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March 28, 1986

TMI-2 Cleanup Project Directorate
Attn: Dr. W. D. Travers
Director
US Nuclear Regulatory Commission
c/o Three Mile Island Nuclear Station
Middletown, PA 17057

Dear Dr. Travers:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Reactor Building Decontamination and
Dose Reduction Activities Safety Evaluation Report

Attached for your information is the updated Safety Evaluation Report (SER) for the Reactor Building (RB) Decontamination and Dose Reduction Activities. The purpose of this SER is to assess the safety aspects of the scheduled RB decontamination and dose reduction activities for 1986 and the first quarter of 1987.

Section 5.0 of this SER contains the radiological assessment of RB decon and dose reduction activities for 1986. Since the scope of the SER includes activities for the first quarter of 1987, the values presented in Section 5.0 require revision. Section 5.1.1 presents the external occupational exposures. An estimate of the external occupational exposure for 1986 and the first quarter of 1987 is 1000 person-rem. The estimates of internal exposures provided in Section 5.1.2, and the offsite radiological releases provided in Section 5.2, will not change as they are presented as averages.

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Section 5.1.1 will be updated as soon as the projected job-hours needed to complete the tasks planned for the first quarter of 1987 are finalized.

Sincerely,

F. R. Standerfer
Vice President/Director, TMI-2

FRS/CJD/eml

Attachment

GPU Nuclear

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SER 15737-2-G07-112 REV. 0

ISSUE DATE

☒ ITS

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TMI-2

DIVISION

SAFETY EVALUATION REPORT

FOR

Reactor Building

Decontamination and Dose Reduction

Activities for 1986

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RTR E.T. Smith DATE 2/24/86

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DOCUMENT TITLE: Safety Evaluation Report for Reactor Building Decontamination and Dose Reduction Activities for 1986

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1.0 INTRODUCTION

1.1 Purpose

This safety evaluation report (SER) describes reactor building decontamination and dose reduction activities which are scheduled for 1986. By evaluating the safety concerns presented by the accomplishment of these activities, it is the purpose of this SER to demonstrate that the decontamination and dose reduction activities in the reactor building planned for 1986 can be accomplished without presenting undue risk to the health and safety of the public.

1.2 Scope

The scope of this SER includes those activities and techniques which comprise normal decontamination and dose reduction methods to be used in the reactor building. These include such methods as low to high pressure water flushes, scabbling, shielding, scrubbing and steam cleaning. The scope includes all such activities scheduled during 1986 and through the first quarter of 1987, unless this SER is superceded.

This SER does not include an evaluation of safety issues associated with:

o use of ultrahigh pressure (greater than 20,000 psi) water flush
o large scale use of chemical decontamination agents
o use of robotic devices for decontamination.

Safety issues presented by these activities will be addressed in other SERs prior to their implementation.

Collective occupational exposures and offsite releases for use of ultrahigh pressure water flush and use of robotics for decontamination tasks described in this SER are included in Sections 5.1 and 5.2.

1.3 Organization

This report is organized as follows:

o Section 1.0 provides an introduction to the SER, including purpose, scope, organization, safety classification of activities, and background information.

o Section 2.0 provides a brief description of decontamination and dose reduction techniques which may be used.

o Section 3.0 describes decontamination and dose reduction activities which are scheduled.

o Section 4.0 addresses safety issues associated with the planned activities, including criticality, heavy load handling, fire protection and industrial safety.

- o Section 5.0 provides the radiological assessment of the planned activities including occupational and offsite exposures.
- o Section 6.0 discusses radioactive waste management.
- o Section 7.0 provides the 10CFR50.59 evaluation.
- o Section 8.0 is the summary and conclusions section, and
- o Section 9.0 gives a list of references.

1.4 Safety Classification

Decontamination activities are classified according to their potential impact on plant equipment. An activity is designated as important to safety (ITS) if it involves one or more of the following subjects applicable to ITS systems, components, structures, and activities:

- o Breach of a system pressure boundary (e.g., internal flushing of components/systems)
- o Potential to exceed the tolerance of an engineering acceptance criterion (e.g., scabbling painted concrete to a close design criteria tolerance)
- o Potential to impact or impair ability to perform an ITS design function because of operator or equipment failure (e.g., superheated steam cleaning, corrosive chemical cleaning)
- o The movement of significant or unknown quantities of radioactive material

Decontamination activities that do not involve ITS systems components, structures, or activities are classified as Not Important to Safety (NITS).

1.5 Background

The March 1979 accident resulted in extensive radioactive contamination of reactor building surfaces and systems. In March of 1982, a large-scale decontamination experiment was conducted which resulted in the removal of significant quantities of loose contamination from the surfaces in the reactor building. The primary techniques evaluated included low pressure flushing and high pressure spraying with water. Abrasive floor scrubbing, wet vacuuming, and the use of various chemical decontamination agents were also evaluated. The results of the experiment are documented in Ref. 1.

The methodology to be used for decontaminating surfaces inside the reactor building is based upon the results of the experiment described above and subsequent experience gained in decontamination of the auxiliary and fuel handling buildings. The basic approach consists of flushing surfaces with water to remove gross deposits, followed by a secondary technique such as surface coating removal or wet vacuuming to further reduce contamination levels. Where appropriate, strippable coatings or paint may be applied to control residual contamination, prevent recontamination, and facilitate decontamination maintenance.

Significant resources have been expended to reduce surface contamination levels, radiation exposure rate and airborne radioactivity by various methods of decontamination and other dose reduction techniques. These efforts have been successful in reducing exposure rates as shown in the following table. Dose rates given are average person-millirem/job-hour as taken from radiation work permit data.

	Fall 1980	Spring 1985
Elevation 305'	430 millirem/hr	67 millirem/hr
Elevation 347'-6"	240 millirem/hr	40 millirem/hr

Airborne radioactivity and surface contamination levels have likewise been reduced in most normally-accessed areas in the reactor building.

Since 1982 significant experience with many decontamination techniques has been gained, both in the auxiliary and fuel handling buildings and in the reactor building. This SER is thus updated periodically to include a discussion of planned activities for the reactor building and to include new decontamination or dose reduction techniques. Previous issues of this SER are Refs. 2, 3, and 4.

All activities will be scheduled and implemented through a program designed to achieve established goals. GPUN also maintains a program to review these goals and to pursue additional options if desired endpoint objectives are not being achieved.

2.0 Decontamination and Dose Reduction Techniques

During the past four years many decontamination and dose reduction techniques have been used in the reactor building. These techniques have been proven on various types of surfaces and for various contamination conditions. In general these techniques involve source removal by way of physical removal of the object itself or removal of the radioactive material from its surface (decontamination). Shielding is also a dose reduction technique that may be used when source removal is difficult or when it is determined that source removal will entail unacceptable personnel exposures. This experience will be of significant value during 1986 when D-ring and basement decontamination activities are undertaken.

2.1 Selection of Decontamination and Dose Reduction Technique

Several key factors are considered when selecting the decontamination or dose reduction technique to be used. Among these are:

- o desired endpoint
- o effectiveness of the technique (including shielding)
- o person-rem and job-hours spent and saved for a given technique
- o quantities and types of wastes generated
- o impact on cost and schedule
- o compatibility with support systems
- o procedural requirements
- o area accessibility
- o need for plant modifications

This SER lists commonly used decontamination and dose reduction techniques. Not all techniques listed in this SER may be used for decontamination tasks during 1986. Likewise variations of decontamination techniques listed here may be used for particular applications, provided they do not create safety concerns not addressed in this SER.

2.2 Low Pressure Water Flush

This technique is used to dislodge large amounts of dirt and debris. The purpose is to remove deposits of loose contamination and dissolve as much of the remaining contaminants as possible. It is generally followed with a technique which will attack the more tightly adherent contamination.

Low pressure flushing cleans surfaces with water at nozzle discharge pressures between 100 and 1000 psi. To decontaminate large surfaces, high flow rates (between 20 and 25 gpm) improve flushing effectiveness. The temperature of the water at the pump discharge can be varied up to $170^{\circ}F$ to take advantage of increased solubility of the contaminants at higher temperatures.

Remote flushing operations can bc accomplished using several different types of nozzles. Nozzle selection is based on providing sufficient flow rates and the ability to position the nozzles in areas of limited access due to physical restrictions or radiological conditions.

2.3 High Pressure Water Flush

High pressure (1000-20,000 psi) water cleaning utilizes the mechanical action of a jet stream to remove dirt and loose, unbonded surface coatings. By varying several operating parameters, a wide range of results can be achieved. Using medium pressures, loose surface accumulations can be removed, while leaving the substrate intact. Stand-off distance and impingement angle may be varied to adjust fluid impingement forces for the appropriate degree of removal. Trial operations with mockups and information contained in historical data are used to determine the required operating variables. Generally, higher pressures require lower flow rates to minimize overspray and heavy mists.

Two types of nozzles in common use are the straight zero-degree tip and the flat fan tip. Irregular surfaces are readily cleaned with the straight pattern nozzle, while the flat fan tip produces a spray which acts like a blade to lift away surface accumulations. A three-dimensional nozzle similar to those used for low pressure flushing operations is used for remote high pressure applications. This nozzle operates at 6000 psi and 25 gpm, and rotates at 8 to 80 rpm to provide 360 degree coverage at a radius of 3 to 4.5 feet. A two-dimensional nozzle can also be used for remote operations.

High pressure positive displacement pumps provide the driving force for water cleaning. The pump units used for cleanup applications operate at discharge pressures of between 1,000 and 20,000 psi and flow rates of 4 to 30 gpm.

2.4 Scrubbing

Scrubbing is a mechanical technique that is generally used on floors and walls to remove loosely held contamination. Rags, absorbent cloths and abrasive materials, such as brushes or pads, are used for contamination which is more tightly fixed. Approved chemical decontamination agents may be used to enhance the effectiveness of this technique. Grit or abrasives may also be added, if necessary, to aid in surface cutting or removal of a portion of the surface.

Equipment required for scrubbing includes manually and mechanically driven hand brushes, and mechanically driven floor brushes.

2.5 Vacuum Techniques

Dry vacuuming removes loose contaminants in the form of dust and small debris and collects it in a bag or container. This technique is very valuable in the removal of powdered contaminants and dried residue, especially from water-sensitive components that cannot be flushed.

Wet vacuuming removes contaminants entrained in solution and collects the solution in a drum or container. The technique is applied after flushing to remove puddles of contaminated water or other liquids such as chemicals or oils. Wet vacuuming also minimizes airborne particulate contamination associated with dry vacuuming.

Vacuum cleaning equipment consists of a portable unit driven by an electric motor, including vacuum section, separator, and dirt removal components. The air separator removes solid and/or liquid material from the airstream created by the vacuum pump. Air is passed through a HEPA filter prior to being discharged to the reactor building atmosphere. Because liquid droplets tend to decrease filter efficiency, the system is designed to remove liquids prior to reaching the filter.

2.6 Scabbling

Scabbling is an agressive decontamination technique which roughens concrete surfaces and removes surface coatings with toothed pistons or a rotating drum. Testing conducted in May of 1984 evaluated the effectiveness of removing the surface coating from areas on the 347'-6" el. using a scabbler. The scabbling operation was performed in two passes, each pass removing approximately 1/16" from the surface. TLD measurements showed approximate dose rate reductions of 50-60% gamma and 80-98% beta. Effectiveness of scabbling operations is dependent on the penetration depth of the contaminants, which is highly variable.

The scabbler is moved along the floor or wall to remove the surface layer. The resultant surface is suitable for application of epoxy, polymer, or similar finishes. The tool is modified to include a vacuum shroud connected to a HEPA-filtered vacuum system which collects contaminated dust.

2.7 Strippable Coatings

The strippable coating technique involves the application of an organic coating which contains chemicals that aid in the removal of radioactive contaminants from a surface. It may also be used to control the spread of contamination or to protect a previously decontaminated surface.

The strippable coating material is applied as a liquid which attracts and binds contaminants from the surface. It contains sequestrants, complexing agents, oxidizing/reducing agents, and wetting agents, which migrate into the pores of the surface and entrain the contaminants. When the coating dries, the contaminants are fixed in a solid layer which may be stripped off the surface and disposed of as solid waste. The coating should be applied with sufficient thickness to provide the tensile strength necessary to overcome adhesion during removal.

Equipment required for the application of strippable coatings includes an airless spray pump, spray gun, associated hoses, and squeegees. A wet-film thickness gauge is used to establish the coating thickness during the application process. The strippable coating is removed with commonly available equipment.

2.8 Abrasive Blasting

Blasting steel surfaces with particles driven at high velocity is effective in removing contamination, especially from small and irregular surfaces that are not compatible with mechanical scrubbing techniques. The blasting media may be entrained in air or water. Steel, oxide compounds, lead shot, sand, glass, or zeolites may be used as the abrasive media. The entrainment pressure, choice of media, resistance time and number of decontamination passes determine the depth of cut. Although the cutting rates for the technique are slow, a high degree of decontamination effectiveness can be achieved, in addition to creating a smooth, polished surface suitable for application of a protective coating.

The "Vacu-Blast" abrasive blasting unit is an air-driven device which applies the media through an external gun and reclaims it near the work surface using a vacuum, thus minimizing airborne hazards. The media is reclaimed using a centrifugal air wash feature. The unit has a wide range of applications including cleaning, etching, finishing and peening.

Implementation of the device is still in the developmental stage for in-containment use. Field modificatons will be made to provide increased media storage capability, greater work comfort, and stand-off capability. The unit will be evaluated for "booth type" decontamination and decontamination of painted and unpainted metal surfaces outside the D-rings.

2.9 Kelly Vacu-Mac Decontamination System

The Kelly Vacu-Mac system combines a "steam" cleaning nozzle and high efficiency vacuum in a single head to permit effective decontamination of various surfaces while minimizing the spread of contamination and impaired visibility from "spray back". It is a self-contained system which applies hot water (flashing to steam), loosens contaminants, collects the condensate by vacuum, and separates the resulting waste stream for processing. The substantial temperature increase over previous flushing (240°F as opposed to 140°F) is effective in removing boron deposits due to the increased solubility. The water flashing principle takes advantage of the large specific volume of superheated steam, resulting in a substantialy lower waste generation rate (2 gpm versus previous flushing in a range of 15 - 25 gpm).

The system consists of five basic units:

- o Pressurized water supply
- o Vacuum power unit
- o Demister/HEPA filter units
- o Liquid separator/trash collection system
- o Decontamination tools

The main unit is designed to supply water at 200-250 psi and maximum temperature of 300°F to the nozzles, mounted in stainless steel vacuum/spray "head" tools, to perform the actual decontamination. The system is designed to provide for most efficient operation when the spray is in a solid stream as it exits the nozzle and carries as much heat to the surface as possible.

Trial operations have demonstrated an average decontamination factor (DF) of 5 for a single pass on ductwork and cable trays, with DF's of 40 at individual survey points. Comparable results were obtained on floors and walls. Bare concrete showed much lower results (DF = 1.6), and subsequent leaching restored contamination levels. Therefore this technique is not recommended for large scale use on bare concrete, but may be used on hot spots such as boron deposits on concrete. Likewise, decontamination of Fuel Pool A proved steam cleaning to be reasonably effective on stainless steel liner surfaces. Coverage rates of at least 100 ft^2/min on painted concrete floors and walls using steam cleaning indicate that routine decontamination maintenance of these surfaces can be accomplished in less time than with the use of hand scrubbing or equivalent techniques.

2.10 Chemical Decontamination

Chemical decontamination agents, such as phosphoric acid foam, sulfamic acid gel, and citric acid complexes may prove effective for decontaminating external surfaces of pipes and tanks and system internals. Small scale use of specific chemicals is subject to evaluation and chemicals are controlled, used, and disposed of in accordance with appropriate GPUN administrative procedures and applicable Federal, State, and local regulations. The large scale use of chemicals will be addressed in other SERs, if required.

2.11 Shielding

Shielding for dose reduction is temporary and does not preclude decontamination of shielded surfaces. Shielding may be a prerequisite to some decontamination tasks for ALARA reasons. The material used for shielding may eventually be decontaminated or disposed of as radioactive waste. Shielding is selected on the basis of the reduction factor needed, the geometry of the source, the degree of permanence, decontaminability, portability, expense, and location. Shielding material may include lead, steel, concrete, sand, and water.

2.12 Component Removal

Removal of components or parts of components may be used to accomplish dose reduction for discrete sources. If decontamination is difficult or ineffectual, component removal may be considered a desirable option.

2.13 Ultrahigh Pressure Water Flush

Ultrahigh pressure water flush uses water pressurized to between 20,000 and 55,000 psi. At this pressure water is used to remove tightly adherent contamination layers, and contamination bound in corrosion layers and surface coatings. The operation of the ultrahigh pressure water flush and safety concerns presented by the use of this equipment are addressed in a separate SER.

3.0 Decontamination and Dose Reduction Activities

3.1 Decontamination and Dose Reduction Accomplished in 1985

The SER for Reactor Building Decontamination and Dose Reduction Activities for 1985 (Ref. 4) listed several areas which would be evaluated for dose reduction. The status of these activities is given below.

The reactor building air coolers were shielded during 1985. A standing shield was installed which reduced dose rates from 120 millirem/hr to 30 millirem/hr close to the air coolers. An upper shield for the air cooler motors was not installed. An evaluation of the upper shield indicated that the primary affect of dose rates from the motors was at the hatch on 347'-6" el. and that they did not significantly affect 305' el. floor areas. Providing shielded hatch plates for the 347'-6" el. floor hatch was determined to be more effective in reducing the effects of the air cooler motors than the proposed upper shield. Shielded hatch plates will be provided in 1986.

The 305' el. floor hatch was shielded. Both LOCA ducts were also shielded. The reactor coolant pump motor stand was shielded for beta only, and the reactor coolant pump stand was determined not to be a significant enough source to justify shielding.

A decontamination test using the steam cleaning system on part of the open stairwell was performed. However, dose rate reduction was not to the desired levels. Further decontamination without coating removal is not considered to be viable.

The shield at the base of the open stairwell was not modified, due to evaluation of possible alternate transit routes for personnel going from the 305' el. to the 347'-6" el. Efforts in providing an alternate access route to the 347'-6" el. and resolution of issues dealing with the open stairwell are to be continued, and are discussed in Section 3.4.4.

Decontamination of overheads has had limited success and extensive decontamination of the overheads with methods currently available is not planned for 1986. Some limited decontamination of the overheads may be done on an as-needed basis.

Dose reduction on the tops of the D-rings was started in late 1985 and will continue in early 1986. These activities include scabbling and painting around the tops of both D-rings and removal of the highly contaminated handrail coating. Shielding of the polar crane operator station was done.

Dose reduction to support in-vessel defueling activities was completed. These tasks included removal of the IIF platform and main fuel handling bridge, and shielding the incore instrument seal table and the cable trays in the canal area.

Currently no plans are in place to drain or flush piping systems in the reactor building for dose reduction purposes.

3.2 Prioritization of 1986 Activities

The recovery program has been structured into three phases:

I. Stabilization
II. Fuel Removal
III. Cleanup

Phase I has been completed and the basic objectives for Phases II and III have been outlined (Ref. 5). Phase II is currently in progress and Phase III cleanup work has begun. Final Phase III endpoint criteria for radiation dose rates and contamination levels are being developed. Since the defueling program has been initiated the decontamination and dose reduction priorities have shifted from support for dose reduction for defueling (Phase II) to general plant cleanup (Phase III).

Establishing priorities for decontamination and dose reduction activities is based on the consideration of many factors, such as

- Recovery program direction
- Program schedules
- Collective occupational exposures
- Endpoint achievement
- Area accessibility
- Other safety concerns

As such, decontamination priorities reflect program priorities and may be expected to change as program goals are achieved, as new information becomes available, and as program direction changes.

During 1986 significant work will commence in several areas of the reactor building to which access is to some degree limited. These areas are the 'A' and 'B' D-rings and the basement (282'-6" el.). It is expected that decontamination priorities and plans may change as additional information becomes available about these areas. At the end of 1985, priorities were developed for major reactor building decontamination and dose reduction activities. These priorities were developed based on program direction and the programmatic priorities listed below.

1. Decontamination and dose reduction to support in-vessel fuel removal

2. Decontamination and dose reduction to support ex-vessel fuel location in the D-rings

3. Decontamination and dose reduction to support ex-vessel fuel removal

4. Basement characterization

5. Basement sludge removal

6. Basement gross water flushing and general cleanup.

Decontamination and dose reduction to support in-vessel defueling has been completed. Any new source created due to defueling activities, such as contamination in DWCS piping or valves, will be mitigated as needed to ensure that dose rates to defueling operators are maintained as low as reasonably achievable. Dose reduction and decontamination in the D-rings will be accomplished as early as possible to provide access for ex-vessel fuel location data taking activities. Based on fuel removal requirements and the desired endpoints, decontamination in the D-rings will be completed to achieve Phase III endpoint criteria. Characterization of the basement will be performed and will be used as input into future decontamination and dose reduction plans. Modifications to personnel transit routes from 305' to 347'-6" els. will be made to allow robotic access to the basement via the open stairwell. Water flushing for the basement to remove loose contamination and to consolidate sludge is scheduled to be performed in 1986.

Due to the prioritization of activities in the reactor building, decontamination activities will be coordinated with ongoing defueling operations. This includes work which impacts or has the potential for impacting defueling operations on the work platform. An example of this type of activity is the decontamination and dose reduction work planned in the 'B' D-ring. Currently, certain areas of the 'B' D-ring are used for storage of long handled tools. Decontamination and dose reduction activities and defueling operations will be coordinated to ensure an acceptable interface for the accomplishment of both program objectives

3.3 Activities in the D-Rings During 1986

3.3.1 Current Conditions

Data obtained from TLD placement, gamma ray spectrometry, gamma ray photography, radiological survey, and subsequent analysis demonstrates that high levels of contamination on the RCS components beneath the mirror insulation and on structural surfaces are responsible for the major fraction of exposure rates in the upper zones of the D-rings. Lower areas are increasingly influenced by sources in the basement.

As of August 30, 1985 the following general conditions existed in the D-rings:

	Elevation	Exposure Rates
'A' D-Ring	349'	80 mR/hr - 5 R/hr
	330'	1 R/hr
	315'	750 mR/hr
	308'	1.2 R/hr to 6 R/hr
	295'	10 R/hr and greater
'B' D-Ring	356'	0.45 R/hr to 30 R/hr
	349'	1 R/hr to 6 R/hr
	330'	8 R/hr to 20 R/hr
	315'	unknown
	308'	unknown
	295'	unknown

3.3.2 Activities to Date

Decontamination and dose reduction work to date has included low pressure flushing from the D-ring top to support ex-vessel fuel location and data acquisition efforts. These flushes proved to be only slightly effective in the reduction of dose rates; however, they were effective in reducing loose surface contamination on exposed surfaces. Dose rates and contamination remain above acceptable limits for extensive activities.

Some mirror insulation has been removed to allow access to the steam generator and pressurizer surfaces for the purpose of ex-vessel fuel location and quantification activities. It was discovered after insulation removal that extensive high specific activity contamination was present on the equipment surfaces. This activity is in the form of salt deposits, highly contaminated coatings, and corrosion products bound to the equipment surfaces. The source of this contamination has been postulated as seepage and fine sprays of reactor coolant from fittings during and after the accident. This is somewhat supported by radiation survey and gamma ray photography results for both steam generators and the upper region of the pressurizer.

The source of contamination and major exposure sources in the 'B' D-ring are assumed to be of similar character to those in the 'A' D-ring. Higher radiation readings in some areas of the 'B' D-ring are postulated to result from greater seepage from the instrumented manway, inspection port, and hot leg vent valve. The attempted restart of RCP-2B during the accident at the point in time near where maximum core disruption occurred may have tended to transport core region materials (cladding shards, cladding oxides or hydrides and some fuel fines) to the 'B' loop. This flow lasted only seconds yet transported a significant volume of reactor coolant to the 'B' loop. The result of this deposition was to place a higher radionuclide loading into the stagnated 'B' loop.

Calculations of dose rate contribution from a reasonable estimate of deposition of fuel materials in the steam generators and associated piping do not explain the high existing dose rates in either 'A' or 'B' D-ring. Additional radiation source modeling demonstrated that dose rates in the D-rings cannot be explained by internal contamination of RCS components at levels equal to the highest contamination found on the H-8 leadscrew.

Radiation profile data resulting from personnel access to the 'A' D-ring down to el. 308' coupled with TLD string drops to el. 282'-6" demonstrate that at el. 308' only approximately 30% of the dose rate is due to sources below el. 308'. Above el. 308' the proportion of the general area dose rate resulting from the basement decreases rapidly.

3.3.3 Overall Approach

The general approach to be used in the work in the D-rings is to perform necessary dose reduction to support ex-vessel fuel location data taking and then to decontaminate to support ex-vessel fuel removal and to achieve Phase III endpoints.

The current state of planning for ex-vessel fuel removal is dependent on ex-vessel fuel location data which is incomplete at this time. For the purpose of this description ex-vessel fuel removal tasks in the D-rings are assumed to include removal of reactor coolant pump motors and pump impellers from each loop. This scenario requires the maximum dose reduction and decontamination effort that will be associated with ex-vessel fuel removal. In the absence of ex-vessel fuel removal requirements, techniques, and possible changes of program completion criteria, the decontamination approach must assume this maximum effort scenario.

3.3.4 Dose Reduction

Dose reduction to support ex-vessel fuel location will follow the general sequence described below:

- o Removal of contaminated coatings from the top of the D-rings coupled with removal of the contaminated D-ring handrail coatings will be done first to provide a lower exposure location for decontamination and support personnel. Scabbling of the tops of the D-rings was begun in late 1985.

- o Low and high pressure flushing will be used to reduce loose surface activity levels and to help reduce airborne radioactivity generation during other work steps.

- o Selected removal of mirror insulation from RCS components will be done to reduce dose rates in areas of required access.

- o Exposed RCS components will be cleaned by high pressure water flushing. More aggressive techniques, such as ultra-high pressure water flush, which is not within the scope of this SER, may be used. Abrasive blasting of components and scabbling of concrete surfaces may also be considered.

- o Temporary shielding will be used for discrete sources where decontamination is ineffectual or not dose effective.

3.3.5 Endpoint Achievement

In general the following sequence will be followed to achieve end point dose rates and contamination levels.

- o Mirror insulation will be removed as required. Since it is likely that contamination exists within the layers of stainless steel of the mirror insulation, it is currently believed that decontamination of the panels to clean levels is not feasible. If this is the case, removed mirror insulation panels will be cut and packaged as radioactive waste. The cut mirror insulation may undergo further volume reduction at a later time.

- o The exposed surfaces of RCS components will be cleaned by high pressure water to remove high specific activity contamination and contamination present in corrosion layers.

3.4 Activities to Support Basement Recovery During 1986

3.4.1 Current Conditions

The reactor building basement has general area dose rates ranging up to hundreds of rem/hour and high surface contamination levels. Local airborne contamination is likely to increase during decontamination of the basement. These factors make it advisable to isolate the basement from the higher floor levels of the reactor building to minimize further contamination of cleaner levels. Characterization activities planned for the reactor building basement during 1986 include obtaining further data on dose rates, sediment thickness and penetration depth of radioactivity into concrete surfaces.

3.4.2 Characterization of the Basement

This is an on-going activity and is presently being performed remotely using the Remote Reconnaissance Vehicle (RRV-1) and video inspection. Data obtained by the RRV-1 show general area dose rates ranging from a low of 5 rem/hour in the north eastern sector to a maximum of 318 rem/hr in the southeastern sector. Sediment levels have also been remotely determined by video inspection using the RRV-1. Wall core bores taken by RRV-1 have been used to determine the penetration depth of radioactivity. The sediment which is present on the basement floor is deepest in the south and southwest sectors and thinnest in the northern and eastern sectors. Future use of the RRV-1 video and core bore of the walls will be augmented in 1986 by the use of TLD's strategically placed on equipment in the basement. Core bores on the floor will also be used for characterization of the basement during 1986 if the sediment has been removed.

3.4.3 Basement Isolation

To prevent cross-contamination of the 305' and 347'-6" elevations from the basement, and possible cross-contamination between the upper levels, it may become necessary to limit openings between floors. The tops of the D-rings may also be closed, in which case the D-rings will become a part of the basement from an air control viewpoint. The need for a barrier on the tops of the D-rings will be evaluated on the basis of the activities planned in the D-rings and experience with the spread of contamination during D-ring decontamination activities. Likewise, the need for isolation of floors will be evaluated on the potential spread of contamination between floors during decontamination activities. The method used to close an opening depends on the size of the opening and whether access through it is likely to be required during decontamination activities. Small openings, such as pipe penetrations and the seismic gap, can be sealed using expandable polymers. A layer of strippable coating or epoxy paint may be necessary to ensure airtight seals. Larger openings, such as stairwells and gratings, will require more solid structures such as metal caps or enclosures. Hatches or airlocks may be used to provide access to large penetrations such as floor hatches. The use of capped sleeves with polymers will allow access to the small penetrations. A combination of polymer and structured seals may also be used.

The need to modify reactor building HVAC systems to accommodate the establishment of isolation zones is being evaluated. If the need for HVAC modifications is established, the current overall approach is that all air discharged from the air coolers will be directed to the 347'-6" el. by way of the LOCA ducts. The LOCA ducts will be equipped with filters to prevent spread of airborne contamination. These filters will not be required to be high efficiency filters but will be designed to filter out the larger sized particles which are associated with the predominant sources of airborne radioactivity. Air from the air coolers will not be supplied to the basement since access by people will be minimal in that area. The capability to maintain negative pressure in the reactor building will be retained for any reactor building HVAC modifications considered.

3.4.4 Decontamination and Dose Reduction

General area dose rates in the basement are extremely high. Recent measurements taken by RRV-1 indicated dose rates ranging up to 318 rem/hr. Decontamination and dose reduction activities at this level will therefore be performed remotely. The activities will include high pressure flushing, vacuuming of sediment, and dewatering the basement.

Prior to starting decontamination activities any electrical equipment that cannot be flushed with a hydrolaser will be identified. A determination of the impact flushing will have on the sediment waste class will be made prior to flushing or sediment removal.

High pressure flushing will be used to remotely flush all accessible walls, overheads, and equipment from the northeast quadrant to the southern quadrant, including the enclosed stairwell and leakage cooler cubicles.

Following the flushing in these areas a vacuum attached to a remote device will be used to remove the sediment in the area from the southwestern outer edge of the leakage coolers to the northeastern sector of the basement. Transfer of the sediment from the basement will be covered in a separate safety evaluation report. Sediment in areas that the remote device cannot reach can be flushed towards it by a remote flushing wand operated manually through floor penetrations from the 305' level or by the high pressure flushing tool. A camera on the remote device will aid in determining the direction for flushing.

The reactor building sump pumps will be used to remove sediment and water due to decontamination activities. It is known that one of the two sump pumps is in working order; however, before dewatering is started it is planned to have a contingency pump available for use. In addition to the sump pumps a remote device fitted with a hydrolaser will be used as necessary for moving standing water towards the floor drains. This may also be used to sweep water from suspected drain areas in an attempt to locate drains. Clogged drains may be cleared by high pressure flushing or by removing the drain cover and using a mole nozzle. For areas where a drain cannot be found by hydrolasing, vacuuming may be used to remove standing water from around the floor drain.

The area in the basement around the open stairwell will be treated in the same way as described above but will be decontaminated as a separate entity because of difficulties in access. Prior to any work being performed in this area it is necessary to provide access through the open stairwell. This necessitates modifications to the existing shielding around the stairwell. Flushing of the stairwell may be performed by high pressure and ultrahigh pressure flushing performed from the 305' el. Flushing of overheads, walls, floors and equipment, sediment removal and dewatering will be performed as described for other areas of the basement, taking care not to use high pressure flushing on vital electrical equipment that is susceptible to damage.

3.4.5 Alternate Personnel Transit from 305' El. to 347'-6" El.

During 1986 the open stairwell above and below the 305' el. will be modified to permit robot access through the stairwell opening to the basement.

During the modification work and during subsequent periods of robotic work in that area of the basement the stairwell will not be usable for personnel transit to the 347'-6" el. An alternate route to the 347'-6" el. will be made available by way of the enclosed stairwell. The feasibility of shielding inside the enclosed stairwell at the 305' el. or at the 326' el. platform will be evaluated. Based on these evaluations the whole stairwell will be used or scaffold stairs to the 326' el. stairwell entry will be used, with the existing stairs being used above the 326' el.

If dose reduction in the enclosed stairwell is sucessful enough it may become the primary access route to the 347'-6" el. If transit doses are still higher for the enclosed stairwell, the open stairwell may remain as the primary transit route. If the open stairwell remains the primary transit route, the transit dose may be reduced by replacing the shield at the 305' el. and placing lead curtain shielding around the open stairwell to reduce the dose rate on the stairwell from cable trays in the 305' el. overhead area. Coating removal from the stairway structure may also be considered.

3.5 Miscellaneous Activities

Other decontamination and dose reduction activities may be done in the reactor building during 1986. Activities which were ongoing at the end of 1985 are:

1. Installation of shield panels on the 347'-6" el. equipment floor hatch
2. Scabbling of the top of the elevator housing

In addition activities may be accomplished as the need arises. If defueling operations, such as tool changeout/storage or DWCS operation creates new sources, dose reduction activities to reduce the effects of these sources may be done to maintain low operator doses.

3.6 Decontamination Effectiveness Measurements

The effectiveness of decontamination operations is monitored to evaluate progress. The measurements taken are in accordance with GPUN Radiological Controls procedures and effectiveness is determined by either Data Management and Analysis or the Decontamination Section.

3.7 Contamination Control

The degree of contamination control employed in containment varies with locations and the number of job-hours to be spent in the area. The defueling area and associated transit areas on elevation 347'-6" el. have the most controls, whereas less frequently used areas of el. 305' are less stringently controlled. Methods of contamination control are administrative controls, engineered controls, and decontamination maintenance practices.

3.7.1 Administrative Controls

Administrative controls are procedural practices used by individual workers, in conjunction with health physics support, to control the spread of contamination. These procedures exist to reduce recontamination and implement efficient radiological practices, such as the use of glove bags, and step-off-pads.

3.7.2 Engineered Controls

Engineered controls include equipment and techniques developed and constructed to minimize a given radiological hazard, to control contamination, and to facilitate decontamination maintenance. Examples include temporary ventilation systems, tents, and enclosures and the use of strippable coatings.

3.7.3 Decontamination Endpoint and Maintenance

After a decontamination goal has been established, a contamination endpoint is determined. Progress is measured by comparing ongoing results to the endpoint. When the endpoint is achieved, the emphasis is shifted to monitoring the radiological condition within established tolerances. Decontamination maintenance is a routine activity.

Decontamination maintenance is an ongoing program to maintain high occupancy areas at low levels of loose surface contamination. These areas are maintained as clean as practical to minimize personnel protective clothing requirements, to minimize the use of respiratory protective devices and to minimize the possibility of skin contaminations.

Surface contamination levels for different areas will be specified as a decontamination maintenance goal. The defueling work platform and the areas in the refueling canal will be maintained at low levels of loose surface contamination during the defueling program.

4.0 Safety Issues

4.1 Criticality

Criticality of fuel either in the core region or outside the core is precluded by means of poison, geometry or quantity of fuel. During decontamination the activities that could increase the potential for a criticality event are: 1) dilution of the reactor coolant during water flushing activities through the top of the vessel or via flushing of other primary system components such as the steam generators or the pressurizer and 2) criticality of fuel which may have been transported to the reactor building basement floor by way of the reactor coolant drain tank.

4.1.1 Boron Dilution of the RCS

During water flushing activities in the reactor building, potential boron dilution of the RCS through two pathways has been considered. These pathways are through the open reactor vessel and through openings in other components of the RCS.

Boron dilution through the open reactor vessel will be prevented by administrative controls. Flushing directly above or around the top of the reactor vessel will not be permitted during defueling activities with shield panels removed from the defueling work platform. When decontamination operations present a possible dilution pathway through the open vessel, all defueling work platform shield panels or a temporary support structure will be in place and an impervious covering will be installed to prevent unborated water from entering the vessel. Water borated to RCS levels may be used for decontamination when there is a potential for introduction into the RCS.

During decontamination activities in the D-rings, water flushing of RCS components will be done. As part of the ex-vessel fuel location program, openings may be created in the RCS by removal of instrument ports and manways in steam generators or the pressurizer. Boron dilution of the RCS via these pathways will be prevented by one of the following methods:

1. When uncovered openings in RCS components exist, no water flushing will take place in the affected D-ring. Other decontamination methods, such as handscrubbing or vacuum techniques, which do not present a credible boron dilution hazard, may be used.

2. Water flushing in the affected D-ring can only take place if an impervious cover has been used to seal the opening and if water flushing will not be performed in the area of the opening, or if water is borated to RCS levels. Procedures that verify the cover installation and condition will be used in these circumstances.

3. Any replacement hatches or covers for RCS components to be used to permit direct water flushing in the area of the cover will be capable of withstanding the decontamination water spray directed on the covers without leakage into the RCS component.

4.1.2 Unborated Water in the Reactor Building Sump

In the past decontamination water used in the reactor building for surface decontamination has contained boron for the purpose of criticality control. The two issues involving unborated water in the sump have been addressed.

First, it had been conservatively assumed that the basement could contain sufficient fuel to present a criticality hazard should unborated water be used in quantity. The Safety Evaluation Report for Reactor Building Sump Criticality Evaluation (Ref. 6) has demonstrated by way of measured data and analysis that the maximum quantity of fuel that could be located in the basement of the reactor building is insufficient to create a criticality concern under credible conditions.

Prior to NRC approval of Ref. 6, water borated to 1700 ppm will be used for general reactor building decontamination. However, the use of unborated water for decontamination is preferred for several reasons.

1. The accumulation of boron salts on decontaminated surfaces increases recontamination by increasing the mobility of contaminants.

2. Boron salts increase airborne radioactivity potentials, and increase slip and fall hazards.

3. Borated water increases wear to decontamination equipment and has limited the use of decontamination techniques such a ultrahigh pressure water flush.

Therefore the use of unborated water for surface decontamination is preferred for normal surface decontamination throughout the reactor building.

Second, in the event that a loss of primary system integrity occurs, water from the basement may need to be recirculated to the reactor vessel. The recirculation water via the RB sump recirculation system must be a minimum of 4350 ppm boron. This requirement will exist as long as a quantity of fuel equivalent to a critical mass is located in the primary system.

Due to this requirement for water recirculated to the reactor vessel from the sump to be no less than 4350 ppm boron, no more than 70,000 gallons of unborated water may be allowed to accumulate in the basement and sump. This is based on dilution of vessel water and BWST inventory and the capability to inject highly borated water. The basis for this inventory of unborated water in the sump is given in Ref. 7.

Administrative controls will be used to ensure that the maximum allowable quantity of unborated water in the basement is not exceeded. From a decontamination standpoint the maximum allowable accumulation of 70,000 gallons in the basement is not a very restrictive limitation and should not significantly impact water flushing operations.

Site Operations will maintain records of all low and unborated water uses and inventory in the reactor building. Site Operations will maintain liaison with Waste Management in order to match water processing capabilities with decontamination use.

The intake for the portable pumps that will recirculate water from the RB basement to the reactor vessel is equipped with a screen with 3/8" x 1 1/2" slots which prevents large debris from entering the pump. The pump is designed to pump water and any entrained debris that can pass through the slots, without damage to the pump. If during operation the screen becomes clogged, it can be cleared by momentarily shutting the pump off and/or relocating the pump if necessary. Therefore, it is not expected that debris in the RB basement will preclude recirculation.

Solid materials (e.g., concrete and paint chips) removed from contaminated surfaces during decontamination activities may eventually accumulate in the reactor building basement. These materials may be introduced into the reactor vessel in the unlikely event the recirculation mode is used to maintain the reactor vessel water level. These solid materials are not expected to replace borated water as the primary moderator, thus, based on Ref. 8, there is essentially no limit on the amount of the solid material that can be introduced into the reactor vessel. Consequently, it is concluded that the solid foreign materials, removed from contaminated surfaces during the decontamination activities, and transported to the reactor vessel during recirculation operations, will not create a criticality safety concern.

4.1.3 Boron Dilution of the Fuel Transfer Canal (FTC) Water

The boron concentration in the FTC must be maintained at a level of 4350 ppm to 6000 ppm according to TMI-2 Technical Specifications. Any decontamination activity which may introduce water borated to levels less than 4350 ppm into the FTC must be evaluated to ensure that the operation will not dilute the FTC boron to a level below the Technical Specification limit. Adequate means, such as FTC water level monitoring or boron sampling, will be available during these decontamination activities to ensure that the Technical Specification boron level is maintained.

4.2 Heavy Load Handling

Decontamination and dose reduction activities may necessitate the movement of heavy loads at various locations in the reactor building. It is anticipated that these loads may include shielding and decontamination equipment. These loads will be handled according to the Safety Evaluation Report for Heavy Load Handling Inside Containment (Ref. 9) or be evaluated on a case by case basis and be subject to NRC approval.

4.3 Vital Component Protection

Some decontamination activities such as high pressure water flush or abrasive blasting may create the potential for damage to plant equipment.

During decontamination activities vital components which are susceptible to damage will be protected by administrative controls and/or physical barriers. These structures, systems, and components shall be identified in implementing procedures. The vital components are defined as those:

1. necessary to protect the integrity of the reactor coolant system,
2. required to maintain and monitor the boron concentration in the reactor coolant system,
3. required to prevent unacceptable offsite releases, and
4. required to be operable by the Technical Specification.

4.4 Use of Temporary Shielding

Temporary shielding may be used for dose reduction where decontamination is difficult or ineffectual or for ALARA purposes. Shielding attached to or interfacing directly with systems or structures which are safety related will be evaluated to assure that the safety functions provided by these components are not adversely affected by this shielding. The placement of temporary shielding on piping is controlled to ensure that the pipe loading limits are not exceeded. Other shielding structures are reviewed to assess the potential interface with safety related components, including potential collapse of large shielding structures.

4.5 Structural Effects of Scabbling

Scabbling concrete walls and floors is used as a decontamination technique to remove contaminated coatings and the surface layer of concrete. The thickness of the layer removed must be limited in the case of some structures to ensure their structural integrity. Scabbling thicknesses in the reactor building are limited by engineering change authorization. Scabbling thicknesses greater than these limits are evaluated on a case by case basis to ensure that proper concrete configurations are maintained.

4.6 Fire Protection

Fire detection in the reactor building is currently provided by way of detectors placed around the tops of the D-rings and in the outlet ducting of the air coolers. Activities planned for 1986 which may interfere with the normal function of the detectors are water spraying in the D-rings and the isolation of reactor building areas along with modifications in the reactor building HVAC systems.

During water spraying activities, the fire detectors are normally disconnected and covered for protection. A fire watch is required when the detection system is defeated. These requirements will be implemented during water spraying activities in the D-rings.

Isolation of reactor building areas and modification of the HVAC system will require an assessment of the adequacy of the current duct mounted detectors. Additional general area detectors may be provided to meet fire detection requirements within isolated areas in the reactor building.

4.7 Industrial Safety

During performance of dose reduction and decontamination activities, personnel health and safety hazards will be reduced to as low a level of risk as is reasonably achievable. Certain industrial hazards inherent in the nature of the operations being conducted are as follows:

- o heat stress
- o fall hazards

- o electrical shock
- o high-pressure water sprays
- o noise
- o eye hazards
- o tripping hazards
- o rotating equipment
- o sharp equipment and objects
- o materials lifting and handling

Written procedures, personnel training and use of safety equipment are used to minimize the risk from these hazards.

Heat stress problems have been reduced due to the installation and operation of the reactor building chilled water system. During the summer it can maintain the ambient reactor building temperature at 65°F. This has enhanced worker comfort and has improved worker productivity. Heat stress protective gear may be used if considered necessary. This includes vortex cooling suits and ice vests.

Fall hazards are controlled by the installation of handrails and the use of safety belts and life lines. The protection of workers from fall hazards as well as other common industrial hazards, such as electric shock, noise, tripping hazards, moving equipment, and high pressure water sprays, is ensured by a safety review of work procedures by the Safety and Health Department. Special protective equipment to mitigate these hazards may be required as determined by the Safety and Health Department.

5.0 Radiological Assessment

5.1 Occupational Exposures

5.1.1 External Exposure

All individuals entering the reactor building will be monitored for external exposures in accordance with GPUN Radiological Controls procedures to ensure personnel exposures are maintained within 10CFR20 dose equivalent limits. Administrative dose limits in accordance with GPUN procedures will be used in order to assure that 10CFR20 dose limits are not exceeded. Extremity monitoring will be performed as needed in accordance with existing procedures.

Personnel exposures are estimated annually for decontamination and dose reduction activities to be done in the reactor building. For 1985 the person-rem estimate for activities listed in Ref. 4 was 65 to 195. Actual tasks accomplished are discussed in Section 3.1 of this SER. The actual personnel exposures for these activities was 89 person-rem through December 31, 1985.

During 1986 the recovery program emphasis has shifted from decontamination to support reactor vessel defueling to plant cleanup. Therefore it is expected that there will be a significant increase in decontamination and dose reduction tasks in the reactor building during 1986.

In addition, significant work is scheduled to be started in high dose rate areas, such as the 'A' and 'B' D-rings. For these reasons, personnel collective exposures projected for 1986 are higher than for previous years. The decontamination and dose reduction efforts in the D-rings are required to support the ex-vessel fuel characterization and removal programs, which are part of the total recovery program.

The projected exposure estimates are based on job-hours estimated for the tasks described in Sections 3.3, 3.4 and 3.5. The job-hours to be spent in the D-rings are separated from general building activities due to the differences in general area radiation levels. The dose rates for reactor building activities are based on historical data collected in similar areas for similar tasks. For work in the D-rings, dose rate estimates are based on TLD data to date, along with assumptions regarding decontamination and dose reduction effectiveness.

Collective exposures for reactor building decontamination and dose reduction activities for 1986 are given below.

	Job-Hours	Person-Rem
General area decontamination	3400	280
Decon in the D-rings	1200	370
Basement recovery	2300	150

The total exposure estimate is therefore 800 person-rem. Due to uncertainties in estimates, as well as the difficulty in predicting job hours and dose rates in the D-rings, a total uncertainty of 50% is added. The estimate for personnel exposures to accomplish decontamination and dose reduction activities in the reactor building during 1986 is 400 to 1200 person-rem.

5.1.2 Internal Exposures

Personnel entering the Reactor Building will be protected against inhalation of gaseous or particulate radioactivity as necessary in accordance with GPUN Radiological Controls Procedures. As specified by Regulatory Guide 8.15, analyses of expected airborne contamination levels will be performed in order to select appropriate respiratory protective devices. Air sampling for particulate activity will be performed using devices such as lapel samplers and continuous air monitors. Tritium air samples will be taken unless deemed unnecessary by Radiological Controls personnel.

An estimate of the airborne radioactivity to be encountered by the individuals performing decontamination activities was derived from the breathing zone air sampling results of workers participating in decontamination. The average concentrations of Cs-134, Cs-137 and Sr-90 are shown below.

Cs-134	Cs-137	Sr-90
1.3E-9 μCi/cc	4.7E-8 μCi/cc	7.2E-9 μCi/cc

Estimated MPC-hours are 0.01 MPC-hr/hr with air purifiers (protection factor of 1000) using the above concentrations. It is a design parameter to limit internal exposures to 1 MPC-hr/hr for all decontamination activities, considering all radionuclides present and considering respiratory protection factors. Tritium levels are not expected to pose difficulties. Bioassay results from persons participating in decontamination tasks have indicated uptakes which would result from exposures to a mean tritium airborne activity level of 4.02E-7 μCi/cc or 8.0E-2 MPC-hr/hr.

5.1.3 Measures Taken To Maintain Occupational Radiation Exposures As Low As Is Reasonably Achievable (ALARA)

The objective of minimizing occupational exposure has been a major goal in the planning and preparation for all activities in the reactor building. The actions that have been taken or are being planned toward meeting this objective are summarized in this section. Protective clothing and respirators will be used as necessary to reduce the potential for external contamination and internal exposure of personnel.

The techniques and sequence of operations chosen have been developed to achieve the greatest decontamination at minimum job-hour and person-rem expediture in the containment.

Execution of individual decontamination tasks are maintained ALARA by a detailed radiological review by Radiological Controls and mockup training of work crews. This training will approximate the actual work situation as closely as can be achieved for each task utilizing appropriate equipment, protective clothing, and respiratory protection.

Extensive planning of tasks to be conducted in a radiation field and training of personnel will be used to reduce the time needed to complete a task. Extensive use of training aids will be made to familiarize personnel with the work area. The higher radiation areas are identified to personnel and the work is structured to avoid these areas to the extent practical. Practice sessions will be utilized as necessary to ensure that personnel understand their assignments prior to entering the reactor building. Planning and training are proven methods of ensuring that personnel are properly prepared to conduct the assigned task expeditiously.

Potential improvements in operational technique will be fed back into future work packages and mockup training in a manner consistent with the development of work activities. If the observed techniques demonstrate major operational problems or the ineffectiveness of a particular decontamination technique, the decontamination activities shall be altered to properly accommodate this feedback. It should be noted, however, that the evaluation of the adequacy of a particular decontamination technique must take into account and weigh several operational factors such as person-rem and job-hour expenditures, personnel safety, operational complexities and training requirements.

Decision making processes regarding decontamination and dose reduction tasks and techniques are made with consideration of personnel exposures. Decision analysis is needed to evaluate different options to accomplish the desired task. Different levels of radiation protection for a given task may also be considered. The decision analysis is not intended to force the option which entails the lowest personnel exposure, but is intended to ensure that personnel exposures are considered, along with other variables. Procedures are in place which establish this decision making process to make the ALARA philosophy part of the work task, from task inception and engineering to implementation.

5.2 Offsite Radiological Releases

A small fraction of the airborne radioactivity in the reactor building may be transported to the environment by way of the purge system exhaust. Particulate radioactivity and tritium are the airborne contaminants considered in assessing the potential offsite doses due to releases from the reactor building during decontamination activities. The offsite doses which might be expected during 1986 due to normal decontamination operations were calculated as described below.

The airborne particulate concentrations of the predominant airborne contaminants in the reactor building environment were determined for the period January-September 1985 and are listed below. The tritium concentration was determined by grab samples taken on the defueling work platform during defueling activities during January 1986. The maximum tritium value for the samples taken is used.

Radionuclide	Airborne Concentration ($\mu Ci/ml$)
Cesium-137	3.53×10^{-10}
Strontium-90	3.79×10^{-11}
Tritium	1.2×10^{-7}

It is assumed that these concentrations will represent the average concentration throughout 1986. This is a reasonable assumption since decontamination activities may increase local concentrations of particulates temporarily but as decontamination tasks have been accomplished there has been a long term reduction in general area airborne radioactivity.

The purge exhaust vents air from the reactor building through the plant HEPA filters and to the environment. For calculating offsite doses it is assumed that the purge exhaust flow rate is 25,000 cfm and that it exhausts continuously for one year. It is assumed that the HEPA filters remove 99.9% of all particulates but do not remove tritium.

The total radioactivity then calculated to be exhausted for the period of one year is:

Radionuclide	Environmental Release (Curie/Year)
Cesium-137	1.31×10^{-4}
Strontium-90	1.41×10^{-5}
Tritium	4.46×10^{1}

These quantities of radioactive materials expected to be released to the environment are considered reasonable yet conservative for the following reasons:

The reactor building purge is normally not run continuously throughout the year. Measured releases from the plant vent, including releases from the reactor building and the auxiliary and fuel handling buildings, have been less than these values for the period from 1982 through 1985. In addition, alternate decontamination techniques which minimize the generation of airborne radioactivity, or use of local ventilation control may be used to reduce the impact of the decontamination operations on general area airborne radioactivity levels. The radionuclides listed above are expected to represent the most significant airborne radioactivity sources. Gross alpha radioactivity is expected to constitute a small fraction of the total radioactivity released to the environment Alpha radioactivity released to the environment is monitored and total radioactivity released to the environment will be maintained within TMI-2 Technical Specification limits.

Assuming these activities of cesium-137, strontium-90 and tritium are released, the offsite dose consequences are calculated using the methodology described in NRC Regulatory Guide 1.109. The atmospheric dispersion factors (X/Q values) and relative deposition per unit area (D/Q values) are calculated from information taken from the TMI-1 Offsite Dose Calculation Manual.

The resulting offsite doses are given in Table 5.1. From this table it is seen that the maximum exposed individual with the highest organ dose is the child with a liver dose of 9×10^{-3} millirem/yr. The maximum total body dose is 8×10^{-3} millirem/yr. These doses are only a small fraction of the dose limits given in the TMI-2 Technical Specifications Appendix B. During decontamination operations, if the purge system is exhausting to the environment, the plant vent radiation monitors will alert operators to increases in environmental releases. The radiation monitors will alarm and will automatically shift the purge system to recirculation mode at a level which will assure that the TMI-2 Technical Specifications limits will not be exceeded.

Table 5.1

Estimated annual dose to maximum offsite individual due to decontamination activities, in millirem

DOSE FROM ALL PATHWAYS (MILK FROM COW)

AGE GROUP	BONE	TOTAL BODY	LIVER	LUNG	SKIN
Adult	1.047E-3	5.769E-3	5.763E-3	5.421E-3	1.559E-4
Teen	1.204E-3	6.135E-3	6.408E-3	5.874E-3	1.559E-4
Child	2.090E-3	7.496E-3	8.195E-3	7.270E-3	1.559E-4
Infant	2.192E-3	3.662E-3	5.323E-3	3.635E-3	1.559E-4

DOSE FROM ALL PATHWAYS (MILK FROM GOAT)

AGE GROUP	BONE	TOTAL BODY	LIVER	LUNG	SKIN
Adult	1.283E-3	6.058E-3	6.132E-3	5.558E-3	1.559E-4
Teen	1.615E-3	6.452E-3	7.008E-3	6.075E-3	1.559E-4
Child	3.033E-3	7.860E-3	9.222E-3	7.584E-3	1.559E-4
Infant	3.648E-3	4.134E-3	7.229E-3	4.138E-3	1.559E-4

6.0 Radioactive Waste Management

Radioactive waste from operations in the reactor building will include solid, liquid and chemical wastes.

6.1 Solid Waste

The solid wastes can be broken down into the following categories:

1. Disposable Protective Clothing - includes gloves, shoe covers and wet suits which will be utilized by personnel entering the reactor building and actually conducting the decontamination.
2. Reactor Building Trash - this category consists of the accumulated trash (e.g., plastic bags, framing lumber, polyethylene sheets and other disposable equipment) from general activities within the reactor building. Sources of this trash include initial construction materials and recovery construction activities.
3. Submerged Demineralizer System, Defueling Water Cleanup System, and EPICOR II - consists of the volume of liners of ion exchange material and filters which will be generated by processing the flush water used for decontamination.
4. Miscellaneous Waste - includes material for hand wiping surfaces, plastic bags, strippable coating, rubble from the scabbling process, framing lumber, polyethlene sheet and other disposable equipment used in support of decontamination activities.
5. Solidified Sludge - consists of the sludge removed from system piping, tanks, sumps and floors, combined in a solid matrix with concrete, polymers, or bitumen.
6. Structural Components - consists of cinder blocks, metal, and piping, which may be shredded before putting into storage containers.
7. Mirror Insulation Panels - Consists of insulation removed from primary system components such as the steam generators and the pressurizer. These will be flushed and segregated by point of origin before being put in containers for disposal. The insulation panels may be compressed, cut or shredded, as necessary, to fit into containers.

Solid waste will be classified and disposed of in accordance with established procedures.

6.2 Liquid Waste

Processed water will be used for decontamination activities as required. When operational flexibility permits, processed water with the lowest concentrations of radionuclides will be used. Most of the water actually used for decontamination will drain through the floor drains and be collected in the containment sump area. This water will be processed through the submerged demineralizer system, defueling water cleanup systm, and/or EPICOR II.

6.3 Chemical Waste

Chemicals will be considered for decontamination uses in accordance with GPUN procedures. Chemical waste will be appropriately treated and processed for disposal in a manner that is in compliance with federal regulations. For example, acid wastes will be neutralized prior to solidification and disposal. Dilute chemical wastes are stored in the Concentrated Waste Storage Tank (CWST, WDS-T-2) which has an administrative capacity of 7900 gallons. All sources of chemicals result in the processing of one to two tank volumes per year.

7.0 Safety Evaluation for Reactor Building Decontamination and Dose Reduction Activities

10CFR50, paragraph 50.59, "Changes, Tests, and Experiments", permits the holder of an operating license to make changes to the facility or perform a test or experiment without prior NRC approval, provided the change, test, or experiment is determined not to be an unreviewed safety question and does not involve a modification of the plant's technical specifications.

A proposed change involves an unreviewed safety question if:

a. the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased; or

b. the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created; or

c. the margin of safety, as defined in the basis for any technical specification, is reduced.

None of the activities associated with reactor building decontamination and dose reduction will affect the condition of the reactor coolant system or the fuel. The core is being maintained in a subcritical condition by the boron concentration in the reactor coolant. Activities that occur during decontamination will not affect the boron concentration in the reactor, as established by administrative and physical controls. While flushing the refueling canal and adjacent areas, the reactor vessel will be covered to prevent inleakage and dilution of RCS boron. While flushing in the D-rings, precautions will be taken to prevent inleakage to the RCS by way of openings in primary system components. Precautions will be taken to ensure that the fuel transfer canal water is maintained at TMI-2 Technical Specification levels. Until the use of low borated water is approved by the NRC, boron concentrations in the water used in decontamination will be maintained at or above 1700 ppm, per NRC approved procedure. Decontamination operations will not affect decay heat removal by the loss-to-ambient cooling mode. Safety related equipment susceptible to damage will be protected by physical and/or administrative means.

Decontamination will not increase the probability of occurrence or the consequences of an accident previously evaluated in the FSAR and/or other safety evaluations submitted to the NRC. Decontamination does not create the possibility for an accident different than any evaluated previously in the FSAR and/or other safety evaluations submitted to the NRC.

Decontamination will not reduce the margin of safety as described in the basis for any technical specification. Additionally, no changes to the TMI-2 Technical Specifications are required to perform this activity.

Therefore, reactor building decontamination and dose reduction activities do not involve an unreviewed safety question as defined in 10 CFR 50, paragraph 50.59, and do not require a modification to the Technical Specifications.

8.0 Conclusion

Based upon the radiological and safety evaluation contained in this report, it is concluded that:

1. Offsite releases and doses for ongoing reactor building decontamination and dose reduction activities are well within the bounds of the TMI-2 Technical Specification limits,

2. Occupational exposures to perform decontamination activities are consistent with ALARA considerations, and

3. Decontamination activities do not constitute an unreviewed safety question as defined by 10CFR50.59, and do not require a modification to the Technical Specifications.

9.0 References

1. Gross Decontamination Experiment Report, GEND-034, July 1983.

2. Radiological and Safety Evaluation of Ongoing Containment Building Decontamination Activities for TMI-2 Recovery, Rev. 0, transmitted by GPUN letter 4410-82-L-0007, 9-23-82.

3. Radiological and Safety Evaluation of Ongoing Containment Building Decontamination Activities for TMI-2 Recovery, Rev. 0, transmitted by GPUN letter 4410-83-L-0227, 9-83.

4. Safety Evaluation Report for the Reactor Building Decontamination and Dose Reduction Activities, Rev. 1, February, 1985, SA #4340-3153-83-4.

5. Technical Plan for TMI-2 Program Strategy, TPO/TMI-115, Rev. 0, June, 1984.

6. Safety Evaluation Report for Reactor Building Sump Criticality, SA #4550-3254-85-02.

7. GPUN Letter 4418-84L-0154, F. R. Standerfer to B. J. Snyder, "Technical Specification Change Request No. 46," 11-6-84.

8. Report on Limits of Foreign Materials Allowed in the TMI-2 Reactor Coolant System During Defueling Activities, 15737-2-N09-002, Rev. 1, September, 1985.

9. Safety Evaluation Report for Heavy Load Handling Inside Containment, 15737-2-G07-105, Rev. 2, 8-19-85.