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Risk Management Study for the Retired Hanford Site Facilities

Risk Management Executive Summary

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RISK MANAGEMENT EXECUTIVE SUMMARY

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ABSTRACT

This document provides an executive summary of an approach to facilitate risk management of personnel safety and environmental release issues from 100 and 200 Area retired, surplus facilities during the predemolition time frame. It provides a summary of the risk evaluation process, shows applicable results, and includes cost comparisons for different risk-reduction options. The facilities evaluated include retired surplus production reactors, chemical processing facilities, and a variety of support facilities.

The retired facilities investigated for this evaluation are located on the 100 and 200 Areas of the 1,450-km^2 (570-mi^2) Hanford Site. The Hanford Site is a semiarid tract of land in southeastern Washington State. The nearest population center is Richland, Washington, (population 32,000) 30 km (20 mi) southeast of the 200 Area.

This document is the first in a four volume series that comprise the risk management study for the retired, surplus facilities. Volume 2 is the risk evaluation work procedure; volume 3 provides the results of the risk evaluation; and volume 4 is the risk-reduction cost comparison.

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1.0 INTRODUCTION

This executive summary is the first volume of a four volume series that comprise the risk management study for the 100 and 200 Area retired, surplus facilities on the Hanford Site. Volume 2 is the risk evaluation work procedure; volume 3 provides the results of the risk evaluation; and volume 4 is the risk-reduction cost comparison.

This document provides a summary of the risk evaluation process, shows applicable results, and includes cost comparisons for different risk-reduction options. It is a short description of an approach that facilitates risk management of personnel safety and environmental release issues from retired, surplus facilities (managed by Westinghouse Hanford Company [WHC]) during the predemolition time frame. These facilities include production reactors, chemical processing facilities, and a variety of support facilities.

The overall risk management study is the product of a major effort performed in fiscal year 1993 to produce qualitative information that characterizes certain risks associated with these surplus facilities. The primary motivation for this effort is an integrated action plan outlined in correspondence (Hughes 1992) from WHC to the U.S. Department of Energy, Richland Operations Office (RL) following the fatal accident that occurred at the 105-F Reactor Building in 1992. The plan is a response to a large number of findings, recommendations, and proposed actions that followed reviews of that accident.

Significant risk and risk management problems exist at the retired facilities on the Hanford Site. In the past, risk at these facilities has been assumed low because no work activities that generate a product are being performed. Although actual demolition activities have an element of risk associated with them, significant risk also exists for the period of time that the facilities must be maintained before demolition takes place--this length of time may exceed 30 years in some cases. Controlling risk during this interim period ensures risk remains low while continuing to move toward the ultimate goal of removal and site restoration. Identification of facility hazards and their accompanying risk is key in implementing a strategy to developing controls to limit risk during predemolition activities.

The following sections include summaries of the risk evaluation work procedure, the risk evaluation results, and the risk-reduction cost comparison.

2.0 VOLUME 2 - RISK EVALUATION WORK PROCEDURE

The risk evaluation work procedure (Volume 2) was specifically developed to identify and evaluate risks in the retired, surplus Hanford Site facilities (Coles et al. 1993a). This procedure meets a number of needs: (1) to identify all important risks to the onsite worker and the environment; (2) to evaluate both radiation and industrial safety risks on a comparable basis; (3) to accommodate the assessment of a large number and variety of buildings; (4) to gather eyewitness information from seldom-visited areas; and (5) to address the effects of continued aging on these facilities.

The objective of the procedure is to produce a process that would provide (1) a qualitative basis for establishing the risk to humans and the environment from retired, surplus facilities; (2) a way to identify dominant risk contributors for each facility; and (3) a common basis for evaluating risk to provide a basis for comparing and prioritizing actions that would reduce facility risks to an acceptable level. This process is explained in more detail in the risk evaluation work procedure (Coles et al. 1993a).

Unlike full-scope probabilistic risk assessments, this risk evaluation process is qualitative in nature, although numerical indexes are used. Full-scope probabilistic risk assessments can be very time consuming and expensive. The risk evaluation process is more time and cost efficient and retains the best features of the risk assessment approach to screen hazards and rank them according to their relative risk. This approach requires order-of-magnitude estimates of the likelihood, and consequences of potential events are used to estimate risk in order to facilitate identification of the best risk-reduction measures. Likelihood and consequence are based on expert professional judgment formed during investigations of the retired facilities and augmented by historical surveys and other existing documentation.

A key part of the risk evaluation is the investigation of the building by a team of experts from different professional disciplines. This investigation took the form of physical walkdowns and information searches. Physical walkdowns were necessary because current information on conditions or configurations did not exist for many facilities. To ensure safety by the team during the investigations, a special hazards identification investigation preceded the walkdowns. As a result in some cases, certain areas were restricted for entry because of the identification of possible eminent hazards. During the walkdowns, identification of aging factors that could increase risk in the 5 to 10-year time frame were noted.

The hazard evaluation process for determining the risk consists of three parts: (1) a building hazard investigation, (2) a findings evaluation performed in a team meeting format, and (3) an evaluation of results.

Team members conducted walkdown investigations of retired, surplus facilities and recorded findings on evaluation worksheets. The team included WHC and Kaiser Engineering Hanford professionals trained in the structural, electrical, industrial, radiation, and environmental safety disciplines. Walkdowns were augmented by reviews of applicable existing documentation, such as facility drawings, routine surveys, and hazard reports. All team members visited all buildings and whenever possible, every part of a building.

During team meetings, members (aided by the Team Risk Evaluation Lead) evaluated and condensed individual findings, decided on the likelihood and consequence to assign each finding, and recorded them on Risk Evaluation Summary Sheets. Risk Evaluation Summary sheets, organized by hazard categories, were completed for each facility. Evaluations of results determined overall risk categories and corresponding risk indexes for each hazard.

Risk is a function of likelihood and consequence. Consequences were divided into four broad categories: catastrophic, severe, unplanned releases, and minor. Unplanned releases were further divided into three subcategories based on the estimated effort it would require to remediate such an unplanned release. The risk dominant consequence and likelihood was assigned to a postulated accident. Potential accidents were grouped by consequence categories into similar outcomes. The consequence categories were assigned relative weighing factors (indexes) that reflect societal attitudes towards accident severity. For these particular facilities, no differentiation is made between Site personnel and the uninvolved public in the weighing factors.

After the consequence of an accident resulting from the presence of a hazard was established, it was assigned a likelihood index. Five likelihood categories were used: frequent, probable, occasional, remote, and improbable. These categories have probability ranges and were obtained from *System Safety Program Requirements* (MIL-STD-882B).

A risk matrix (Table 1) was developed to assign risk categories based on likelihood and consequence. Risk categories simplify the risk determination and encourage consistency in presenting risk. Indexes based on the weighing factors of likelihood and consequence taken together determine the indexes for the risk matrix categories. Five risk categories were generated with the ranges indicated based on the scaling of the product of the likelihood and consequence factors: critical (50,000) serious (1,500), moderate (250), minor (20), and negligible (1).

Table 1. Risk Matrix Categories.

Likelihood index	Consequence categories			
	I	II	III	IV
A	Critical	Critical	1 Serious 2 Moderate 3 Minor	Moderate
B	Critical	Serious	1 Moderate 2 Minor 3 Negligible	Minor
C	Serious	Moderate	1 Minor 2 Negligible 3 Negligible	Minor
D	Minor	Minor	1 Negligible 2 Negligible 3 Negligible	Negligible
E	Negligible	Negligible	1 Negligible 2 Negligible 3 Negligible	Negligible

As shown, the risk of each hazard is a function of both the likelihood and consequence of an undesired event. Therefore, the risk index for each facility is the sum of the index values for all the identified risks for that facility.

3.0 VOLUME 3 - RISK EVALUATION RESULTS

The risk evaluation results in Volume 3 (Coles et al. 1993b) were reported in a number of ways, including (1) a list of facilities in rank order by risk index with associated risk category information; (2) a list of overall risk contributors by hazard category for the near and far term estimates for the 100 Area (reactor and support facilities) and 200 Area (fuel processing and support facilities), respectively; (3) a general narrative of dominant risk contributors and sensitivities; (4) a facility-specific list of risk contributors for near and far term estimates for the 100 and 200 Areas, respectively; and (5) a facility-specific narrative of dominant risk contributors and sensitivities. Examples of each kind of output is included in this section. Volume 3 provides the complete results of the risk evaluation.

Prioritization was achieved by rank ordering the 100 and 200 Area retired facilities by their risk index values. The general and specific lists of overall risk contributors by hazard category for near (less than 5 years) and far term (5 to 10 years) cases identify which hazards are important and how aging contributes to risk. The general and specific descriptions of dominant risk contributors provide engineering insights that can be used to determine how risk can be reduced. The general and specific discussions of risk sensitivities provide insight on how the risk might increase if the baseline operating mode changes (i.e., physical or administrative control changes associated with the buildings).

It is important to note risk contributors that represented an apparent imminent danger to life or health or were considered particularly important for other reasons were remediated immediately. However, it was not within the scope of this effort to track these repairs but to identify and record them so they could be handled effectively.

Table 2 provides a rank order of the fifteen surplus facilities with the highest risk index for both the 0 to 5- and 5 to 10-year cases. The rank order for the 5 to 10-year case is different than the longer term case because aging and degradation contribute to risk.

Table 2. Rank Order of Buildings by Highest Risk.

Building			
Order	0 to 5 years	Order	5 to 10 years
1	105-F Reactor	1	105-DR Reactor
2	105-DR Reactor	2	105-F Reactor
3	105-H Reactor	3	105-H Reactor
4	105-D Reactor	4	105-D Reactor
5	221-U Canyon	5	105-C Reactor
6	105-B Reactor	6	183-C Water Plant
7	190-KW Pump House	7	1713-H Warehouse
8	202-S Canyon	8	105-B Reactor
9	105-C Reactor	9	224-B Office and Canyon
10	212-R Storage	10	205-A Solvent Handling

Of the hazards identified, falling, electrical shock hazards, and radiation exposure (to a smaller degree) are the most significant risk contributors at the Hanford Site facilities. Falling hazards are primarily related to deteriorating roof panels, and there is a need for more positive access control to the roofs from interior doors. Table 3 shows how many risks were identified for a facility by risk category and the resulting risk index.

Table 3. Hazards Per Risk Category

Building	Number of hazards per risk category					
	Critical	Serious	Moderate	Minor	Negligible	Risk index
0 to 5 years						
105-F Reactor	3	0	3	4	7	150,837
105-DR Reactor	2	2	2	5	8	103,608
105-H Reactor	1	1	3	6	8	52,378
105-D Reactor	1	1	2	7	6	52,146
221-U Canyon	1	1	0	1	7	51,527
105-B Reactor	1	0	2	7	9	50,649
190-KW Pump House	1	0	1	4	8	50,338
202-S Canyon	0	3	1	2	11	4,801
105-C Reactor	0	2	2	6	9	3,629
212-R Storage	0	2	2	0	2	3,502
224-B Office and Canyon	0	2	1	5	5	3,355
1713-H Warehouse	0	2	0	1	4	3,024
105-KW Reactor	0	1	4	5	9	2,609
105-KE Reactor	0	1	3	6	9	2,379
185-B/190-B Pump Houses	0	1	2	2	3	2,043
5 to 10 years						
105-DR Reactor	3	1	3	5	7	152,357
105-F Reactor	3	1	2	6	6	152,126
105-H Reactor	2	1	3	6	7	102,377
105-D Reactor	2	0	3	7	5	100,895
105-C Reactor	2	0	3	6	8	100,878
183-C Water Plant	2	0	1	3	5	100,315
1713-H Warehouse	2	0	0	3	2	100,062
105-B Reactor	1	1	3	7	7	52,397
224-B Office and Canyon	1	1	2	5	4	52,104
205-A Solvent Handling	1	1	0	4	5	51,585
221-U Canyon	1	1	0	3	5	51,565
105-KE Reactor	1	0	3	6	9	50,879
190-KW Pump House	1	0	3	3	7	50,817
291-S Exhaust Fan	1	0	2	4	3	50,583
292-U Stack Gas Monitor	1	0	1	1	2	50,272

Potential electrical shock is also a significant hazard. Out-of-service electrical distribution systems apparently are being energized for tours, surveillance work, and other activities. These systems are old, degraded, patched together, and in certain cases receive no regular preventative maintenance. Potential radiation exposure risk exists primarily in the 200 Area retired processing facilities where there is a high potential for uptake of radionuclides and external exposure to ionizing radiation. Figures 1 and 2 show the risk contribution from different hazard types for the 100 and 200 Areas, respectively.

Figure 1. Production Reactor Facilities Risk Contribution.

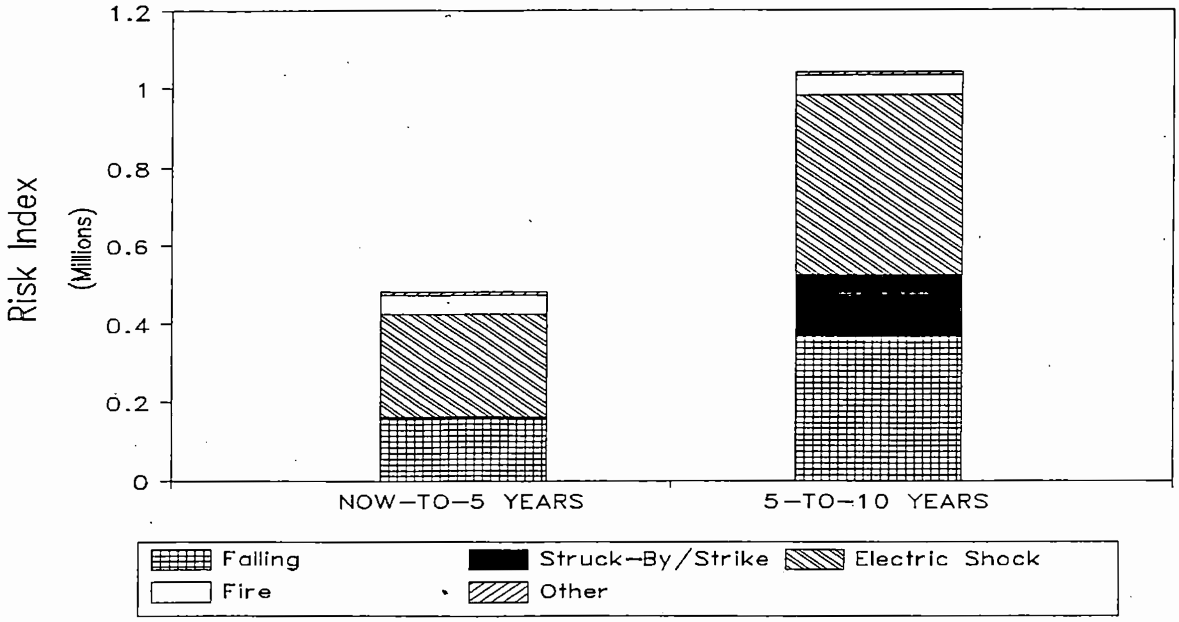
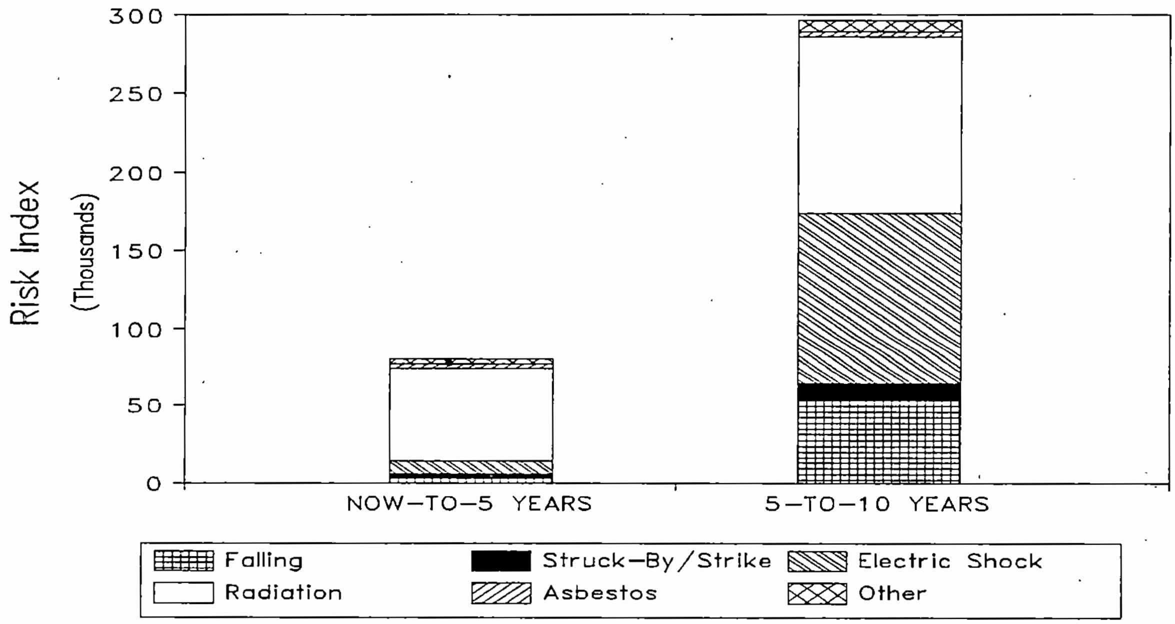


Figure 2. Chemical Separations Facilities Risk Contribution.



The dominant risks from these facilities are sensitive to factors that could change and should therefore be noted. These are referred to as risk sensitivities. For example, one risk sensitivity is the primary dependency on the amount of human activity in a building; an increase in activity increases human exposure to hazards. A second example is the possibility of increased radiation exposure or release risk when cutting into piping or structures, or uncovering activated materials. For some chemical separation facilities in the 200 Area, ventilation failure might increase the risk of a hazardous or radioactive material release. Two final important factors are changes in administrative controls (such as changes in building access control) and the lack of human awareness to safety rules and potential hazards.

4.0 VOLUME 4 - RISK-REDUCTION COST COMPARISON RESULTS

Volume 4 (Coles et al. 1993c) provides the complete results of the cost comparison analysis. Risks rated as critical, serious, or moderate are considered important risk contributors and candidates for risk reduction. The risk-reduction cost analysis builds on the risk analysis results by estimating costs for reducing the risk of the dominant contributors. By comparing costs of the various risk reduction approaches, selection of the most cost-effective reduction method can be performed.

The estimated total cost for reducing all risk to an acceptable level is $15,852,264. The cost to eliminate all critical risk is $1,386,091; to eliminate all serious risk is $10,263,401; and to eliminate all moderate risk is $4,202,772. In general, the most benefit is obtained by addressing the critical risks because these are the least expensive to remediate and contribute the most to the overall risk.

Costs of risk-reduction measures were estimated in present values only for dominant risk contributors. When future estimates are needed, it is assumed that cost and risk updates will be performed by integrating more current information gained from decommissioning and demolition experience.

Costs of risk-reduction measures were estimated using unit costs with one exception: costs associated with demolition were taken from *Surplus Facilities Program Plan - Fiscal Year 1993* (Winship and Hughes 1992). Hanford Site-specific unit costs were developed for different kinds of work activity. Several unit costs were developed by using the 105-F Reactor Building as a baseline.

The objective of risk-reduction measures is to reduce risk to an acceptable level (i.e., minor or negligible risk categories). However, when an important risk is mitigated, other lesser but still important risk issues emerge. For example, the roof may be repaired to mitigate a critical falling hazard, but a serious falling hazard related to guard rails remains. These issues are addressed level by level of decreasing risk contribution.

Cost comparison of risk reduction is shown in increasing levels of detail to facilitate risk management. For example, it is important to know that it may cost $15 million to reduce risk at all the reactor facilities to an acceptable level. However, this information alone does not specifically explain how reduction should be performed and where the cost should be incurred; more detail is needed. Furthermore, some levels of detail may not be helpful in some cases but could be in other cases. The level of detail provided in Volume 4 (Coles et al. 1993c) is sufficient to help management develop actual work plans to reduce risk-specific risk contributors.

Three general ways to mitigate risk contributors were considered: (1) physical repairs (or "fixes"); (2) isolation of the facility from workers while containing the hazard; and (3) demolition of the facility, resulting in elimination of the risk.

Of the three options for reducing risk, demolition not only reduces risk but also meets the goal of decommissioning facilities. In a similar way, partially isolating a facility fulfills decommissioning goals because much of the hazardous material is removed in the process. Repairing the facilities is generally the most expensive option and does little to meet decommissioning goals.

Overall risk-reduction costs by risk category are provided in Tables 4, 5, and 6. These tables show facility hazards grouped according to critical, serious, and moderate risks, and displays the costs of viable risk-reduction options. The nature of the risk-reduction option is identified by its corresponding hazard category only. The asterisk line in a cell indicates that the corresponding risk-reduction option is not considered viable. It should be noted that the risk contributor information is based on conditions that existed at the time of the facility investigations and does not acknowledge risk-reduction measures that occurred soon or very soon after identification of the risk.

Table 4. Risk-Reduction Costs for Critical Risk.

Costs for eliminating CRITICAL hazards				
Building/section	Hazard	Repair option	Isolation option	Demolition option
105-B storage basin	Electric shock	$43,385	*	*
105-B fan house	Electric shock	$41,760	*	*
105-B process area	Electric shock	$$44,285	*	*
105-B work/valve pit area	Electric shock, falling	$68,495	*	*
105-B office/miscellaneous	Electric shock	$24,210	*	*
105-D process area	Electric shock	$1,000	*	*
105-DR storage basin	Falling, electric shock	$834,130	$320,050	*
105-DR process area	Electric shock	$1,000	*	*
105-DR work/valve pit area	Falling	$770,990	*	*
105-F storage basin	Falling	$577,005	$26,631	*
105-F fan house/valve pit	Electric, fire	*	*	$393,562
105-H process area	Electric shock	$1,000	*	*
190-KW Process Water Pump House	Falling	$1,000	*	$2,802,666
221-U Canyon	Electric shock	$1,000	*	$156,452,000

* Not considered a viable option.

Table 5. Risk-Reduction Costs For Serious Risk.

Costs for eliminating SERIOUS hazards				
Building/section	Hazard	Repair option	Isolation option	Demolition option
105-C storage basin	Falling, electric shock	$972,720	$270,972	*
105-C fan house	Falling, electric shock	$708,400	$197,340	$688,160
105-C process area	Falling, electric shock	$1,217,230	*	*
105-C work area	Falling, electric shock	$1,048,600	*	*
105-D storage basin	Falling	$578,005	$26,631	*
105-D fan house	Falling	$547,105	$25,056	$217,152
105-D process area	Falling	$575,705	*	*
105-D work/valve pit area	Falling	$890,435	*	*
105-DR storage basin	Struck-by, falling, explosion	$2,200	$320,050	*
105-DR fan house	Falling, explosion	$380,120	$168,422	$523,980
105-DR process area	Falling, explosion	$1,000	*	*
105-DR work/valve pit area	Struck-by, electric shock, explosion	$59,340	*	*
105-DR office/miscellaneous	Falling, electric shock, explosion	$476,510	$169,825	$382,704
105-F storage basin	Electric shock	$44,385	$26,631	*
105-F process area	Falling, electric shock	$619,990	*	*
105-F work area	Falling, electric shock	$483,980	*	*
105-H storage basin	Falling	$904,240	$240,024	$1,633,896
105-H process area	Falling, electric shock	$731,080	*	*
105-H work area	Falling, electric shock	$317,965	*	*
105-KE control/fan room/ miscellaneous	Electric shock	$2,000	*	*
105-KE process area	Electric shock	$1,000	*	*
105-KE work, supply fan area	Electric shock	$1,000	*	*
105-KW work/supply fan area	Falling	$694,135	*	*
103-B Riggers Loft	Electric shock	$11,448	*	$51,000
1701-BA Exclusion area badge house	Electric shock	$1,000	*	$12,000
1702-C Badge House	Electric shock	*	$15,053	$6,000
1714-C Solvent Storage	Electric shock	$1,000	*	$13,398
1713-H Warehouse	Struck-by, electric shock	$5,000	*	$524,000
165-KW Power Control	Electric shock	$2,000	*	*
205-A Solvent Handling	Falling	*	$14,185	$481,000
224-B Office and Canyon	Electric, radiation exposure	*	$1,275,985	$14,835,000
215-C Storage	Electric shock	*	$41,856	$87,740
212-P Fuel Storage	Electric shock	$29,450	*	$1,343,000
212-R Fuel Storage	Falling, electric shock	*	$260,755	$1,343,000
202-S Canyon	Struck, electric shock, radiation exposure	$234,244	*	$174,582,000
233-S Plutonium Concentration	Struck, electric shock, radiation exposure	$9,072	*	$16,873,000
291-S Exhaust Fan	Electric shock	$1,650	*	$1,034,000
241-SX-401 Waste Disposal Condenser House	Electric shock	*	$47,733	*
241-SX-402 Waste Disposal Condenser House	Electric shock	*	$47,733	*
221-U Canyon	Electric shock, radiation exposure	$209,580	*	$154,178,630
292-U Jet Pit House	Electric shock	*	$24,162	$19,360
232-Z Plutonium Incinerator Facility	Radiation exposure	$1,000	*	$2,370,000

* Not considered a viable option.

Table 6. Risk-Reduction Costs for Moderate Risk.

Costs for eliminating MODERATE hazards				
Building/section	Hazard	Repair option	Isolation Option	Demolition option
105-DR storage basin	Falling	$1,000	$320,050	[a]
105-DR fan house	Falling	$1,000	[b] $0	[b] $0
105-DR process area	Falling	$1,000	[a]	[a]
105-DR work area	Falling	$1,000	[a]	[a]
105-DR office/miscellaneous	Falling	$1,000	[b] $0	[b] $0
105-KE process area	Radiation exposure	$165,616	[a]	[a]
105-KW process area	Electric shock, radiation exposure	$18,200	[a]	[a]
103-B Riggers Loft	Falling	$500	[a]	$51,000
185-B Water Treatment Plant/ 190-B Main Pump House	Falling, struck-by, biological, temperature extreme	[c,a]	[a]	$2,240,000
190-B Tunnel/Annex	Struck-by	[a]	[a]	$200,000
183-C Filter Plant Pump Room	Struck-by, biological	[c] $5,915,520	$2,328,654	$235,000
103-D Fresh Metal Storage	Falling	$1,000	$49,125	$49,000
108-F Biology Laboratory	Biological, temperature extreme	[c,a]	$809,362	$4,272,000
183-F Clearwell	Falling	[a]	$33,034	$73,803
202-S Canyon	Fire	$332,232	[a]	$174,582,084
233-SA Exhaust Filter	Radiation exposure	$1,152	[a]	$1,330,000
291-S Exhaust Fan	Radiation exposure	$990	[a]	$113,770
2711-S Stack Gas Monitoring	Falling	[a]	$16,786	$57,184
271-U Office	Fire	$1,000	[a]	$1,598,000
291-U Exhaust Fan	Radiation exposure, biological	[c] $990	[a]	$113,770
232-Z Plutonium Incinerator	Falling	$7,310	[a]	[b] $0

Notes:

[a] Not considered a viable option.

[b] These hazards were eliminated when the serious hazards were eliminated by isolation or demolition; therefore, no additional expenditure is required.

[c] Biological hazards and temperature extreme hazards were rated as moderate in many facilities; however, the cost of mitigation is not included here because the cost for related controls will be included in administrative costs for all facilities.

It is apparent in several facilities that significant risk reduction can be obtained for an expenditure of between $1,000 and $5,000 for certain critical, serious, and moderate hazards. After this group of risk-reduction measures is obtained, the costs for the next risk-reduction measures increase dramatically to the $10,000 and $100,000 range. This increase generally results from the remaining hazards, causing the risk to be more global in nature.

As a final precautionary note, the process of reducing risk (e.g., roof repair) can actually introduce new risk. Therefore, all repair, isolation, and demolition actions should be analyzed carefully for risk concerns.

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