study

Final Product and Required Records For Portsmouth Treatability Studies

Memo to CMR Resumption File From John Fitzpatrick, Waste Generation And Verification Of Readiness to Handle Waste

PORTS SOP

Procedure Treatability Studies Unpackaging Of Material
Flowsheet For Study #1

Procedure Treatability Study #1 Experimental Plan
Flowsheet For Study #2

Procedure Treatability Study #2 Experimental Plan
Flowsheet For Study #3

Procedure Treatability Study #3
Flowsheet for Study #4

Flowsheet for Study #5
Procedure Treatability Study #5 Experimental Plan

Flowsheet for Study #6
Procedure Treatability Study #6 Experimental Plan

Flowsheet for Study #7
Procedure Treatability Study #7 Experimental Plan

Memo to CMR Resumption File From John Fitzpatrick, Effective Procedure, Controls In-Place And Procedures Adequate

Memo To CMR Resumption File From John Fitzpatrick, Engineering Controls And Verification

Engineering Controls, Good Practices For Portsmouth Treatability Studies Task Area

Memo to CMR Resumption File From John Fitzpatrick, Record Of Completion Of WBS

Memo To C Resumption File From John Fitzpatrick, Hazard/Review and Verification

Resumption Plan

Supporting Documentation for Ports Treatability Studies Resumption Activity

Index For Supporting Documentation for Ports Treatability Studies

MST Resumption Approach Plan, Ports Treatability Studies

Supporting Documents

Memo to Jerry Evans From Audrey Martinez, Request Authorization To Receive Residues For Treatability Studies From Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

Enclosure, Recovery and Recycling of Highly Enriched Uranium From Mixes Waste, #1

Enclosure, Recovery And Recycling Of Highly Enriched Uranium From Mixes Waste, Fluorination Of Oil Leak Gunk, #2

Enclosure, Recovery and Recycling of Highly Enriched Uranium From Mixed Waste Filter Ash, #4

Enclosure, Recovery and Recycling of Highly Enriched Uranium From Mixed Waste Freon Degrader Residue, #5

Enclosure, Recovery and Recycling of Highly Enriched Uranium From Mixed Waste, Pyrohydrolysis of Freon Degrader Residue, #6

Enclosure, Recovery and Recycling of Highly Enriched Uranium From Mixed Waste Fluorination Of Freon Degrader Residue, #2

MST Hazard Control Plan, Portsmouth Treatability Study, 11/18/97

What If-Ports/Memo to CMR Resumption File From John Fitzpatrick, Hazard Identification

What If-ULISSES/Process Flow Diagram Steps For ULISSES, 5/28/97, Pages 1-93

USQD/Unreviewed Safety Question Determination and Screening Worksheet

Procedures

Portsmouth Treatability Studies Task Area Procedure List

LANL Chemical Hygiene Plan, LS106-01.0

Memo to CMR Resumption File From John Fitzpatrick, Chemical Hygiene Plan

CMR Document, TRU Waste Bag Out For Certified WIPP Waste

CMR Document, CMR Waste Management Plan

Emergency Plan

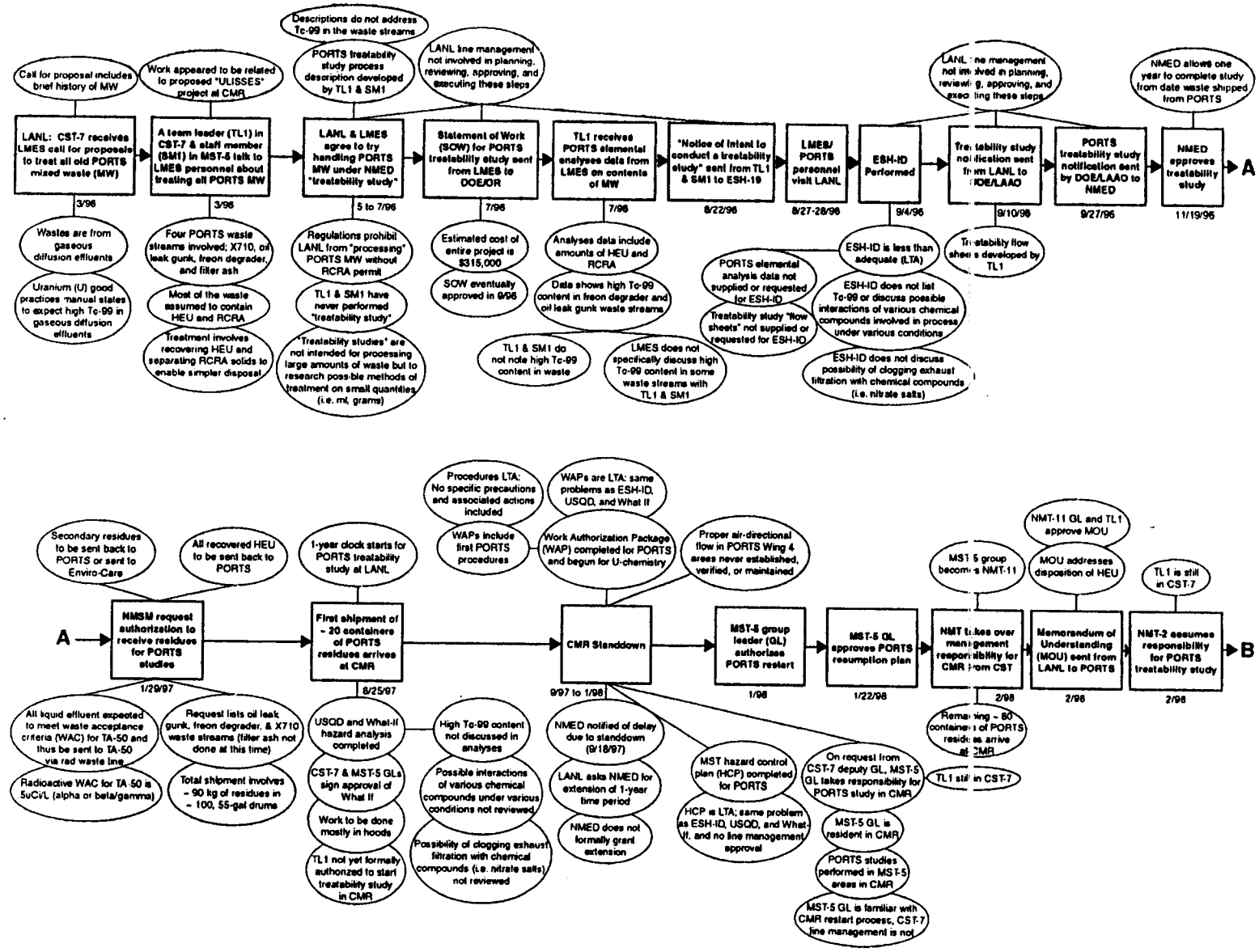
CMR Radiation Protection Practices In the CMR Facility

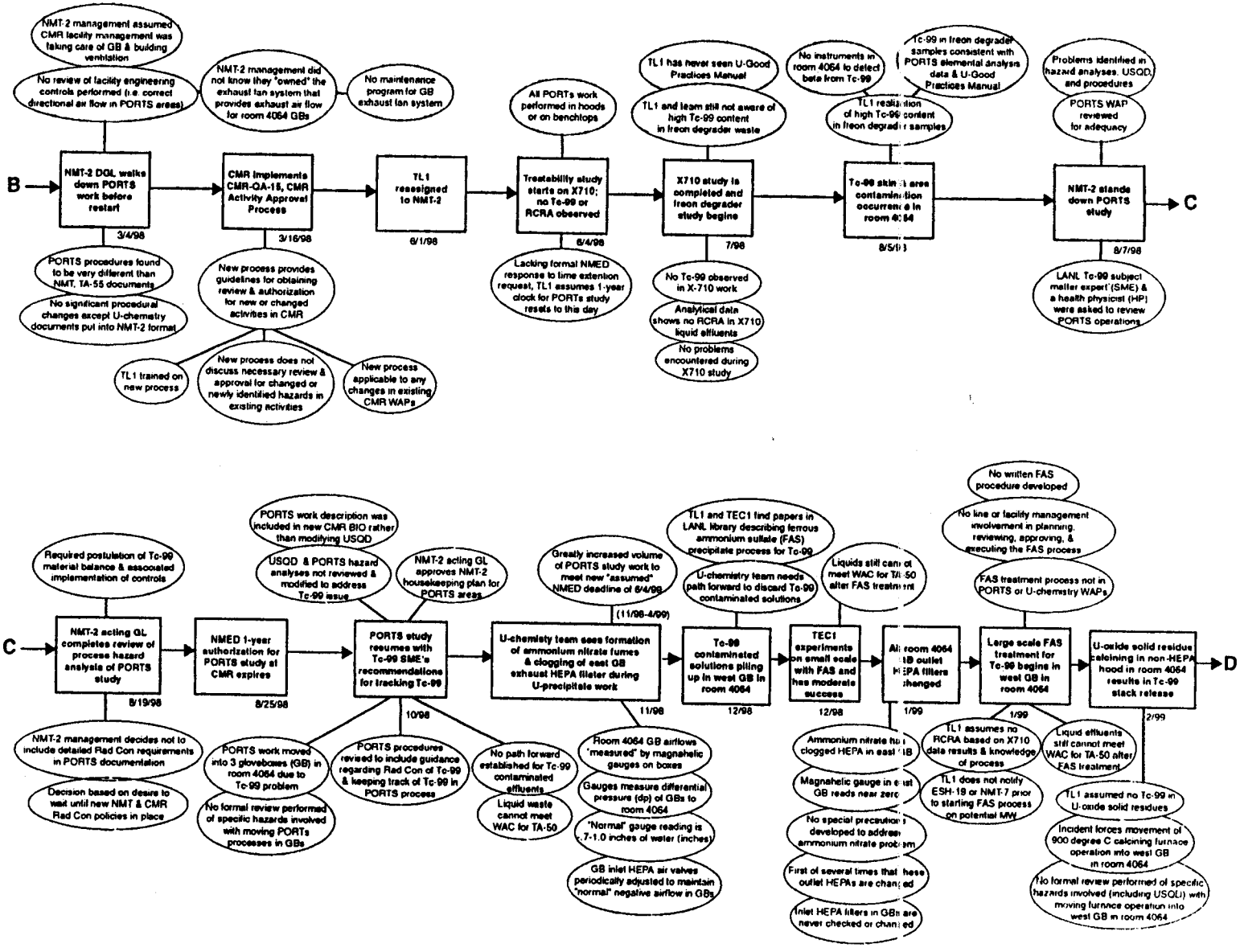
CMR Policy On Normal Working Hours

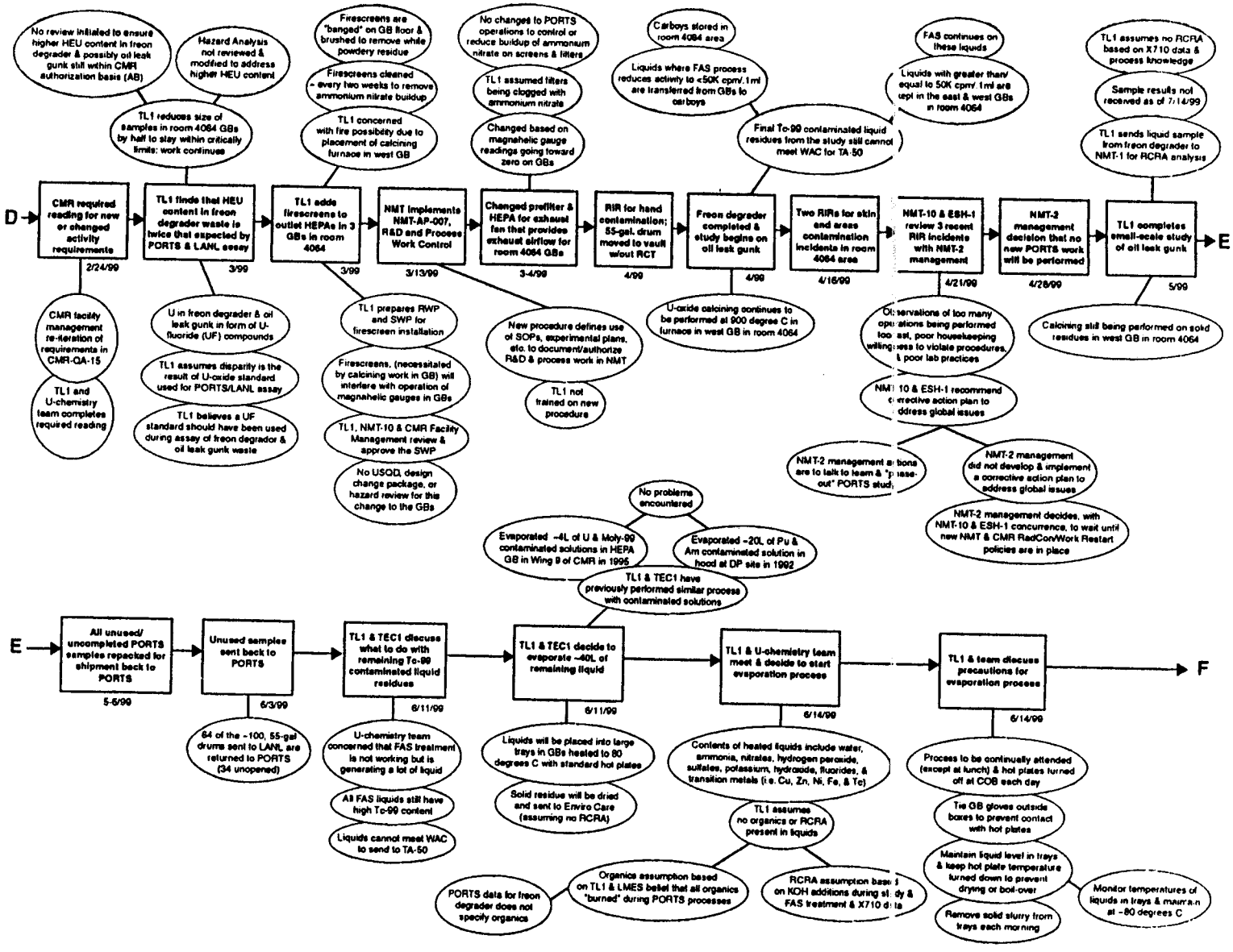
Memo To John Fitzpatrick From John Phillips, ESH-6 Criticality Safety Guidance For Portsmouth Treatability Studies

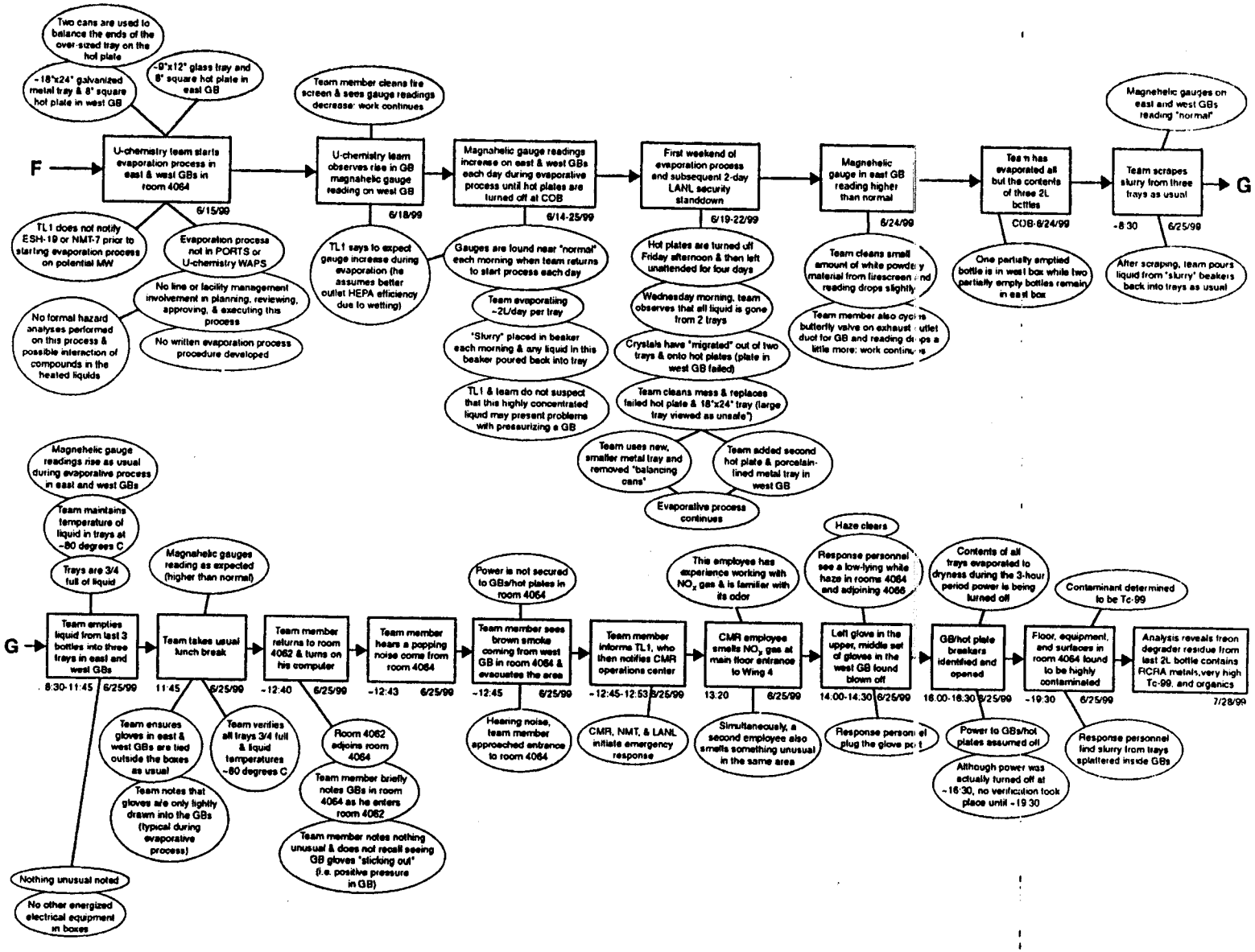
Memo To John Fitzpatrick From R. W. Brewer, Criticality Safety Limits For The Portsmouth Treatability Study

Appendix F—Event and Causal Factor Charting




B
NMT-2 DOL walks down PORTS work before restart
3/4/98
NMT-2 management assumed CMR facility management was taking care of GB & building ventilation
No review of facility engineering controls performed (i.e. correct directional air flow in PORTS areas)
PORTS procedures found to be very different than NMT, TA-55 documents
No significant procedural changes except U-chemistry documents put into NMT-2 format
CMR Implements CMR-QA-15, CMR Activity Approval Process
3/16/98
NMT-2 management did not know they "owned" the exhaust fan system that provides exhaust air flow for room 4064 GBs
No maintenance program for GB exhaust fan system
New process provides guidelines for obtaining review & authorization for new or changed activities in CMR
TL1 trained on new process
New process does not discuss necessary review & approval for changed or newly identified hazards in existing activities
New process applicable to any changes in existing CMR WAPs
TL1 reassigned to NMT-2
6/1/98
Treatability study starts on X710; no Tc-99 or RCRA observed
6/4/98
All PORTs work performed in hoods or on benchtops
Lacking formal NMED response to time extention request, TL1 assumes 1-year clock for PORTs study resets to this day
X710 study is completed and freon degrader study begins
7/98
TL1 has never seen U-Good Practices Manual
TL1 and team still not aware of high Tc-99 content in freon degrader waste
No Tc-99 observed in X-710 work
Analytical data shows no RCRA in X710 liquid effluents
No problems encountered during X710 study
Tc-99 skin & area contamination occurrence in room 4064
8/5/98
No instruments in room 4064 to detect beta from Tc-99
TL1 realization of high Tc-99 content in freon degrader samples
Tc-99 in freon degrader samples consistent with PORTS elemental analysis data & U-Good Practices Manual
NMT-2 stands down PORTS study
8/7/98
Problems identified in hazard analyses, USQD, and procedures
PORTS WAP reviewed for adequacy
LANL Tc-99 subject matter expert (SME) & a health physicist (HP) were asked to review PORTS operations
C
C
NMT-2 acting GL completes review of process hazard analysis of PORTS study
8/19/98
Required postulation of Tc-99 material balance & associated implementation of controls
NMT-2 management decides not to include detailed Rad Con requirements in PORTS documentation
Decision based on desire to wait until new NMT & CMR Rad Con policies in place
NMED 1-year authorization for PORTS study at CMR expires
8/25/98
PORTS study resumes with Tc-99 SME's recommendations for tracking Tc-99
10/98
PORTS work description was included in new CMR BIO rather than modifying USQD
USQD & PORTS hazard analyses not reviewed & modified to address Tc-99 issue
NMT-2 acting GL approves NMT-2 housekeeping plan for PORTS areas
PORTS work moved into 3 gloveboxes (GB) in room 4064 due to Tc-99 problem
No formal review performed of specific hazards involved with moving PORTs processes in GBs
PORTS procedures revised to include guidance regarding Rad Con of Tc-99 & keeping track of Tc-99 in PORTS process
No path forward established for Tc-99 contaminated effluents
Liquid waste cannot meet WAC for TA-50
U-chemisty team sees formation of ammonium nitrate fumes & clogging of east GB exhaust HEPA filter during U-precipitate work
11/98
Greatly increased volume of PORTS study work to meet new "assumed" NMED deadline of 6/4/99
(11/98-4/99)
Room 4064 GB airflows "measured" by magnahelic gauges on boxes
Gauges measure differential pressure (dp) of GBs to room 4064
"Normal" gauge reading is .7-1.0 inches of water (inches)
GB inlet HEPA air valves periodically adjusted to maintain "normal" negative airflow in GBs
Tc-99 contaminated solutions piling up in west GB in room 4064
12/98
TL1 and TEC1 find papers in LANL library describing ferrous ammonium sulfate (FAS) precipitate process for Tc-99
U-chemistry team needs path forward to discard Tc-99 contaminated solutions
TEC1 experiments on small scale with FAS and has moderate success
12/98
Liquids still cannot meet WAC for TA-50 after FAS treatment
Ammonium nitrate has clogged HEPA in east GB
Magnahelic gauge in east GB reads near zero
No special precautions developed to address ammonium nitrate problem
First of several times that these outlet HEPAs are changed
Inlet HEPA filters in GBs are never checked or changed
All room 4064 GB outlet HEPA filters changed
1/99
No written FAS procedure developed
No line or facility management involvement in planning, reviewing, approving, & executing the FAS process
FAS treatment process not in PORTS or U-chemistry WAPs
Large scale FAS treatment for Tc-99 begins in west GB in room 4064
1/99
TL1 assumes no RCRA based on X710 data results & knowledge of process
TL1 does not notify ESH-19 or NMT-7 prior to starting FAS process on potential MW
Liquid effluents still cannot meet WAC for TA-50 after FAS treatment
U-oxide solid residue calcining in non-HEPA hood in room 4064 results in Tc-99 stack release
2/99
TL1 assumed no Tc-99 in U-oxide solid residues
Incident forces movement of 900 degree C calcining furnace operation into west GB in room 4064
No formal review performed of specific hazards involved (including USQD) with moving furnace operation into west GB in room 4064
D


D
CMR required reading for new or changed activity requirements
2/24/99
CMR facility management re-iteration of requirements in CMR-QA-15
TL1 and U-chemistry team completes required reading
No review initiated to ensure higher HEU content in freon degrader & possibly oil leak gunk still within CMR authorization basis (AB)
TL1 reduces size of samples in room 4064 GBs by half to stay within critically limits; work continues
TL1 finds that HEU content in freon degrader waste is twice that expected by PORTS & LANL assay
3/99
U in freon degrader & oil leak gunk in form of U-fluoride (UF) compounds
TL1 assumes disparity is the result of U-oxide standard used for PORTS/LANL assay
TL1 believes a UF standard should have been used during assay of freon degrador & oil leak gunk waste
Hazard Analysis not reviewed & modified to address higher HEU content
TL1 adds firescreens to outlet HEPAs in 3 GBs in room 4064
3/99
Firescreens are "banged" on GB floor & brushed to remove white powdery residue
Firescreens cleaned - every two weeks to remove ammonium nitrate buildup
TL1 concerned with fire possibility due to placement of calcining furnace in west GB
TL1 prepares RWP and SWP for firescreen installation
Firescreens, (necessitated by calcining work in GB) will interfere with operation of magnahelic gauges in GBs
TL1, NMT-10 & CMR Facility Management review & approve the SWP
No USQD, design change package, or hazard review for this change to the GBs
NMT implements NMT-AP-007, R&D and Process Work Control
3/13/99
No changes to PORTS operations to control or reduce buildup of ammonium nitrate on screens & filters
TL1 assumed filters being clogged with ammonium nitrate
Changed based on magnahelic gauge readings going toward zero on GBs
New procedure defines use of SOPs, experimental plans, etc. to document/authorize R&D & process work in NMT
TL1 not trained on new procedure
Changed prefilter & HEPA for exhaust fan that provides exhaust airflow for room 4064 GBs
3-4/99
RIR for hand contamination; 55-gal. drum moved to vault w/out RCT
4/99
Carboys stored in room 4064 area
Liquids where FAS process reduces activity to <50K cpm/.1ml are transferred from GBs to carboys
Final Tc-99 contaminated liquid residues from the study still cannot meet WAC for TA-50
Freon degrader completed & study begins on oil leak gunk
4/99
U-oxide calcining continues to be performed at 900 degrees C in furnace in west GB in room 4064
Two RIRs for skin and areas contamination incidents in room 4064 area
4/16/99
NMT-10 & ESH-1 review 3 recent RIR incidents with NMT-2 management
4/21/99
FAS continues on these liquids
Liquids with greater than/ equal to 50K cpm/.1ml are kept in the east & west GBs in room 4064
Observations of too many operations being performed too fast, poor housekeeping, willingness to violate procedures, & poor lab practices
NMT-10 & ESH-1 recommend corrective action plan to address global issues
NMT-2 management actions are to talk to team & "phase-out" PORTS study
NMT-2 management did not develop & implement a corrective action plan to address global issues
NMT-2 management decides, with NMT-10 & ESH-1 concurrence, to wait until new NMT & CMR RadCon/Work Restart policies are in place
NMT-2 management decision that no new PORTS work will be performed
4/28/99
TL1 completes small-scale study of oil leak gunk
5/99
TL1 assumes no RCRA based on X710 data & process knowledge
Sample results not received as of 7/14/99
TL1 sends liquid sample from freon degrader to NMT-1 for RCRA analysis
Calcining still being performed on solid residues in west GB in room 4064
E
No problems encountered
Evaporated ~4L of U & Moly-99 contaminated solutions in HEPA GB in Wing 9 of CMR in 1995
Evaporated ~20L of Pu & Am contaminated solution in hood at DP site in 1992
TL1 & TEC1 have previously performed similar process with contaminated solutions
E
All unused/ uncompleted PORTS samples repacked for shipment back to PORTS
5-5/99
Unused samples sent back to PORTS
6/3/99
64 of the ~100, 55-gal drums sent to LANL are returned to PORTS (34 unopened)
TL1 & TEC1 discuss what to do with remaining Tc-99 contaminated liquid residues
6/11/99
U-chemistry team concerned that FAS treatment is not working but is generating a lot of liquid
All FAS liquids still have high Tc-99 content
Liquids cannot meet WAC to send to TA-50
TL1 & TEC1 decide to evaporate ~40L of remaining liquid
6/11/99
Liquids will be placed into large trays in GBs heated to 80 degrees C with standard hot plates
Solid residue will be dried and sent to Enviro Care (assuming no RCRA)
TL1 & U-chemistry team meet & decide to start evaporation process
6/14/99
Contents of heated liquids include water, ammonia, nitrates, hydrogen peroxide, sulfates, potassium, hydroxide, fluorides, & transition metals (i.e. Cu, Zn, Ni, Fe, & Tc)
TL1 assumes no organics or RCRA present in liquids
Organics assumption based on TL1 & LMES belief that all organics "burned" during PORTS processes
PORTS data for freon degrader does not specify organics
RCRA assumption based on KOH additions during study & FAS treatment & X710 data
TL1 & team discuss precautions for evaporation process
6/14/99
Process to be continually attended (except at lunch) & hot plates turned off at COB each day
Tie GB gloves outside boxes to prevent contact with hot plates
Maintain liquid level in trays & keep hot plate temperature turned down to prevent drying or boil-over
Remove solid slurry from trays each morning
Monitor temperatures of liquids in trays & maintain at ~80 degrees C
F


F
Two cans are used to balance the ends of the over-sized tray on the hot plate
~18"x24" galvanized metal tray & 8" square hot plate in west GB
~9"x12" glass tray and 8" square hot plate in east GB
U-chemistry team starts evaporation process in east & west GBs in room 4064
6/15/99
TL1 does not notify ESH-19 or NMT-7 prior to starting evaporation process on potential MW
Evaporation process not in PORTS or U-chemistry WAPS
No line or facility management involvement in planning, reviewing, approving, & executing this process
No formal hazard analyses performed on this process & possible interaction of compounds in the heated liquids
No written evaporation process procedure developed
Team member cleans fire screen & sees gauge readings decrease: work continues
U-chemistry team observes rise in GB magnahelic gauge reading on west GB
6/18/99
TL1 says to expect gauge increase during evaporation (he assumes better outlet HEPA efficiency due to wetting)
Magnahelic gauge readings increase on east & west GBs each day during evaporative process until hot plates are turned off at COB
6/14-25/99
Gauges are found near "normal" each morning when team returns to start process each day
Team evaporating ~2L/day per tray
"Slurry" placed in beaker each morning & any liquid in this beaker poured back into tray
TL1 & team do not suspect that this highly concentrated liquid may present problems with pressurizing a GB
First weekend of evaporation process and subsequent 2-day LANL security standdown
6/19-22/99
Hot plates are turned off Friday afternoon & then left unattended for four days
Wednesday morning, team observes that all liquid is gone from 2 trays
Crystals have "migrated" out of two trays & onto hot plates (plate in west GB failed)
Team cleans mess & replaces failed hot plate & 18"x24" tray (large tray viewed as unsafe")
Team uses new, smaller metal tray and removed "balancing cans"
Team added second hot plate & porcelain-lined metal tray in west GB
Evaporative process continues
Magnehelic gauge in east GB reading higher than normal
6/24/99
Team cleans small amount of white powdery material from firescreen and reading drops slightly
Team member also cycles butterfly valve on exhaust outlet duct for GB and reading drops a little more: work continues
Tea n has evaporated all but the contents of three 2L bottles
COB-6/24/99
One partially emptied bottle is in west box while two partially empty bottles remain in east box
Magnehelic gauges on east and west GBs reading "normal"
Team scrapes slurry from three trays as usual
~8:30
6/25/99
After scraping, team pours liquid from "slurry" beakers back into trays as usual
G
G
Magnehelic gauge readings rise as usual during evaporative process in east and west GBs
Team maintains temperature of liquid in trays at ~80 degrees C
Trays are 3/4 full of liquid
Team empties liquid from last 3 bottles into three trays in east and west GBs
8:30-11:45
6/25/99
Team takes usual lunch break
11:45
6/25/99
Magnehelic gauges reading as expected (higher than normal)
Team ensures gloves in east & west GBs are tied outside the boxes as usual
Team verifies all trays 3/4 full & liquid temperatures ~80 degrees C
Team notes that gloves are only lightly drawn into the GBs (typical during evaporative process)
Nothing unusual noted
No other energized electrical equipment in boxes
Team member returns to room 4062 & turns on his computer
~12:40
6/25/99
Room 4062 adjoins room 4064
Team member briefly notes GBs in room 4064 as he enters room 4062
Team member notes nothing unusual & does not recall seeing GB gloves "sticking out" (i.e. positive pressure in GB)
Team member hears a popping noise come from room 4064
~12:43
6/25/99
Power is not secured to GBs/hot plates in room 4064
Team member sees brown smoke coming from west GB in room 4064 & evacuates the area
~12:45
6/25/99
Hearing noise, team member approached entrance to room 4064
Team member informs TL1, who then notifies CMR operations center
~12:45-12:53
6/25/99
CMR, NMT, & LANL initiate emergency response
This employee has experience working with NO_x gas & is familiar with its odor
CMR employee smells NO_x gas at main floor entrance to Wing 4
13:20
6/25/99
Simultaneously, a second employee also smells something unusual in the same area
Haze clears
Response personnel see a low-lying white haze in rooms 4064 and adjoining 4066
Left glove in the upper, middle set of gloves in the west GB found blown off
14:00-14:30
6/25/99
Response personnel plug the glove port
Contents of all trays evaporated to dryness during the 3-hour period power is being turned off
GB/hot plate breakers identified and opened
16:00-16:30
6/25/99
Power to GBs/hot plates assumed off
Although power was actually turned off at ~16:30, no verification took place until ~19:30
Contaminant determined to be Tc-99
Floor, equipment, and surfaces in room 4064 found to be highly contaminated
~19:30
6/25/99
Response personnel find slurry from trays splattered inside GBs
Analysis reveals freon degrader residue from last 2L bottle contains RCRA metals, very high Tc-99, and organics
7/28/99