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Title: PRELIMINARY CHEMISTRY AND METALLURGY RESEARCH BUILDING DISPOSITION STUDY

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Submitted to: S-& Classification Group

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LOS ALAMOS NATIONAL LABORATORY CHEMISTRY AND METALLURGY RESEARCH FACILITY REPLACEMENT PROJECT

PRELIMINARY
CHEMISTRY AND METALLURGY RESEARCH BUILDING DISPOSITION STUDY

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Preliminary Chemistry and Metallurgy Research Building Disposition Study

1. Introduction

This analysis is for three alternatives for the future disposition of the Chemistry and Metallurgy (CMR) Facility (TA-3-29). The analysis relies upon previously documented data and cost estimates for the decontamination and decommissioning (D&D) of various wings or portions of the CMR developed during prior upgrade and replacement efforts. The primary sources of data for this study were:

- *CMR Upgrades Project Reconfiguration Evaluation* [2]
- *CMR Reconfiguration Evaluation Assessment (REA) Report* [3]
- *Conceptual Design Report CMR Facility Wing 2 and Wing 4 Safe Standby* [4]
- *Conceptual Design Report CMR Upgrades Project, Phases 2 and 3, Volume VIII Cost Estimate* [5]
- *Study of Status and Cost for Decontamination and Decommissioning of the CMR Building* [8]

The purpose of this study is twofold:

1. Collect and provide bounding waste volume estimates for the disposition of the CMR to support the development of the Environmental Impact Statement (EIS) for the Chemistry and Metallurgy Research Facility Replacement Project (CMRR).
2. Provide a preliminary analysis to aid in the disposition decision process and the future effort to fully develop a CMR disposition plan.

This report develops estimates of waste volumes, cost, and construction or D&D labor for each of the following three alternatives:

1. Continue to use the CMR as is until the year 2060 (No Action alternative).
2. Build a replacement CMR facility, decontaminate the CMR and reuse as office and light laboratory space.
3. Build a replacement CMR facility, demolish the CMR and return the land for reuse.

The results are conservative and are intended to establish a high-level bounding case for each alternative. The analysis and estimates are based on the assumptions listed later in this report; no supplemental measurements or waste characterization efforts were undertaken. The construction cost estimates are based primarily on elements developed in the REA report [3]. The waste volume estimates are based on analysis of contamination data obtained from various reports of facility condition and from a generalized facility map of the CMR Building radiological areas from the CMR resident staff of the LANL Health Physics Group. The available data was compiled and extrapolated to reflect the parameters of each disposition alternative. Where data was not available, some estimates were based on consultation with subject matter experts and on the judgment of the study team.[1]

Volumes of detailed surface contamination data is available from the CMR health physics staff, but the compilation of that data was beyond the scope of this study. That detailed survey data is available from the LANL Health Physics Operations Group, if needed for more detailed D&D planning efforts.

The study team was unable to determine a technically sound approach to subdivide the radioactive waste volumes into the categories of transuranic waste (TRU) and low-level waste (LLW); thus, the waste volumes are reported as radioactive or sanitary. While there is a level of uncertainty in the waste data, the estimates were developed with adequate rigor to be valuable in a relative comparison of each alternative.

Throughout this report, the term “contaminated” means that there is known radioactive contamination present at a level that would require some effort to decontaminate or control in order to use the space for another function or to prevent the spread of contamination during demolition. No effort has been made to quantify contamination levels, and no specific value is implied by the term contaminated. Furthermore the use of a modifier with contamination, such as high or low, is intended to communicate a relative state and does not imply any quantifiable level. The term “clean” means that there is no known contamination that would require decontamination prior to reuse or demolition of the space.

The best established fact related to the D&D of the CMR is that it will be a significant challenge. The challenge is due to the uncertainty of contamination levels that may be present within normally inaccessible areas. Extensive survey, characterization, and careful selection of decontamination methods would be required to develop accurate estimates for planning and budgeting purposes. However, within the framework of the assumptions stated in this report, the development of alternatives for the purpose of comparison is straightforward.

[1] D&D subject matter experts (SMEs) from industry, LANL, and Argonne National Laboratory (ANL) were included in discussions pertaining to the determination of waste volumes. All agreed that without a current, complete and thorough characterization, the best data for use in this analysis is the existing CMR specific facility data, historical information, radiological surveys, and waste generation statistics.

2. Assumptions and Limitations

This section details the assumptions and limitations that were applied for consistency in:

- development of each disposition alternative;
- interpretation of the available data;
- all estimates of man-hours, waste volumes, and cost;
- final conclusions of the study; and
- recommended actions.

a. Project Management

- Work will be performed with uncleared personnel.
- No other operations will be ongoing within the CMR facility during a D&D effort.
- All stock radioactive material will be removed prior to notice to proceed (NTP).
- All classified material will be removed or declassified prior to NTP.
- All process equipment will have been drained to the extent practical prior to NTP.
- All unused or waste chemicals and reagents will have been removed prior to NTP.
- LANL will provide process knowledge expertise to a D&D contractor to the extent that it is available.

b. Building and Equipment Status

- The building will have been placed into a safe-shutdown mode.
- Safety ventilation, fire protection, and alarm systems will be functional.
- All personal property, nuclear materials, and containerized chemicals will have been removed.
- Programmatic equipment will have been removed.
- Gloveboxes, open-front hoods, fume hoods, and the supporting equipment will be in place.
- All building equipment will be in place.
- Contaminated furniture will be in place.

c. Planning/Permitting

- All NEPA and NESHAP documentation requirements will be met prior to NTP.
- LANL will be responsible for submitting all required permits or notifications of intent (NOIs).
- All operational readiness reviews will be completed prior to commencing operations.

d. Mobilization

- LANL will provide office space for a D&D contractor.
- LANL will provide change facilities for D&D personnel.

e. Training

- LANL will provide site-specific training to the contractor at no additional cost to the contractor.
- Workers will be cross-trained and certified to perform their assigned tasks (i.e. integrated safety management, asbestos removal, radiation worker, lock-out/tag-out, waste management, etc.).
- HAZWOPER training will be required.

f. Dismantling, Segmenting and Demolition

- The contractor will be required to provide all heavy equipment, tools, and PPE as part of the bid.
- The only utilities provided by LANL will be water and electric power.
- Facility equipment will be operational and have current inspection certificates.
- LANL will disconnect utilities as necessary.

g. Decontamination

- Decontamination will be performed as necessary during dismantlement, segmenting, and demolition to prevent the spread of contamination.
- Building surfaces (interior walls) will be decontaminated, as appropriate, to minimize radiological waste generation.
- When economically beneficial, decontamination of equipment to permit reuse/recycle will be the preferred choice.
- Standard basic decontamination techniques will be used.

h. Waste Management

- LANL will provide oversight of the contractor waste management technicians.
- Work will be performed in accordance with LANL and WIPP waste acceptance criteria (WAC), when applicable.
- All waste will be packaged and managed by the D&D contractor.
- LANL waste management staff will provide oversight for waste characterization, packaging, and manifesting.
- The contractor will establish a waste staging area in or near the CMR Building.
- Waste stream estimates are for radiological contaminated waste only. No hazardous or mixed waste streams are incorporated into this estimate.

i. Health and Safety

- The contractor will provide its own industrial hygiene, site safety, and health physics support with oversight from LANL to ensure compliance with all safety requirements.
- Radiation survey instruments and air monitoring equipment will be provided by LANL.

- Dosimeters and a bioassay program will be furnished by LANL.
- The contractor will comply with and implement relevant DOE, OSHA, and LANL health and safety standards.
- No explosive concentration of perchlorate salts is expected to be encountered.

j. Final Status Radiological Survey

- Surveys will be conducted in accordance with NUREG/CR5849, the Multi-Agency Radiation and Site Survey Investigation Manual (MARSSIM), HSR-1 survey procedures, and all other applicable regulatory guidance documents.

k. Refurbishment

- Refurbishment will be limited to bring excavations back to grade.
- All associated piping and drain lines will be removed up to the existing security fence.

l. Waste Volume

- A complete demolition will result in 36,000 yd^3 of waste.
- 55% of the total waste will be clean and free–releasable for recycle, reuse, or disposal in a sanitary landfill. 45% of the waste volume will require management as radioactive waste. Insufficient data is available to make any assumption about the proportions of LLW and TRU wastes that may result.
- LANL will release clean waste for reuse or landfill disposal.
- No secondary waste volumes have been calculated for decontamination or demolition.
- No operational waste volumes have been included in this study.

m. Cost Escalation

- A cost escalation of 3% per year has been used in all cases to establish a cost estimate for any given point in time.

n. Ground Contamination

- No remediation of ground contamination is included. Limited testing below the basement floor has confirmed clean soil below. If contaminated soil is found below the basement, soil will be excavated to a depth of 6 inches. Deeper excavation will require assessment and planning by the LANL Environmental Restoration program and has not been included in this assessment.

o. Operating Cost

- The operating costs for the CMRR are assumed to be equal to the cost of the present CMR Building operations. This assumption is used for comparison purposes only, the actual operating cost of the CMRR are unknown.
- The operating cost for the refurbished CMR Building is assumed to be 66% of the current costs for operating the building. The lower cost would be a result of the reduced floor space and reduced operating staff because there would not be a need for the extensive radiation protection, waste management, material

accountability, authorization basis, and operations personnel that are presently necessary to operate the building as a nuclear facility.

3. CMR Facility Description

The CMR Facility is located in LANL's Technical Area 3 (TA-3). It is a 550,000-square foot facility and has been in continuous operation since it was built in 1952. The CMR was built in compliance with the 1947 Uniform Building Code and the work performed today is within the range of operations for which it was originally designed, but has been limited due to factors of facility age and seismic consideration. Once operated as a Security Category I, Hazard Category 2 facility, use is now limited to Security Category II, Hazard Category 3 operations. The reasons for limitations in operations and the long-term viability of the facility are described in "*Strategy for Managing Risks at the Chemistry Metallurgy Facility"* [7] and the *"CMR Basis for Interim Operations"* (BIO) [1]. Significant facility safety upgrades were completed in 2001 that provide for the continued safe operation of the building through 2010.

The building consists of eight wings connected by a spinal corridor. Each wing is served by its own mechanical and electrical systems. There is an Administrative Wing and seven laboratory wings, numbered 1, 2, 3, 4, 5, 7, and 9. Wings 2 through 7 are nearly identical in terms of size and basic construction. Wing 1 is also similar, but approximately one-half the size of other laboratory wings. Wing 9 is uniquely designed and was added to the building in 1962; it has special features to support material science activities performed in hot cells.

The entire building consists of three levels, each essentially covering the full footprint of the structure and includes the following:

- Attic – contains primarily facility supply air filtering/conditioning equipment and is expected to be predominately free of radioactive contamination.
- Main Floor – most of the laboratory and office space is on this level. The ceilings are expected to be predominately clean (due to supply air pressurization), with increasing potential for contamination toward the floor. It is estimated that a maximum of 45% of the items and surfaces at this level are contaminated.
- Basement – contains mostly facility equipment and has the greatest potential for contamination. The ventilation system and facility piping in this area are on the contaminated side of the air flow. As the basement pressure is negative with respect to the laboratory areas above, contamination is expected to have migrated into the basement. For this analysis and to establish the bounding case, it has been assumed that all equipment and materials in the basement are contaminated to some degree. It should be noted that the surfaces in many areas of the basement are clean and personnel can move about freely without protective measures.

At the end of each laboratory wing (Wings 2, 3, 4, 5, and 7), there is a filter tower through which building exhaust is collected, filtered, and discharged to the atmosphere. These towers contain the HEPA filter plenums and related exhaust ventilation components. All of this area has been considered as potentially contaminated. The floor area of the filter towers has been accounted for in the calculations of basement and main floor area. Work within the HEPA filter plenums requires the use of respiratory protection, careful planning, and significant other protective measures due to the radiological conditions present within the system.

Table 1 summarizes the wing sizes and contamination conditions. The contamination data reported in the table was developed to establish a bounding case for determination of waste volumes. The percentages should be applied only over the full area specified. Any smaller division of space within the specified area, such as an individual room, could be found to be 100% clean or contaminated.

Table 1: Summary of CMR Wings, Space, and General Condition

Wing	Level	Approximate Gross Area (ft^2)	Assumed Condition (Clean or Contaminated)*
Administration	Attic	7,000	100% clean
	Main	8,000	100% clean
	Basement	8,000	100% clean
Wing 1	Attic	23,000	100% clean
	main	23,000	95% clean**
	basement	23,000	95% clean**
Shops/Stock	attic	1,500	100% clean
	main	7,300	100% clean
	basement	7,300	100% contaminated
SNM Storage	basement	1,000	100% contaminated
Wing 2	attic	27,000	100% clean
	main	27,000	45% contaminated
	basement	27,000	100% contaminated
Wing 3	attic	27,000	100% clean
	main	27,000	45% contaminated
	basement	27,000	100% contaminated
Wing 4	attic	27,000	100% clean
	main	27,000	45% contaminated
	basement	27,000	100% contaminated
Wing 5	attic	27,000	100% clean
	main	27,000	45% contaminated
	basement	27,000	100% contaminated
Wing 7	attic	27,000	100% clean
	main	27,000	45% contaminated
	basement	27,000	100% contaminated
Wing 9	attic	22,000	100% clean
	main	22,000	45% contaminated
	basement	22,000	100% contaminated

*"Contaminated" indicates that radioactive contamination is suspected or known to be present at a level sufficient to warrant some level of decontamination or control in order to reuse the space or to control the spread of contamination during demolition. Quantified levels of contamination have not been determined in this study. "Clean" indicates that there is no known contamination that would require decontamination prior to reuse or demolition. Detailed contamination data, in the form of routine radiological surveys, is available from the LANL Health Physics Operations Group.

**Previously decontaminated and converted to office space. Some legacy contamination may have been fixed by paint or other methods.

a. Construction

Excluding Wing 9, the main portions of the original building are constructed of reinforced concrete floor diaphragms (typically 4" thick), reinforced concrete shear walls (1'6" thick), reinforced concrete movement-resistant frame, and steel framing with light-gauge, metal deck roof diaphragms. Expansion joints exist between the wings and the filter towers and between the wings and the equipment and change rooms above-grade. The filter towers have reinforced concrete roof diaphragms. The entire facility is supported on reinforced concrete basement walls and columns on spread footings bearing of the native tuff. Wing 9 is constructed differently, with lightly reinforced concrete masonry infill walls (above-grade), thicker floor and grade slabs (~11") and massive footings and concrete around and under the hot cells to support the heavy loads.

From the CMR Facility plans, it was determined that the over-all foot-print of the CMR Facility is 195,000 ft^2 and the average height from the bottom of the basement slab to the top of the roof is 50 feet. The total volume of the building was calculated to be 360,000 yd^3. A high percentage of this total volume is air and the remainder is the physical matter that will contribute to the total waste volume that would be generated by the demolition of the building. To establish a bounding factor for determining the maximum total volume of waste that would be generated by the complete demolition of the building, it was estimated that no more than 10% of the total building volume is solid. Thus, the total estimated volume of waste that will be produced by the demolition is 36,000 yd^3.

b. Ventilation System

The exhaust side of the ventilation system is large and the inside surfaces of the duct work are contaminated at a level that typically requires respiratory protection and other significant personnel protective measures for work within the system. Except for the ducting up to the stacks and the filter towers, most of the contaminated duct work is in the basement. The clean supply side of the ventilation system is in the attic areas and enters the laboratory spaces through the ceiling; these areas have been found to be free of contamination.

A preliminary study of fissile material holdup in the ventilation equipment located in the Wing 7 basement was performed by LANL and Benchmark Corporation in 2001. The data from this study is documented in *Fissile Material Holdup in Wing 7 of the CMR Basement* [6].

c. Radioactive Liquid Waste (RLW) System

The RLW system is a network of drain lines that carry radioactive liquids to the RLW Treatment Facility at TA-50. This system is significantly contaminated and, due to a history of leakage, is thought to be the largest contributing source of contamination within the building.

Gonzales and Elder estimated that in each of Wings 2, 3, 4, 5, 7, and 9, the RLW line consists of 800 feet of 5-inch diameter pipe and 1,400 feet of 2.5-inch pipe, all stainless steel with both welded and coupled joints. The Wing 1 RLW components are approximately one-half of those other wings. In total, there is approximately 4,400 feet of 5-inch diameter, and 7,700 feet of 2.5-inch diameter stainless steel pipe in the system. It is expected that the bulk of this piping would be TRU waste with some mixed-waste portions (traps) due to Hg contamination. Also, in areas of leakage, the walls, surrounding concrete, floors and other adjacent surfaces may have increased levels of contamination.[2] [8] As stated earlier in this report, waste volumes are reported as radioactive or sanitary. The potential for TRU or mixed waste is for information only.

d. Vacuum Systems

Two large vacuum systems extend throughout the building. One is the process vacuum system used by the operating groups and is known to be highly contaminated, especially the pumps. These pumps have been a source of floor contamination in the basement area around them. A second, newer system has been used for the fixed-head and continuous air-monitoring systems, and is expected to have only minor levels of contamination.

e. Walls

The non-structural walls that separate laboratories, offices, and corridors are double-panel steel. In the process areas, a six-inch space exists between walls through which utilities, including RLW lines, are routed. It is known that in many areas, leaks in the RLW lines have resulted in contamination within the walls. In 1987, Gonzales and Elder estimated a 1:1 ratio of clean to contaminated wall panels throughout the building. Their estimate was that 72,000 ft^2 per wing (432,000 ft^2 total) would have to be replaced to achieve a level of decontamination adequate for reuse of the space for cold operations. [8]

f. Floors

The floors of the main level are covered with approximately 20,000 ft^2 of tile per wing. Floor contamination is widespread and ranges from low to high and

[2] A communication received late in the study indicates the connections of the RLW system to the radioactive liquid waste plant were added after the original construction. Originally, the system drained to clay pipes that are thought to be still buried in the area. Further assessment of this condition to determine the parameters of this legacy liquid waste system should be included in future CMR D&D planning efforts. There was no mention of such a system in any of the data and reports referenced in this study.

includes the tile and the surface of the concrete under the tile. The basement floors are concrete and have many areas of fixed contamination, some of which has been painted over. Floor contamination in the attic is limited to the filter tower areas.

g. Asbestos

A 1987 survey of asbestos insulation found approximately 73,000 lineal feet of asbestos piping insulation throughout CMR and 9,400 ft^2 on ducts and vessels [8]. An undetermined portion of the floor tile (up to 20,000 ft^2 per wing) may contain asbestos. There may be a limited volume of asbestos-containing ceiling tiles scattered through the building, but most of the ceiling consists of perforated metal tile.

h. Legacy Programmatic Equipment

In 2001, the Nuclear Materials Technology Division (NMT) Waste Management - Environmental Compliance Group (NMT-7) and Eberline Services performed an assessment of legacy equipment within the CMR Facility to locate and determine the status of unused programmatic equipment throughout the CMR Facility. The evaluation of status was to determine if the equipment was still being used, was in storage for future use, or was a potential candidate for disposal/salvage. The Legacy Equipment Project (LEP) identified approximately 3500 different items that have been entered into a database maintained by NMT-7. The items consist of anything from small transformers, capacitors, drill presses, gloveboxes, filing cabinets, motors and various types of pumps. No analysis has been performed to identify with certainty waste streams and associated costs for disposal or treatment. However, the LEP has made some assumptions as to the disposal path and costs based on available process knowledge for each item. The data is available from NMT-7 and should be reviewed in conjunction with any future CMR disposition planning.

4. Description of Alternatives

a. Alternative 1: Do nothing; maintain CMR operations through 2060

Alternative 1 assumes that the existing facility will continue its mission support at an acceptable level of risk to public and worker health and safety with the present operational restrictions. This alternative takes only present operational parameters into consideration and assumes that maintenance costs of keeping the facility operational through 2060 remain constant other than escalation due to inflation. Due to the age of the facility and deterioration of equipment, actual operating costs may increase at a rate that far exceeds inflation. Also, it is expected that to continue the safe use the CMR Facility for an extended period beyond 2010, extensive upgrades to the building would be needed [7]. For this analysis, this has been considered as the 'do nothing' alternative, so the cost of any upgrades has not been included. The final D&D of the building would be necessary at the end of this alternative.

Known restrictions applicable to Alternative 1:

- Accounting for safety upgrades completed in recent years, the building will have reached the end of its design life by the year 2010. Additional upgrades and extensive corrective maintenance would be necessary for continued use of the building until 2060.
- The building will not be able to meet the mission requirements through 2060.
- The operating limits of the existing Basis of Interim Operations (BIO) continue; however as building systems further deteriorate with age, more restrictive operating limits may become necessary to maintain safe operations.

b. Alternative 2: Replace CMR with new facility; reuse CMR as a low hazard facility.

This alternative would move the present CMR nuclear capabilities to a new facility and retain the CMR Building for use as office and light laboratory space. The facility, the systems, and components would be decontaminated to acceptable levels for the intended occupancy. Reuse would require extensive modifications and upgrades to meet present building code requirements for a light lab/office occupancy; it is not clear that this is feasible. Some systems, such as the RLW, vacuum, and exhaust ventilation, would require demolition and replacement because of the extent of radiological contamination. Wings 2 and 4 should not be reused as their location on a seismic fault would make seismic upgrades infeasible. Wing 2 could be demolished, but Wing 4 would need to remain intact as it contains some facility equipment that is necessary to support the functionality of the building unless these were relocated. The final D&D of the building would be necessary at the end of the reuse period.

Known restrictions applicable to Alternative 2:

- Wings 2 and 4 lie on a seismic fault and it would not be feasible to modify these wings to meet present building codes.

c. Alternative 3: Replace CMR with new facility and demolish CMR Building

This alternative assumes that all capabilities in the existing CMR would be relocated to a new facility or other locations. The existing CMR would then be decommissioned, decontaminated, and demolished to grade. Decontamination of components would be performed when reasonable and disposed of as appropriate for the categories of waste generated. Decommissioning and dismantling of facility equipment/systems would be accomplished after any necessary decontamination. The facility structure would be demolished and all debris removed for recycling or disposal at an industrial waste site.

Known restrictions applicable to Alternative 3:

- The preparedness to proceed with this alternative in concert with the safe shut-down of the CMR Facility is a critical cost factor. Delays between CMR closure and the final demolition will require on-going operation of the unused facility in order to maintain nuclear safety requirements.

5. Evaluation of Alternatives

a. Evaluation of Alternative 1

The study team was directed to analyze a "No Action alternative" in which the CMR Building operated as is until 2060. Therefore, the only factor evaluated in this alternative is the operating cost. However, the NNSA has already decided that the CMR would not be upgraded for an extended operating period. This alternative does not provide a path forward that ensures the availability of facilities to meet the NNSA mission requirements far beyond 2010. Considerable action to upgrade the building would be required for longer-term operations and there is considerable doubt as to whether the building could meet long-term mission requirements. Assuming such upgrades would be supported by the NNSA and were physically attainable, the minimum cost would be at least equivalent to those described later in Alternative 2 ($611M), but would be expected to be substantially greater because the building would need to continue to be operated as a nuclear facility.

The estimated annual operating cost for the CMR Building in 2003 is based on the FY03 CMR facility management budget of $33M. This estimate includes operations, maintenance, radiation protection operations, waste operations and the facility support currently at CMR. The estimate does not include utility costs, the replacement cost of major equipment, upgrades, or other unexpected expenses. Assuming 3 % escalation per year, the total cost of continued operations for the period 2003 to 2060 is estimated to be $5B. The added cost and loss of productivity due to the age of the building and systems has not been factored into this cost, but those costs could be substantial.

The effort and cost for final D&D of the building remains at the end of this alternative. The $100M (2003 dollars) effort described in the evaluation of Alternative 3 would be necessary to complete the final disposition.

b. Evaluation of Alternative 2

In 1998 a detailed study and estimate was performed by Fluor Daniel, Inc. titled *CMR Reconfiguration Evaluation Analysis* (REA) [3]. For the purposes of this analysis, the REA study results have been considered equivalent to this alternative in that the REA provided for the decontamination and continued use of CMR for low hazard laboratory and office work. The REA study estimated a total of 3,236,960 man-hours at a total cost of $527M (1998). Escalated to 2003, the cost is estimated at $611M. This estimate includes the necessary efforts for decontamination, reconstruction, waste disposal, engineering, project management and reconstruction of CMR for reuse. While the cost will change based on factors applicable at the time the work is performed, the man-hour estimate should be considered less variable and is the best basis for future estimates. The details of this estimate can be found in the REA report [3].

The cost for D&D of plutonium-contaminated facilities at TA-21 in 1980 was \$110 per square foot [8]. This cost included removal of gloveboxes and hoods, removal of contaminated systems, scarifying the floor to significant depths into the concrete, laying a new concrete cap on the floors, and removing or fixing other radioactivity. This cost also includes all engineering, work planning, and waste disposal costs. Similar work performed by Kaiser Engineering in 1993 is reported to have been performed at a cost of \$200 per square foot[3]. The higher cost is used in this analysis to establish the upper bounding case.

The TA-21 work included similar D&D activities to those that will be necessary at CMR to prepare for building reuse, but that work did not include the expense of modifications to meet current building code and seismic criteria. Escalating to 2003 cost (3% per year), the square foot D&D estimate would be approximately \$270 per ft^2 for the same work. Based on a comparison of costs and man-hours from the REA study, it has been deduced that each 1 square foot of nuclear facility space will require an estimated 2 man-hours to decontaminate and prepare for reuse. Using this assumption, the estimated 247,500 ft^2 of contaminated CMR space would take an estimated 495,000 man-hours to remove old equipment and decontaminate.

No significant volume of sanitary waste is expected to be generated by this effort as the intent is to remove or clean contaminated systems and leave clean equipment in place. An estimated volume of 13,400 yd^3 of radioactive waste would be generated by this alternative. This volume was derived from the 1987 estimate developed and reported by Gonzales and Elder for a similar scope of work [8]. Since the time of that study, little has changed that would have a significant impact on radioactive waste volume.

As this alternative includes the construction and operation of a new facility (CMRR), as well as the refurbished CMR Building, it is estimated that the total operating cost through the year 2060 would be \$8.3B (\$5B CMRR plus \$3.3B refurbished CMR).

The effort and cost for final D&D of the building remains at the end of this alternative. The cost for final D&D of the building, at the end of this alternative, is estimated to be \$60M (2003 dollars), 60% of the D&D cost described in Alternative 3. The reduction in cost is a result of the decontamination having been completed during the preparations to reuse the building.

[3] Data was obtained by direct communication with the former Kaiser Project Manager.

c. Evaluation of Alternative 3

There has been little previous effort toward estimating the resources and cost associated with the demolition of the CMR Building. Two subject matter experts with significant CMR and D&D knowledge estimated the cost of demolition at $100M. The necessary labor for this alternative is an estimated 945,000 man-hours. This alternative would include a similar level of effort to Alternative 2 for decontamination efforts (495,000 man-hours) and the remaining effort (450,000 man-hours) for the final destruction and removal of the building.

The cost of interim CMR operations between shut-down and D&D have not been included in this analysis. It is important to note that the once the building has been vacated and placed into safe shut-down, there will be on-going requirements to maintain operations of the facility systems necessary to meet containment and other nuclear safety requirements, up to the time of demolition or full decontamination. Thus, it will be most cost efficient to prepare to start D&D immediately upon safe shutdown of the building. Assuming that there are minimal delays between the CMR safe shutdown and the start of D&D efforts, the estimated operating cost through the year 2060, applicable to this alternative, is $5B (this assumes that the CMR Replacement Facility operating costs will be similar to the cost of operating the existing CMR).

The waste volumes tabulated below were determined using the previously discussed approach and assumptions to determine the total volume of materials requiring disposal in a complete demolition. Thus, the total volume of waste was estimated at 36,000 yd^3. Using the previous stated assumption, a maximum of 45% of this volume could be expected to be contaminated. Thus, 16,000 yd^3 of radioactive waste and 20,000 yd^3 of sanitary waste is predicted to be generated by the implementation of this alternative.

6. Summary and Comparison of Data

Figures 1 through 4 present some of the key data for comparison of each alternative. The waste volume graphs include only those wastes associated directly with the D&D of the building; no operational wastes are included. Table 2 contains a complete comparison the data and the results for each alternative.

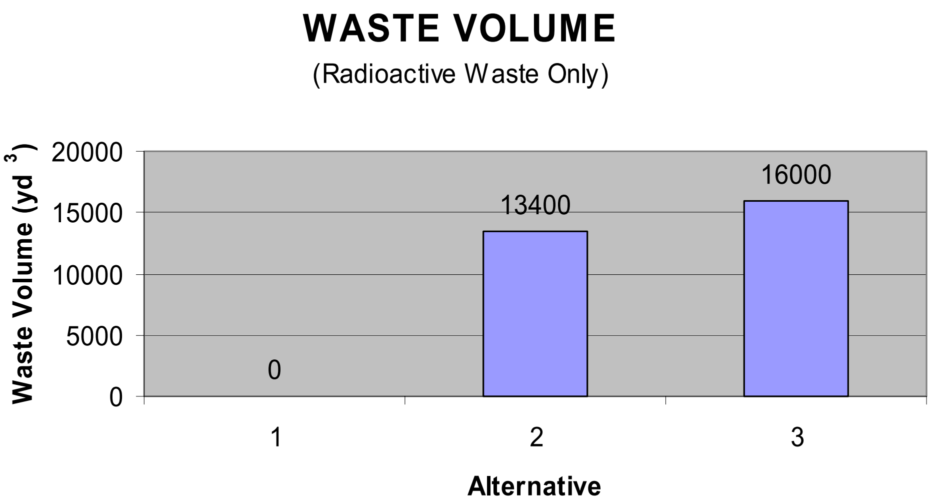

Figure 1: Radioactive waste volume each alternative generates.

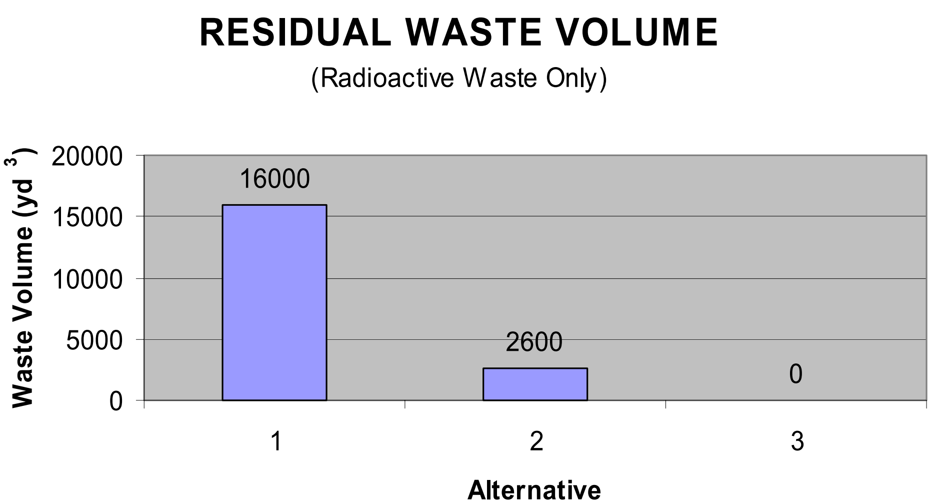

Figure 2: Comparison of residual waste volume unresolved by each alternative.

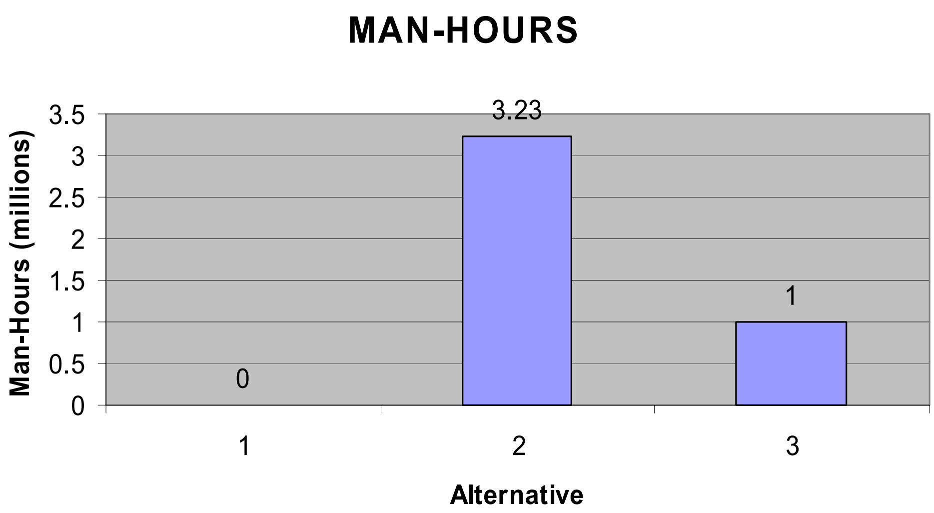

Figure 3: Comparison of man-hour estimates to implement each alternative.

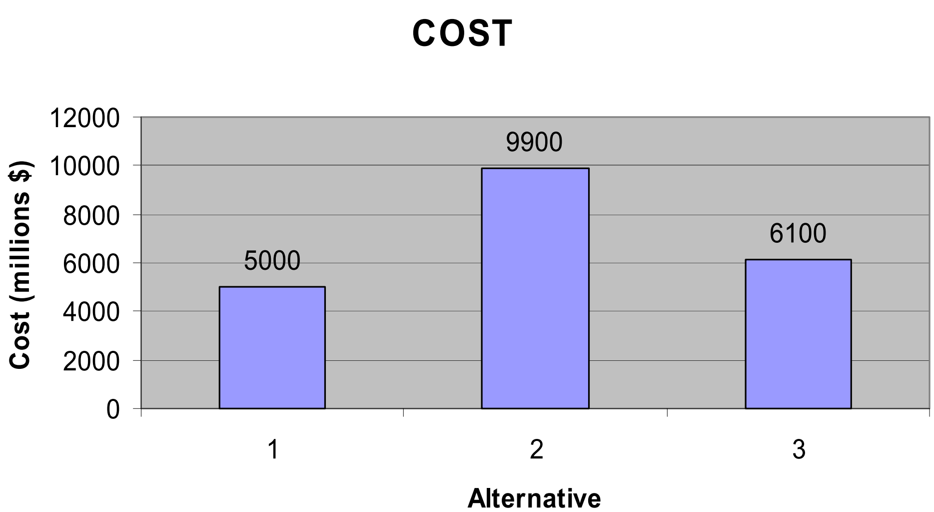

Figure 4: Comparison of estimated cost for each alternative.

Table 2: Comparison of Alternatives

Alternative	Construction and/or D&D Cost (CMR)	Operating Cost (CMR) thru 2060	Operating Cost (CMRR) thru 2060	CMRR Construction Cost	Man-hours to complete action (does not include CMRR Construction)	Waste Volume Estimate	Waste Remaining at Completion of Alternative	End Point Status	Summary (total cost includes the addition of the final demolition estimate)
Alternative 1 Do Nothing Operate CMR thru 2060	0	$5B	0	0	0	0	Total: 36,000 yd^3 Radioactive: 16,000 yd^3	Contaminated CMR building remains. Estimate $100M (2003 dollars) to complete D&D.	$5.1B (Operation beyond 2010 is not feasible without considerable additional cost)
Alternative 2 Replacement & Reuse CMR	$611M	$3.3B	$5B	$1B	3.2M	Total: 13,400 yd^3 Radioactive: 13,400 yd^3	Total: 22,600 yd^3 Radioactive: 2,600 yd^3	Partially Decontaminated CMR Bldg. remains. Estimate $60M (2003 dollars) to complete D&D.	$10B
Alternative 3 Replacement & Demolition of CMR	$100M	0	$5B	$1B	1M	Total: 36,000 yd^3 Radioactive: 16,000 yd^3	0	CMR Disposition Complete	$6.1B

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7. Conclusion and Recommendations

Alternative 1: This alternative does not provide for the long-term NNSA mission requirements. The NNSA has previously determined to perform only those safety upgrades necessary to keep the facility operational to 2010 and considers longer-term operations cost prohibitive and an unacceptable risk. Without substantial facility upgrades, the facility will not be available to meet key NNSA mission requirements much beyond 2010. At the end of this alternative, the cost of final disposition remains.

Alternative 2: This alternative is undesirable based on cost and on technical factors regarding continued use of the structure. While the reconstruction of CMR has been studied in some detail as part of the CMR Upgrades and REA projects, it remains questionable whether the structure can be successfully modified to meet current seismic standards. The cost of decontamination and reconstruction exceeds the cost of decontamination and demolition by 60%. The primary advantage of this alternative is the continued availability of the building space to support LANL missions; however, it is more risk aversive and economical to build a new building. At the end of this alternative, the cost of final disposition remains.

Alternative 3: This alternative is preferred as it provides for the long-term mission need at a reasonable risk and in a cost effective manner. By the time a replacement facility has become operational, the CMR Building will have served its function well for at least 60 years. The least costly approach to implementing this alternative is to start the D&D process at the earliest possible time and work continuously through to the completion of demolition. To prevent costly delays, planning and efforts to obtain approvals and funding should be started well before the closure of the building, so that D&D work can start as soon as or soon after the last operations have moved out. This early action will avoid the added cost of maintaining the facility in safe-shut down mode until D&D is started and avoids further cost escalation due to inflation.

a. Final Disposition Recommendation

It is recommended that final decommissioning, decontamination, and demolition of the existing CMR proceed directly after operations have moved to the new facility. The most cost effective approach would be to fund and proceed directly to demolition immediately upon the closure of the building. Delays in the disposition decision or funding will create unnecessary operating expense and burdens on the NNSA/LANL budget.

b. Interim Actions

The following interim actions are recommended to facilitate the preferred disposition alternative and avoid unnecessary cost and delay.

1. Include the demolition in the CMRR NEPA scope.
2. Develop a complete D&D plan to include all work to prepare for demolition of CMR.
3. Solicit funding for the D&D efforts to begin soon after the commissioning of the CMR Replacement.
4. Begin removal of the existing legacy equipment identified by NMT-7 in the Legacy Equipment Project as soon as feasible.
5. Begin decontamination efforts of unused space as soon as feasible. This effort would allow for pilot studies to determine the best decontamination methods.
6. Develop guidance for the safe shut down and clean up of operations that will be used in the CMR to CMRR transition process. The emphasis should be on the actions necessary to ensure that the facility is left in a condition that will facilitate D&D efforts.

8. References

1. "CMR Basis of Interim Operations, Revision 1," LANL, July 1998.

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5. "Conceptual Design Report CMR Upgrades Project, Phases 2 and 3, Volume VIII Cost Estimate," LANL LACP-95-196, February 1995.

6. "Fissile Material Holdup in Wing 7 of the CMR Basement, Preliminary Report Based on Measurements with Portable Ge and CdZnTe Detectors," C. Bonner, D. Garcia, J. Malcom, J. Pecos, P. Russo, R. Siebelist, LANL LA-UR-01-860, 2001.

7. "Strategy for Managing Risks at the Chemistry Metallurgy Research (CMR) Facility at Los Alamos National Laboratory," David Post, December 1998.

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