INNOVATIVE TECHNOLOGY

Summary Report

DOE/EM-0400

Mobile Integrated Temporary Utility System

Deactivation and Decommissioning Focus Area

Prepared for

U.S. Department of Energy

Office of Environmental Management

Office of Science and Technology

December 1998

Mobile Integrated Temporary Utility System

OST Reference #1795

Deactivation and Decommissioning Focus Area

Demonstrated at
Hanford Site
Richland, Washington

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine if a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://OST.em.doe.gov under "Publications."

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SECTION 1

EXECUTIVE SUMMARY

The Mobile Integrated Temporary Utility System (MITUS) integrates portable electrical power along with communications and emergency alarm and lighting capabilities to provide safe, centralized power to work areas that need to be de-energized for decommissioning work. MITUS consists of a portable unit substation; up to twenty portable kiosks that house the power receptacles, communications, and emergency alarm and lighting systems; and a central communications unit. This system makes sequential decommissioning efforts efficient and cost-effective by allowing the integrated system to remain intact while being moved to subsequent work sites. Use of the MITUS also eliminates the need to conduct zero-energy tests and implement associated lock-out/tag-out procedures at partially de-energized facilities. Since the MITUS is a designed system, it can be customized to accommodate unique facility conditions simply by varying kiosks and transformer configurations. The MITUS is an attractive alternative to the use of portable generators with stand-alone communications and emergency system. It is more cost-effective than upgrading or reconfiguring existing power distribution systems.

■ Technology Summary

MITUS is a mobile temporary power supply and communications system is configured with a trailer-mounted unit substation, up to twenty moveable kiosks, and a central communications unit and has been successfully deployed since March 1997 at a work area of over 5480 square meters (59,000 square feet). The unit substation includes a disconnect switch, transformer, and switchgear. Kiosks can be configured to meet specific plant utility output and configuration needs. Each kiosk is equipped with a power receptacle center, paging/ communications/alarm center, and emergency pack lighting. Cables connect the kiosks to the unit substation. Central communications are housed with an uninterruptible power supply in the communications shed.

Problem Addressed

Before a facility can be decommissioned all electrical power and communication to the facility is turned off and permanently disconnected for safety and zero energy checks are performed. During the process of decommissioning a facility; however, electrical power is still needed for lighting, powering demolition tools, and communication as well as evacuation alarms.

Features and Configuration

- Provides safe, centralized local power to work areas
- Eliminates necessity for tag-out/lock-out procedures
- Portability and flexibility in matching power needs
- Provides efficient flow of information, directives and materials requests
- Alarm system includes color-coded lights and unique audible tones for different types of emergencies
- Highest-priority alarm overrides lower-priority functions

- Long-term cost-effectiveness
- Portable trailer-mounted unit substation that includes a disconnect switch, transformer, and switchgear
- Up to twenty moveable kiosks, each with:
  - power receptacle center
  - paging/communications/alarm center
  - emergency lighting pack
- Armored cables to connect the kiosks to the unit substation
- Central communications unit with uninterruptible power supply (UPS) housed in a communications shed

Potential Markets

The MITUS is useful and cost effective for providing temporary power and communication in facilities to be decommissioned at DOE, EPA, and NRC sites where temporary power/communication is required.

Advantages of the Innovative Technology

The following table summarizes the innovative technology against traditional (baseline) technologies.

Innovative Technology Summary

Category	Comments
Cost	The cost of installation and operation of MITUS is lower than baselines if employed for several years (used for multiple D&D projects)
Performance	MITUS performed better than using permanent power that suffers from constraints and limitations, and is more reliable than using portable generators
Implementation	No special site services are required for implementing MITUS
Secondary Waste Generation	Implementation does not result in the generation of secondary waste
ALARA/Safety	Use of this tool enhances ALARA and safety compared to the baselines

Shortfalls/Operator Concerns

No operator concerns have been identified in the deployment of this technology.

Skills/Training

No special skills or training are required in the operation of the MITUS**.**

■ Demonstration Summary

This report covers the period March 1997 through February 1998. The MITUS will continue to be in operation for the period of the C Reactor demolition and construction of the Interim Safe Storage structure.

Demonstration Site Description

At its former weapons production sites, the U. S. Department of Energy (DOE) is conducting an evaluation of innovative technologies that might prove valuable for facility decontamination and decommissioning (D&D). As part of the Hanford Site LSTD at the C Reactor ISS Project, at least twenty technologies will be tested and assessed against baseline technologies currently in use. DOE's Office of Science & Technology/Deactivation and Decommissioning Focus Area, in collaboration with the Environmental Restoration Program, is undertaking a major effort of demonstrating improved and innovative technologies at its sites nationwide, and if successfully demonstrated at the Hanford Site, these innovative technologies could be implemented at other DOE sites and similar government or commercial facilities.

Applicability

The U. S. Department of Energy, Richland Operations Office (DOE-RL), in collaboration with the OST/Deactivation and Decommissioning Focus Area, has successfully completed a demonstration to verify the capabilities of the MITUS. The system represents an innovative technology that can be used where there is a need to completely isolate and replace permanent power systems with safe, reliable temporary power, and where there is a need to ensure dependable communications, emergency lighting, and alarm capabilities. It is particularly applicable to decontamination and decommissioning operations at nuclear reactor facilities. The design of this technology is not patented. The components are readily available standard commercial items.

Key Demonstration Results

The objective of the MITUS innovation technology demonstration was to determine cost-effectiveness and safety versus baseline technologies and to assess whether the mobile power system would function as designed to replace the permanent power system. Totally de-energizing facilities prior to D&D enhances worker safety and, after zero-energy tests, eliminates the need for tag-out or lock-out procedures at the facility. This system was successfully demonstrated at C Reactor with the following key results:

- The MITUS provided kiosk load center power as designed.
- The paging/communication system facilitated communication among building sections and the central station.
- The alarm system enhanced safety by providing rapid and effective identification of alarm conditions.
- The emergency lights provided safety and ease of egress during loss of normal power.
- The MITUS was flexible in providing power to match power needs.
- The demonstration with its cost analysis indicated that the MITUS provides cost savings over the long run (multiple years/multiple projects use) compared to the baseline systems. Additional benefits, though not quantified in the cost analysis, are gained by not using permanent power with its attendant electrical safety problems during demolition activities.

Regulator Issues

The deployment of the MITUS system did not create regulatory issues. The system meets all National Electrical Code Requirements.

Technology Availability

The deployment of the technology does not require any special parts or components. All components are standard shelf items.

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Licensing Information

Not applicable, but individual components are patented by their manufacturers.

Other

All published Innovative Technology Summary Reports are available at http://em-50.doe.gov. The Technology Management System, also available through the EM-50 Web site, provides information about OST programs, technologies, and problems. The OST Reference # for the Mobile Integrated Temporary Utility System (MITUS) is 1795.

SECTION 2

TECHNOLOGY DESCRIPTION

■ Overall Process Definition

DOE's nuclear facility decommissioning program requirements include decontaminating and decommissioning buildings and structures safely, expeditiously, and cost effectively. To perform the building demolition task safely, the existing electrical connections should be isolated and zero-energy tested before demolition of each section of the building commences. Historically this has been accomplished by reviewing the existing building electrical drawings, followed by proper isolation of electrical power to the section(s) of the building slated for demolition/dismantlement. This is a time-consuming process, and not necessarily reliable since alterations could have been made to electrical systems and not reflected on "as-built" drawings. Also, various measuring difficulties, worker exposure, and physical access constraints have limited the effectiveness of this historical approach. The MITUS provides a viable alternative to the historically practiced methods (reconfiguring existing power distribution or using diesel generators), at the Hanford Site, other DOE Sites, and private industry.

The key benefits of the MITUS feature portability, safety, communication, and effectiveness. The MITUS includes a portable trailer-mounted unit substation (Figure 1), up to twenty portable kiosks (Figure 2), and international orange armored cables (Figure 3) connecting the kiosks to the unit substation. Each kiosk is a single unit that includes a power receptacle center (120, 240, 208Y, and 480 volts), an emergency lighting pack, and a communication/paging/alarm center, that is connected to a central unit at the central communication station (Figure 4). A battery-powered uninterruptible power supply located at the shed, provides continuous power to the paging/communication/alarm system should there be a loss of normal power. Each kiosk also contains emergency lighting that activates upon loss of normal power and continues to operate up to 90 minutes until normal power is restored. Nine to ten kiosks were needed for D&D at C Reactor and were used for the demonstration and deployment.

Figure 1. Portable trailer-mounted Unit Substation.

Figure 2. Portable kiosk.

Figure 3. International orange cables.

Figure 4. Central communication station.

The MITUS can support up to twenty kiosks, although only nine were connected for the demonstration at the C Reactor. A block diagram of the MITUS is presented in Figure 5 showing the specific configuration of components for the demonstration.

The input voltage requirement to the unit substation disconnect switch and transformer is 13,800 volts, three phase. It should be noted that, because MITUS is a designed system, this requirement can easily be modified by substituting the onboard transformer with one that can accommodate the main power source. The unit substation, which includes a disconnect switch, transformer, and switch-gear, is mounted on a flatbed trailer suitable for over-the-road travel. Output voltage and power requirements from the unit substation transformer are 480Y/ 277 volts from a 750 kVA/ 1000 kVA AA/FA transformer.

The main kiosks used for this demonstration have input voltage requirements of 480 volts AC and transform the voltage to 120 volts, 240 volts, or 208 volts. Several other kiosks are 480 volts input and 480 volts output. Again, because MITUS is a designed system the output voltages of the kiosks can be modified to accommodate project needs simply by selecting proper kiosk transformers.

This MITUS technology allows the complete deactivation of existing building power at the Hanford Site production reactors or other Hanford Site facilities (i.e., Hanford Site Canyons) scheduled for D&D once the MITUS is on line for that reactor or facility. Such complete deactivation allows D&D work to continue unhampered by constraints of local area deactivation and extended zero-energy checks.

An important feature of this technology is the versatility of the power, communication, and the safety provisions for the D&D staff. The power can be moved from place to place, and the flexible cables connecting the kiosks to the unit substation allow free movement of the kiosks. The use of paging and telephone party lines allows very efficient flow of information, directives, and requests for materials regardless of the location of the kiosks. Each kiosk is equipped with color-coded lights and unique tones for three separate alarms. Activation at any of the kiosks alerts all other kiosks and the central station cabinet of “Evacuate,” “Alert,” and “Medical” alarm conditions. The MITUS alarm system is designed to discriminate among alarm conditions, overriding lower priority alarm conditions with the highest priority alarm.

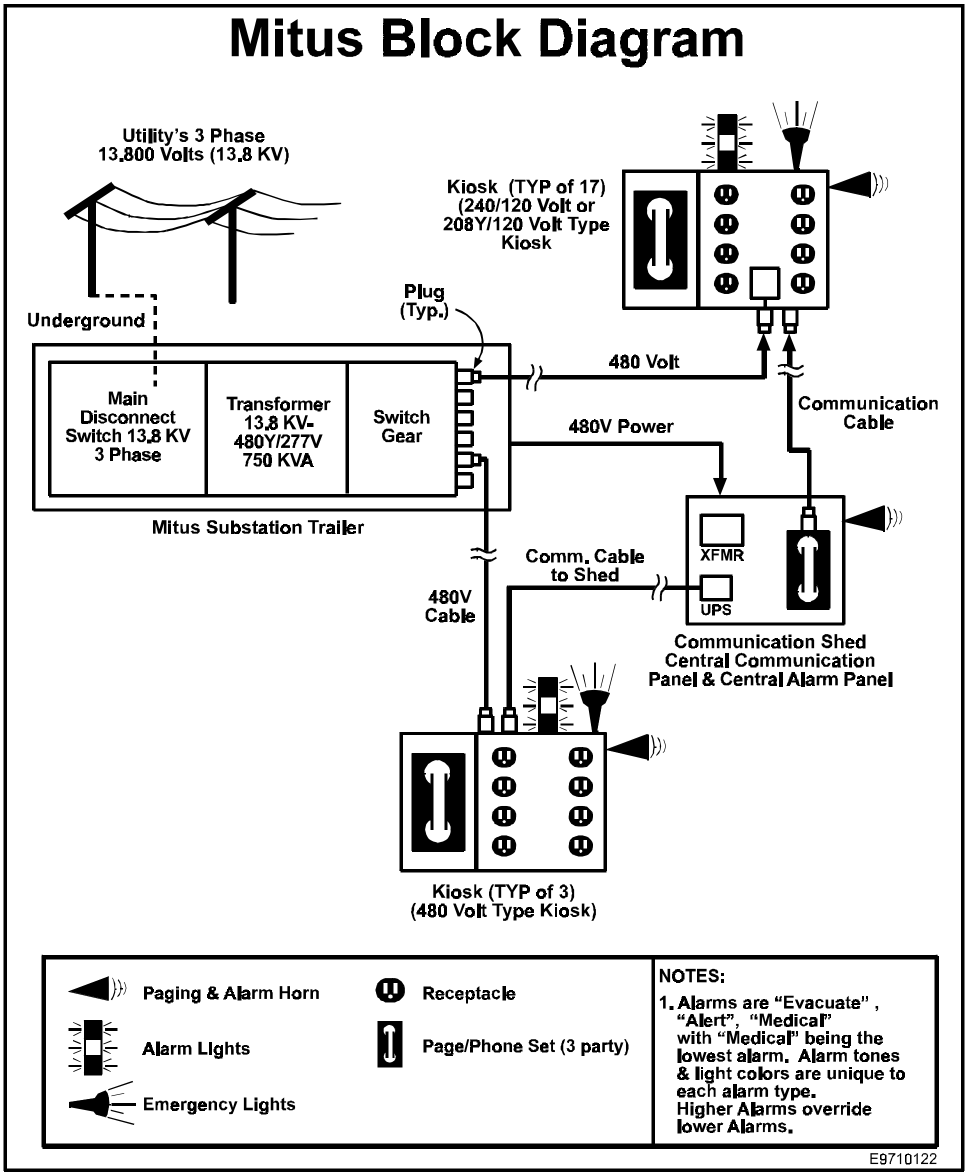

Figure 5. Mitus block diagram.

■ System Operation

With the MITUS in place, the start up and operation are as follows:

- Energize the MITUS unit substation with 13,800 volt electric utility input power.
- Energize the main 480-volt circuit breaker and kiosk branch breaker. This provides power to the individual kiosk fusible disconnects.
- Close the kiosk fusible disconnects to energize the kiosk receptacles, paging/communication/alarm system, and the emergency light system.
- Activate power to the central communication station.

SECTION 3

PERFORMANCE

■ Demonstration Plan

Site Description

The demonstration was conducted at the C Reactor at DOE's Hanford Site. The purpose of the demonstration program is to demonstrate and document performance data, safety and costs for improved and innovative technologies that can aid in placing the C Reactor into an interim storage mode for up to 75 years, or until the final disposal of the reactor's core is completed. The C Reactor ISS objectives include placing the reactor in a condition that will not preclude or increase future decommissioning costs, minimizing the potential for releases to the environment, and reducing the frequency of inspections thereby reducing potential risk to workers.

Prior to initiating D&D work, permanent power supplies must be isolated and de-energized. Zero-energy tests must be conducted in the de-energized zones to ensure worker safety. Temporary lighting and communications must be established in the zone in which work is scheduled. Traditionally, this has been accomplished through a combination of portable generators and hand-held radios or cellular phones, or by a series of reconfigurations of the electrical distribution system within a facility to accommodate the D&D work. These approaches are often time consuming and costly.

Demonstration Objectives

This assessment evaluated MITUS performance, cost, and safety features compared to baseline technologies. The demonstration also assessed whether the mobile power system would function as designed to replace the station's permanent power system allowing total de-energization of the C Reactor complex. Total de-energization of a facility enhances worker safety, minimizes the need for zero-energy testing, and eliminates the need for lock-out and tag-out. Other objectives of this demonstration included the performance features described below:

Physical inspection of the systems and components were conducted for:

- Structure
- Mechanical damage

Unit-substation transformer checkout was performed in accordance with IEEE standards. Electrical assessments on systems and components included checking of:

- power circuit phasing
- control circuit wiring
- instrument transformers
- meters
- device electrical operation
- dielectric tests
- insulation resistance tests

Demonstration Chronology

This section describes the demonstration in detail, and compares the innovative technology to the two baseline technologies. To assess the MITUS performance, cost, and safety benefits as compared to baseline technologies, the MITUS was demonstrated in two phases: pre-energization and energization of equipment. The steps in each phase are listed below.

Equipment Pre-energization

- Meggering of cables.
- Verifying insulation resistance of electrical equipment.
- Operating protective equipment manually for verification of operation.
- Verifying grounding and grounding resistance in the earth.
- Verifying that cables are installed correctly.

Equipment Energization

- Energization of equipment in sequence, starting at the source end of the system, working toward the load, metering and recording voltages for each kiosk.

- Emergency lighting was demonstrated for each kiosk. All of these observed results are recorded in the test register.

- Performed audio tests of the paging system by checking the area of audio coverage from loud speakers.

- Performed party-line audio assessments by checking adequacy of phone sets.

- Checked emergency communication by activating each alarm level at each kiosk.

- Performed central station cabinet alarm activation checks by activating each alarm level and verifying the alarms at the kiosks.

- Checked system alarm prioritization and central station cabinet alarm priority page overrides. This demonstrated that the higher alarm levels would override those of lower priority. Each alarm level was checked for the different tones. All of the results are recorded in the demonstration register.

Results/ Performance

Pre-/Post-MITUS Operation Check

- The MITUS was checked for operation by C Reactor ISS Project personnel before and after the demonstration.

- The MITUS electrical protective devices were checked before and after the demonstration to check for signs of electrical overloads or short circuit protective devices operations.

Baseline Tools

For the purpose of this demonstration two baseline technologies were considered:

- Portable electric generators, plus stand-alone communication, paging, and emergency alarming and lighting systems.

- Upgrade existing plant systems, plus stand-alone communication, paging, and emergency alarming and lighting systems.

The existing power distribution to the C Reactor is from a 300-kVA, 2.4-kV-480Y/277V transformer. The 2.4-kV line powering this transformer is to be de-energized by the Electric Utility in the future. Once the 2.4-kV line is de-energized, upgrading the C Reactor existing power system in the plant would require a new transformer made for 13.8-kV-480Y/277 volts or the use of generators**.** Upgrading the existing C Reactor electrical system would require a detailed review of the entire electrical system to determine the locations of usable electrical distribution panels, and where new distribution panels would be required. Once the panel locations are determined, each upstream distribution panel must be located and evaluated for service adequacy. Once the electrical supply evaluation is completed, the electrical supply to the distribution panels must be refurbished, tested, and placed in service. As D&D work progresses, rooms and areas next scheduled for D&D would be de-energized and temporary power brought in via extension cables to support the D&D. This process would continue until completion of D&D activities. In addition, communication, emergency lighting, and alarms must be established and maintained. This process would be repeated with each reactor or facility at the Hanford site and other DOE sites.

Meeting Performance Objectives

The objectives listed in the demonstration plan section were all met by successfully conducting the assessments over a long period of time (February 1, 1997 to August 30, 1997).

Comparison of Innovative Technology to Baseline

Table 1 summarizes the comparison between baseline and innovative technologies considered under this demonstration.

Table 1. Comparison of Innovative and Baseline Technologies

Activity or Feature	Baseline		Innovative Tech Demo
	Portable Generators	**Restore Plant Electrical**	**MITUS**
Equipment Check	daily	periodically	periodically
Setup	easy to setup	needs more effort and system checks; current electrical drawings are not as built	same level of effort as portable generator but easier than plant restoration
Flexibility	mobile	fixed location	mobile; can accommodate a variety of plant utility output conditions; can be custom designed to facility configuration
Safety	good	medium	safer than restoring plant electrical system
Durability	medium	medium	more reliable than baselines
Ease of operation	needs repeated refueling; needs power interruption for generator servicing	needs more effort and system checks	easier to use than baselines
Waste generation	none	none	none
Utility requirements	none	13,800 volts	13,800 volts*
Training	minimal electrical	minimal electrical	minimal electrical

* This requirement can be modified by substituting the onboard transformer with one that can accommodate the main power supply.

Skills/Training

No special skills or training are required in the operation of the MITUS. Training of field technicians is minimal, provided that the trainees have basic operational knowledge of portable power equipment and page/communication/alarm equipment. The design of the system requires trained engineers.

Operational Concerns

No operator concerns have been identified with the MITUS. However, the MITUS equipment utilizes 13,800 volts as input voltage to the MITUS substation, and 480 volts as the kiosk transformer primary voltage. Handling these voltages and associated charged equipment requires extra caution.

SECTION 4

TECHNOLOGY APPLICABILITY AND ALTERNATIVE TECHNOLOGIES

Technology Applicability

- This technology can be used at DOE and other sites in which the existing facility must be totally de-energized to protect worker safety during D&D activities. The MITUS replaces all existing facility power, providing a safe and reliable temporary power source.
- The MITUS demonstrated at the C Reactor has the capability to provide mobile temporary power to any facility with 13,800 volts available at the site. It should be noted, however, that because MITUS is a designed system, this requirement can easily be modified by simply substituting the onboard transformer with one that can accommodate the main power supply

Competing Technologies

The MITUS technology competes with cost of upgrading the plant electrical system and of maintaining building electrical components to required standards during the D&D activities.

Neither of the competing baseline technologies has components integrating the power supply with the communication, paging, and alarm systems. They include:

- Portable electric generators plus stand-alone communication, paging, and emergency alarm and lighting systems.
- Upgrades to existing power distribution equipment (i.e., installation of a new transformer, reuse or replacement of existing usable electrical distribution equipment) plus stand-alone communication, paging, and emergency alarm and lighting systems. This baseline alternative requires careful examination of the existing plant electrical as-built drawings and physical inspection of the existing usable electrical lines for certification purposes.

Patents/Commercialization/Sponsors

While individual components may be patented, the specific design integrating the components that comprise MITUS is not. The integration of standard commercial items into the mobile power and communications system can be customized to meet facility-specific layout and utility capacities.

SECTION 5

COST

■ Methodology

This cost analysis compares the MITUS innovative technology to two baseline technologies for providing the electric power, communications, alarms, and emergency lighting needed for D&D work. These baselines consist of:

- Portable generators with stand-alone communications, alarms, and emergency lighting
- Restoring the existing plant electrical system with stand-alone communications, alarms, and emergency lighting.

The innovative technology was developed for the D&D of the C Reactor and most of the cost items shown in this analysis are based on observed costs. The baseline technologies were estimated from past experience with similar work. The results of the cost analysis show that the MITUS varies from being slightly more expensive to saving over 26% compared to over the baseline technologies costs, depending upon the size of electrical demand. The MITUS estimate of cost is based on ten-year use (assumes amortization of the design and purchase over the ten-year life).

Cost assumptions and a detailed cost comparative analysis are contained in Appendix C.

■ Cost Analysis

The innovative technology is available as shown in Table 2:

Table 2. Innovative technology acquisition costs

Acquisition Option	Item	Cost
Design Manufacture & Delivery Installation	Plans and Specifications Trailer and Kiosks Trailer	$35,000 $ 544,000 $42,673
Rental or Lease		Not commonly available

The cost shown above does not include maintenance ($4,228 / year). The installation includes set up at the site and running cables ($22,080) and connection to the 13.8 kV site utilities ($20,593 with connections for future moves being one-quarter of the cost).

The life expectancy of the MITUS is anticipated to be ten to fifteen years, if the maintenance on the transformer, switchgear, and Kiosks is performed (the maintenance cost indicated above, is included in the hourly rate used in computations shown in Appendix C). Estimated unit costs presented in Table 3:

Table 3. Summary of unit costs

Innovative Technology	Baseline Technology	
MITUS (200 kW - 750 kW)	**Portable Generator** with standalone communication, alarms, and emergency lights (200 kW - 750 kW)	**Restore Plant Electrical System** with standalone communication, alarms, and emergency lights (200 kW - 750 kW)
\$1.21 - \$0.17 / kWhour	\$2.00 - \$0.23 /kWhour	\$2.85 - \$0.24 / kWhour

Unit costs are based on the total cost (including mobilization, operation, and demobilization) for the duration of the D&D work planned for C Reactor divided by the kilowatt hours of electrical service required.

The demonstration occurred under specific conditions that directly control cost (a detailed table of costs for the demonstration is shown in Appendix C). Some of the principal conditions affecting costs are electrical demand requirements, requirements for alarms and communications, age of the facility and amount of replacement of existing plant (for the restoring plant alternative).

■ Cost Conclusions

- The MITUS costs include connection to the site 13.8kV utility, set-up (cables to work areas and kiosks), operation during D&D work (includes electricity bills), and packing for transport to a future reactor D&D location. The hourly rate used in these activities includes amortization of the design costs, manufacture, delivery, and maintenance costs.

- The baseline alternative using portable generators for power includes design/planning, mobilization of generators to the C Reactor, setting up cables and lights, operation during the D&D work (includes fuel), moving the generators as work progresses from one location to the next in the C Reactor, and demobilizing the generators.

- The baseline alternative for restoration of the existing plant electrical system includes design/planning of the work, replacement of the primary transformer, checking and replacing failed circuits and breakers in the switchgear, motor controllers, and panels, performing a zero-energy check (assure that short circuits are not causing circuits to be energized unpredictably), electric bills during D&D, disconnecting power to an area as demolition begins in that area, rerouting power feeds as needed, and providing temporary power in areas of active demolition.

The electrical design for MITUS was based on Hanford Site electrical design procedures, which resulted in a computed load of 750 kW for simultaneous D&D work at two reactors. The measured electrical demand for the D&D work between April 1997 and September 1997 varied from 95 kW to 135 kW. Future D&D efforts are anticipated to increase the demand by an additional 160 kW. The cost analysis is primarily directed towards an estimate for the 750-kW design, since the MITUS was constructed to that loading amount. But this cost analysis considers other loading situations, particularly a 200-kW loading, which is consistent with the observed loads for a single reactor D&D effort. Total costs for providing power, communications, alarms, and emergency lighting for the C Reactor D&D work are shown below in Figure 6 for each technology.

Figure 6 presents costs for two load situations (200-kW loading for a single reactor decommissioning and 750-kW loading for two simultaneous decommissioning projects) and two MITUS configurations (transformers and kiosks appropriate for a 200-kW load and for a load of 750 kW. The MITUS is cost effective where its capacity matches the load requirements. In situations where the MITUS is oversized (for example provided with larger transformers and more kiosks to accommodate simultaneous reactor decommissioning projects but used only for a single reactor project), then its costs are similar to the costs for the portable generator alternative.

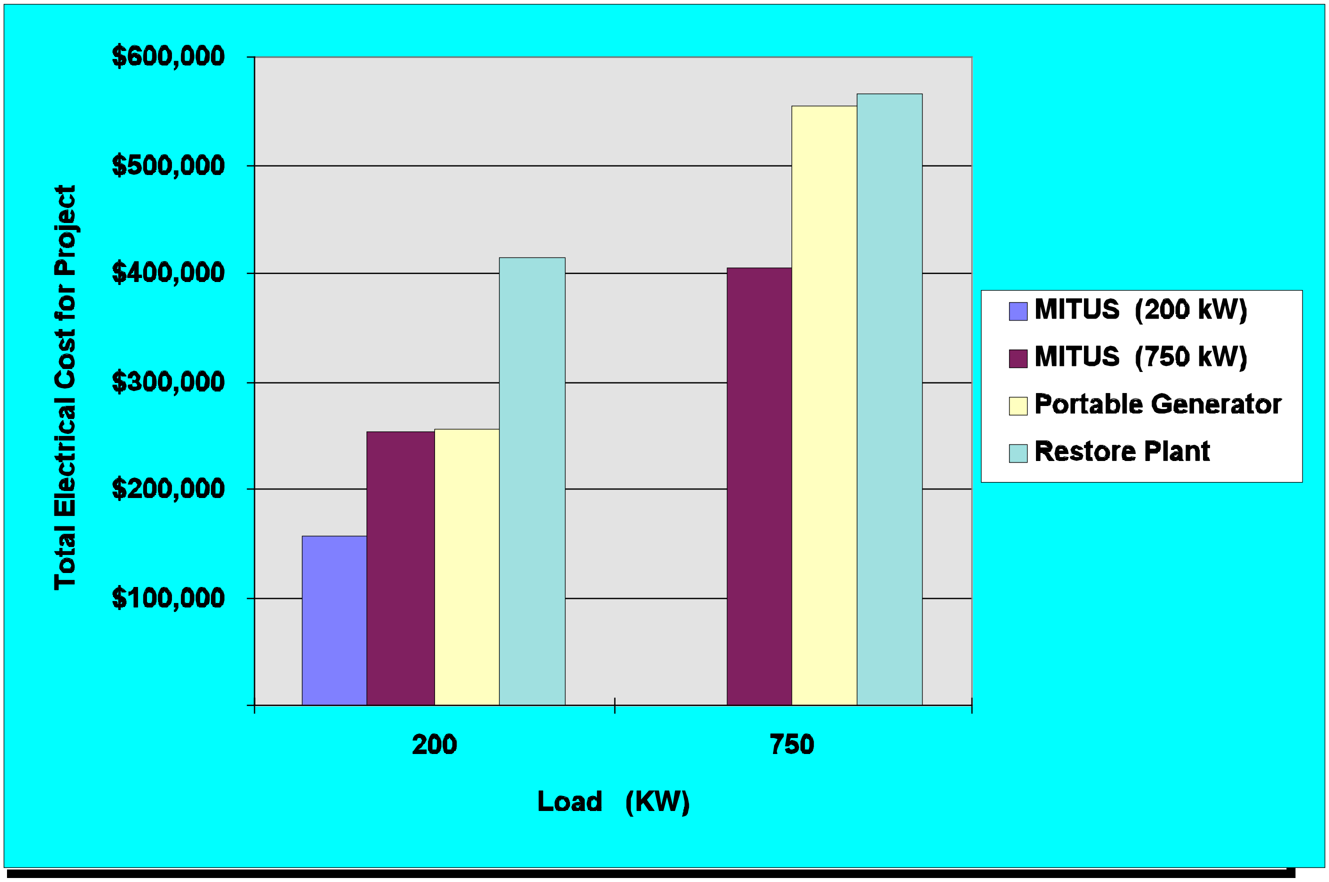

Figure 6. Cost comparison.

As previously described, this cost analysis assumes the cost for MITUS design and manufacture are amortized over its service life. Appendix C contains work sheets for each technology that will allow the potential user to compute a site-specific cost by applying site-specific quantities and conditions in the spreadsheet.

The D&D work at some DOE sites would not support the continual operation of MITUS over a ten-year period. To assist those sites in evaluating MITUS, this cost analysis includes a present worth analysis with a 5.8% discount rate that does not amortize the MITUS design and manufacture cost. The minimum length of operation required for the MITUS to be preferred over the baseline technologies is determined as shown below. The Hanford Site is planning D&D work for 8 reactors with start-up of individual projects at approximate intervals of 1-1/2 years. This tentative schedule of work is used in the present worth analysis. This present worth analysis places the cost for design and purchase of MITUS in the first reactor D&D project (C Reactor). Subsequent projects incur only operation, maintenance, and mobilization costs (the next reactor project at the Hanford Site is assumed to be the F Reactor). The schedule of costs assumed for reactor D&D work is shown in Figure 7:

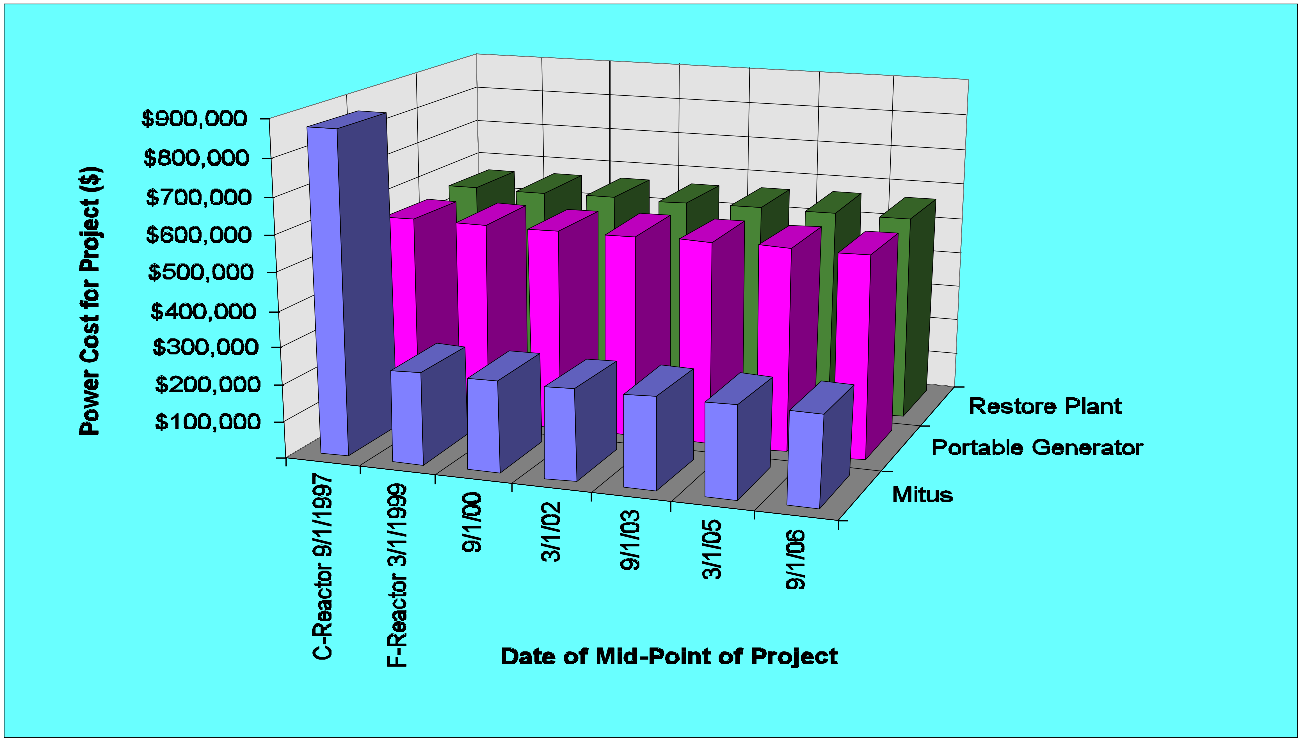

Figure 7. Present worth analysis - schedule of costs

The analysis assumes that the electrical power cost for each reactor D&D project occurs at the mid point in the project. The present worth is computed for various numbers of consecutive reactor D&D projects to determine the size of program at which the MITUS costs reach the break-even point relative to the baseline alternatives. The comparison of the present-worth costs is shown in Figure 8.

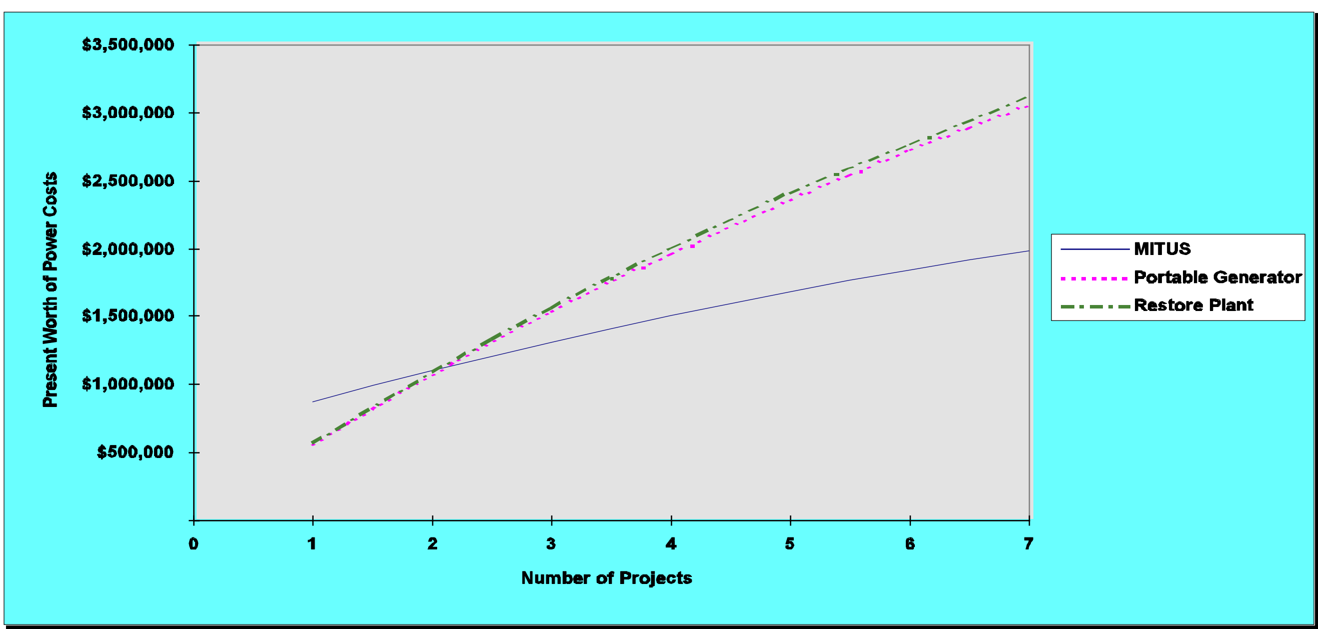

Figure 8. Present worth as a function of the number of reactor projects for 750-kW design

Cost Conclusions

- MITUS technology saves more than 26% the baseline technologies for situations where the MITUS can operate for extended periods.
- The break-even point for cost savings relative to the portable generators alternative is approximately two reactor D&D projects or approximately three years.

In situations where the electrical demand is not well known or where the demand could vary over a wide range, choosing the best power-supply technology is more difficult. Conservative power-load designs for MITUS could result in higher costs than necessary. In these situations, the design uncertainty or the power-demand variation may make the use of portable generators the most attractive alternative because of the ability to add or remove individual generators with variations in demand.

The estimates for the MITUS (750 kW electrical demand) provide costs that are reliable and have few uncertainties. On the other hand, the cost estimate for the restoration of the plant electrical system contains many assumptions that have a limited amount of historical basis. The principal portion of the MITUS cost (manufacture/delivery) is based on actual invoices for that equipment. Consequently, there is little uncertainty in the cost analysis for this technology, other than for the maintenance. The maintenance cost was conservatively estimated based on recommended maintenance practice from the International Electrical Testing Association. The estimate for the MITUS (200 kW electrical demand) is based on parametric extrapolations of the 750-kW design. The major cost element for the portable generator is for the rental and operation of the equipment and the estimate is sensitive to the number of generators assumed. Additionally, the generator tending is a major cost that will vary with the number of generators used and local practice. The MITUS has not required any tending. For both the MITUS and the generator alternative, the costs increase as the number of kiosks and generators increase. But minimizing costs by limiting the number of kiosks and generators will adversely affect the project flexibility. Based on the experience at C Reactor where 9 to 10 kiosks plus occasional generators have been used, there is an optimum number of kiosks and generators (approximately 12 units; more units provide added flexibility) that will be required and this number is not directly influenced by the power demand for the project.

Finally, safety has a cost associated with it, and from numerous lessons learned on D&D projects, electrical safety has always been a problem due to non-accessible or non-as-built drawings. MITUS and the generator baseline alternative have a distinct advantage over the alternative to upgrade existing plant systems; however, this cost savings was conservatively not quantified in this comparison.

SECTION 6

REGULATORY/POLICY ISSUES

■ Regulatory Considerations

- The MITUS is a power supply, paging/communication/alarm, and emergency lighting system that requires no special regulatory permits for its operation or use.
- Even though deployment of the system does not need any special permits, requirements of 10 *Code of Federal Regulations* (CFR) parts 20 and 835 should be considered when the system is used in radiologically contaminated areas, both for worker protection and for equipment contamination controls and release surveys.
- In addition, safety and operational requirements set by OSHA 29 CFR 1910 and 1926 and IEEE should be addressed in the deployment of this system.
- Although the demonstration took place at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site, no CERCLA requirements apply to the technology demonstrated.

■ Safety, Risk, Benefits, and Community Reaction

Worker Safety

- Use of the MITUS technology enhances worker safety compared to power provided via plant upgrade, because with the MITUS there is no live electrical power within walls being demolished.
- Normal radiation protection worker safety and equipment contamination control procedures used at the facility would apply.
- Technology users should implement contamination control practices when use is in an area of contamination.
- Normal electrical grounding requirements of the National Electrical Code should be met for installing the MITUS equipment and use of the power outlets.
- Normal worker safety precautions and practices prescribed by OSHA for operation of electrical equipment apply.

Community Safety, Environmental and Socioeconomic Impacts, and Community Perception

It is not anticipated that implementation of the MITUS innovative technology would present any adverse impacts to community safety or the environment. A benefit to the environment is derived versus using diesel generators if the utility power fed to MITUS is generated using a cleaner energy source than combustion of diesel fuel. Similarly, no socioeconomic impacts are expected in association with use of this technology.

SECTION 7

LESSONS LEARNED

■ Implementation Considerations

- To the extent possible, cables should be kept off the floor by supporting them on hangers throughout the building so there is less risk of cable damage.
- As with any equipment, efforts should focus on preventing the kiosks from becoming contaminated.
- Only personnel qualified in 480 and above voltages should be involved in the installation and operation of the 13,800- and 480-volt systems.

■ Technology Limitations/Needs for Future Development

- The MITUS is very flexible in supplying power, communications, and emergency lighting to any part of the building, so no additional flexibility is required.

■ Technology Selection Considerations

- The MITUS technology is suitable for DOE nuclear facility D&D sites or any other sites involving D&D activities that require permanent power to the site to be de-energized and removed.
- The MITUS technology provides paging/communication/alarm and emergency lighting to the D&D sites that speeds communication and enhances worker safety by provision of immediate alarm situation communications.
- The use of MITUS can accelerate D&D activities by allowing total de-energization of the facility, thus allowing the zero-energy checks to be done at one time. Therefore, the D&D personnel can demolish walls, floors, and ceilings without hold points waiting for de-energization, and without lock and tag constraints.

APPENDIX A

REFERENCES

10 CFR Part 20, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

10 CFR Part 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

Proposed 10 CFR Part 834, "Environmental Radiation Protection," *Code of Federal Regulations*, as amended.

29 CFR 1910, "General Industry Occupational Safety and Health Standards," *Code of Federal Regulations,* as amended.

29 CFR 1926, "Construction Occupational Safety and Health Standards," *Code of Federal Regulations,* as amended.

AID 1986, *Guidelines for Producing Commercial Nuclear Power Plant decommissioning Cost Estimates*, May 1986, National Environmental Studies Project of the Atomic Industrial Forum, Inc., 7101 Wisconsin Avenue, Bethesda, MD 20814-4891.

USACE 1996, *Hazardous, Toxic, and Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary*, Headquarters United States Army Corps of Engineers, 20 Massachusetts Avenue, N.W., Washington, D.C., 20314-1000.

APPENDIX B

ACRONYMS AND ABBREVIATION

Acronym/Abbreviation	Description
ALARA	as low as reasonably achievable
BHI	Bechtel Hanford, Inc.
CFR	*Code of Federal Regulations*
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
FETC	Federal Energy Technology Center
G&A	general and administrative markup cost
GFI	ground-fault interrupt
H&S	health and safety
IEEE	Institute of Electrical and Electronic Engineers
ISS	Interim Safe Storage
kVA	1000 Volt-Amperes
kW	kilowatt
HTRW	hazardous, toxic, and radioactive waste
LS	lump sum
LSTD	Large-Scale Technology Demonstration
MITUS	Mobile Integrated Temporary Utility System
OSHA	Occupational Safety and Health Administration
RL	DOE Richland Operations Office
UPS	uninterruptible power supply
USACE	U. S. Army Corps of Engineers
WBS	work breakdown structure

APPENDIX C

TECHNOLOGY COST COMPARISON

■ Introduction

The demonstration was conducted at the Hanford Site C Reactor under controlled conditions with onsite personnel operating the equipment for which timed, measured, and quantified activities were recorded.

The selected basic activities being analyzed come from the *Hazardous, Toxic, and Radioactive Waste Remedial Action Work Breakdown Structure and Data Dictionary* (HTRW RA WBS), USACE, 1996. The HTRW RA WBS, developed by an interagency group, was used in this analysis to provide consistency with the established national standards.

Some costs are omitted from this analysis so that it is easier to understand and to facilitate comparison with costs for an individual site. The overhead and general and administrative (G&A) markup costs for the site contractor managing the demonstration are omitted from this analysis. Overhead and G&A rates for each DOE site vary in magnitude and in the way they are applied. Decision makers seeking site-specific costs can apply their site's rates to this analysis with out having to first back out the rates used at the Hanford Site. This omission does not sacrifice the cost savings accuracy, because overhead is applied to both the innovative and baseline technology costs. Engineering, quality assurance, administrative costs and taxes on services and materials are also omitted from this analysis for the same reasons indicated for the overhead rates.

The following assumptions were used as the basis of the cost analysis:

- Oversight engineering, quality assurance, and administrative costs for the demonstration are not included. These are normally covered by another cost element, generally as an undistributed cost.
- The procurement cost of 2.2% was applied to all equipment costs to account for costs of administering the purchase (for MITUS, this cost is included in the hourly rate).
- Hourly rates for generators, trailer, tractors, and other miscellaneous equipment appearing in the cost analysis are based upon negotiated rates for the site contractor.
- The equipment hourly rate for the MITUS, representing the Government's ownership, is based on general guidance contained in Office of Management and Budget (OMB) circular No. A-94 for Cost Effectiveness Analysis. The rate consists of ownership and operating costs.
- The standard labor rates established by the Hanford Site for estimating D&D work are used in this analysis for the portions of the work performed by local crafts.
- The analysis uses an eight-hour work day.
- Duration of C Reactor D&D work is assumed to be February 1997 through July 1998 with 3,168 hours of power generation.
- Design load is 750 kW, which allows D&D of two reactors at one time and includes power for the support trailers.
- Observed average load for C Reactor to date is 116 kW with the average anticipated to increase to approximately 200 kW.
- Optimum number of kiosks required for the C Reactor project is 12, based on experience with MITUS and based on the need to locate the power source near the work areas that are dispersed across the facility. (For a two-reactor situation the minimum number required would be 20 kiosks.)

- For the portable generator alternative, the 750-kW load condition is expected to require 20 generators and for the single reactor (typical load of 200-kW) condition 12 generators would be required.
- Alarms, emergency lighting, and communication are required for all technology alternatives.
- For the restoration of the plant electrical system alternative, not all facility panels will be required (assume only 9 of the main panels for lighting and receptacle power are restored(motor controller panels are not restored)) and assume 40% (based on limited past experience with other facility D&D work) of the circuits and breakers must be replaced to make the selected motor controllers and panels functional.
- The design costs for the portable generator is assumed to be 1/4 of the design cost for MITUS (computed as 1/4 of the MITUS design labor cost).
- The restore plant facility alternative assumes that the existing telephone and alarms are restored as part of the power restoration work.
- The present worth analysis assumes future projects will be sequentially occurring projects of 1-1/2 years duration each.
- The present-worth analysis assumes a discount rate of 5.8%.

The Detailed Cost Report for this technology provides details of the analysis for each technology alternative as well as additional cost information and is available upon request from the onsite technical contacts referenced in Section 1.

Tables C-1 through C-3 provide unit durations for work activities, labor and equipment unit costs in a table format that will accommodate insertion of site-specific quantities (in the total quantity column). This will allow a site-specific cost to be developed by the potential technology user.

Table C-1. MITUS - innovative technology

Work Breakdown Structure (WBS)	Unit cost (UC) Labor Hours	Labor Rate	Equipment Hours	Equipment Rate	Other	Total UC	Total Quantity (TQ)	Unit of Measure	Total Cost (TC) Note 2	Mobile Integrated Temporary Utility System Comments
MOBILIZATION (WBS 331.01)								**Subtotal**	**$46.139**	
Install 13.8-kV connection	33.16	$46.02	33.16	$9.48	$733.75	$ 2,574	8	Pole	$20,593	8 power poles were required (2 poles typical of future reactors), includes equipment costs for two trucks with cranes @ $4.74/hour each and materials costs for poles, transmission wire, guy wires, etc. @ $733.75/pole plus labor of 33.16 hours/pole
Trailer/System Setup	80.00	$276.12	80.00	$43.20	$ -	$25,546	1	Each	$25,546	Labor for 2 crews of 2 electricians and 1 foreman at $46.02/hr per person (future reactors would be approximately 1`/2 this initial installation) includes MITUS (as amortized rate for design and manufacture & kiosk trailer @ $77.24/month (Note 3)
POWER SUPPLY FOR D&D (WBS 331.17.04)								**Subtotal**	**$343,580**	
Power for C Reactor D&D	1	$ -	1	$43.20	$ 65 Note 4	$108	3,168	Hours	$343,580	Power for duration of D&D - February 97 thru July 98 (396 days @ 8 hours per day = 3168 hours) at a daily electric bill of $0.087/kW hour x 750 kW-load, includes MITUS amortized rate for design and manufacture
Communication	0.000	$ -	0.000	$ -		$ -	-		$ -	Included in system
Alarms	0.000	$ -	0.000	$ -	$ -	$ -	0		$ -	Included in system
Emergency Lighting	0.00	$ -	0.000			$ -	-		$ -	Included in system
DEMOBILIZATION (WBS 331.21)								**Subtotal**	**$15,518**	
Packup for Move	0.00	$ -	0.00	$ -	$ -	$ -	-		$ -	
Cables & Kiosks	40.00	$138.06	40.00	$43.20		$7,251	1	Each	$7,251	Labor for crew of 2 electricians and 1 foreman (includes MITUS standby)
Ready Trailer & Tractor	40.00	$172.99	40.00	$21.19	$ 500	$ 8,267	1	Each	$8,267	Crew of 3 teamsters @ $36.35/hour and 2 D&D workers @ $31.97/hour each and one tractor freightliner @ $11.71/hour and 2 lead cars @ $4.74/hour each
								TOTAL	**$405,236**	

NOTES;
1. The rates shown are standard rates for Hanford and include base wages, fringe benefits, and some departmental overhead, but exclude BHI overhead and G&A.
2. TC = UC * TQ
3. The cost for design and manufacture of MITUS is shown as an amortized hourly rate.
4. For power for C Reactor D&D, “Other” unit cost is for electric power supplied by the utility for the applicable load/demand.

Table C-2. Portable generator - baseline technology

Work Breakdown Structure (WBS)	Unit Cost (UC)						Total Quantity (TQ)	Unit of Measure	Total Cost (TC) Note	Portable Generator Comments
	Labor		Equipment		Other	Total UC				
	Hours	Rate	Hours	Rate						
DESIGN								**Subtotal**	**$23,332**	
Design	507	$46.02				$23,332	1	Each	$23,332	Design and planning to bring generators onsite
MOBILIZATION (WBS 331.01)								**Subtotal**	**$36,129**	
Transport Generators	1.50	$72.70	1.50	$122.8	-	$293	5	Trips	$1,466	Transport from local storage area (1-1/2 hour each round trip) for 5 trips, includes labor for 2 teamsters @ $36.35/hour each and 1 truck and trailer at $12.19/hr plus generator standby at $110.60/hr
Run Power Cables	12	$138.06	12	$110.60	$17,024	$20,008	1	Each	$20,008	Labor for crews consisting of 2 electricians & 1 foreman at $46.02/hr per person and 2000 lineal feet of power cord @ $261.37/100 feet, 1000 lineal feet of extension cord @ $31.49/50 feet and 30 GFI receptacle boxes @ $372.22 ea plus generator standby
String Lights	40	$138.06	40	110.60	$3,840	$13,786	1	Each	$13,786	Labor for crews(same as above) and 2000 lineal fet of lights @ $192/100 lineal feet plus generator standby
Power-Loss Protection					$290	$290	3	Unit	$869	Protection for lights and alarms requires 3 units @ $289.66 each
POWER SUPPLY FOR D&D (WBS 331.17.04								**Subtotal**	**$494,879**	
Power for C Reactor D&D	1	$38.88	1	$110.60		$149.48	3,168	Hours	$473,553	Power for D&D - February 97 through July 98 (396 days @ 8 hours per day = 3,168 hours), including twenty 45-kW generators @ $5.53/hr each = $110.60/hr (this rate includes rental, operation, and maintenance) plus equipment operator (tender) @ $38.88/hr
Move Generators	12	$174.41	12	$9.52		$2,207	4	Locations	$8,829	Move generators 4 times as work locations shift, crew as above plus one teamster at $36.35/hour plus pickup @ $9.52/hr
Communication	1.0	$138.06	0.0	$ -	$159.74	$ 298	9	Each	$2,680	Three-channel intercom system @ $39.74 each station and 500 lineal feet of cable @ $0.24/foot plus 1 hour for the crew shown above to install
Alarms	1.0	$138.06	0.0	$ -	$662.0	$ 800	9	Each	$7,201	Alarms @ $562 each and 500 lineal feet of cable @ $0.20/foot plus labor for the crew shown above
Emergency Lighting	1.0	$138.06	0.0	$ -	$152.7	$291	9	Each	$2,617	Emergency lights @ $152.69 each plus the crew shown above to install
DEMOBILIZATION (WBS 331.21)								**Subtotal**	**$293**	
Transport Generators	1.50	$72.70	1.50	$122.79		$293	1	Each	293	
PROCUREMENT COST								**Subtotal**	**$ 21**	
Procurement Cost	0.00	$ -	0.00	$ -	$21.44	$ 21	1	Each	$21	2.2% charge for procurement of materials
NOTE: TC = UC * TQ								TOTAL	$554,655	

Table C-3. Restore existing plant electrical system - baseline technology

Work Breakdown Structure (WBS)	Unit Cost (UC) Labor Hours	Labor Rate	Equipment Hours	Equipment Rate	Other	Total UC	Total Quantity (TQ)	Unit of Measure	Total Cost (TC) Note	Restore Plant Electrical System Comments
DESIGN								**Subtotal**	**$8,743.80**	
Design	190	$ 46				$8,743.80	1	Each	$ 8,744	1/4 of the effort for MITUS
POWER SUPPLY FOR D&D (WBS 331.17.04)								**Subtotal**	**$554,733**	
Initial Electrical Work										
Install 750-kVa Transformer	57	$164.07	57	$129.1	$15,300	$32,011.8	1	Each	$32,012	750 kVA transformer @ $15,300 plus labor for crew of 1 electrician and 1 foreman @ $46.02/hour each and 1 crane @ $28.46/hr and 1 operator @ $43.57/hour
Connect Transformer and Switchgear	18	$138.06	0	$ -		$2,485.08	1	Each	$ 2,485	Labor for crew of 2 electricians and 1 foreman @ $46.02/hour
Replace Switchgear Breakers	2.5	$138.06	0	$ -	$69,528	$69,873.2	1	Each	$69,873	One 100 Amp @ $2,368 each, five 225 amp @ $2,468 each, nine 600 amp @ $6,080 each and labor for crew shown above for 15 replacements and 10 minutes each
Replace Failed Circuits - Switchgear to Motor Controllers	0.296	$138.06			$16.83	$57.70	1,000	Feet	$57,696	40% replacement of 5 circuits = 1000 lineal feet, 2-1/2 inch conduit @ $7.47/foot + cable @ $2.34/foot with 4 conductors per conduit plus labor for crew as shown above
Replace Failed Motor-Control Breakers	0.167	$138.06			$1,000	$1,023.00	28	Each	$28,644	5 motor controllers with 14 circuit breakers each with 40% replaced, $1,000 each breaker
Replace Failed Circuits - Motor Controller to Panels	0.192	$138.06			$11.77	$38.24	1,800	Feet	$68,825	40% replacement of 9 circuits = 1800 lineal feet, 2 inch conduit @ $4.45/foot + cable @ $1.83/foot with 4 conductors per conduit plus labor for crew as shown above
Replace Panel	6	$138.06			$2,500	$3,328.36	9	Each	$29,955	9 panels replaced entirely @ $1500/panel and new breakers, 20 per panel @ $50/breaker plus labor as shown above
Zero Energy Check	0.250	$138.06				$34.52	300		$10,355	10 minutes per circuit for 300 circuits for crew as shown above
During D&D										
Power for C Reactor D&D					$65.25	$65.25	3,168	Hours	$206,712	Power for duration of D&D - February 97 through July 98 (396 days @ 8 hours per day = 3,168 hours) at a daily electric bill of $0.087 /kW/hour x 750 kW load
Disconnect Power Feed To/Through Areas Being Demolished	4	$138.06	0	$ -	$ -	$552.2	6	Areas	$3,313	Labor for crew as shown above
Route Power Feed Around Work Area	0.192	$138.06			$11.77	$38.2	1000	Feet	$38,236	100 lineal feet, 2 inch conduit @ $4.45/foot + cable @ $1.83/foot with 4 conductors per conduit plus labor for crew as shown above
Temporary Power in Work Area	8	$138.06	0		$ -	$1,104.48	6	Areas	$6,627	Labor for crew shown above for one day
PROCUREMENT COSTS								**Subtotal**	**$1,946**	
Procurement Cost	0.00	$ -	0.00	$ -	$1,945.5	$1,945.54	1	Each	$1,946	2.2% charge for procurement of materials
NOTE: TC = UC * TQ								TOTAL	$565,422	