DISTRIBUTION:
DN 50-320
NRC PDR
Local PDR
DCS
TMI HQ r/f
TMI Site r/f
WDTravers
MTMasnik
RAWeller
PJGrant
RCook
CCowgill
LChandler
IE
ACRS
M-Town Office
Service List

November 12, 1985
NRC/TMI 85-089

Docket No. 50-320

Mr. F. R. Standerfer
Vice President/Director
Three Mile Island Unit 2
GPU Nuclear Corporation
P. O. Box 480
Middletown, PA 17057

Dear Mr. Standerfer:

Subject: Safety Evaluation for Early Defueling

Your letter dated May 20, 1985, as revised by letter dated October 10, 1985, submitted the safety evaluation report (SER) for early defueling of the TMI-2 reactor vessel and requested Nuclear Regulatory Commission (NRC) approval. This letter provides NRC staff approval of your request and includes our safety evaluation of the proposed early defueling activities.

By letter dated October 24, 1985, GPU requested NRC approval to conduct limited preliminary defueling activities inside the reactor vessel. Staff approval was granted in a letter dated October 29, 1985, with a supporting safety evaluation. As described in that approval letter, authorization was given for: 1) rearrangement of core debris within the reactor vessel to allow complete installation and rotation of the Canister Positioning System and to provide access for defueling tools, and 2) identification and positioning of core debris samples in the vessel. It was also understood that general movement of core debris could include the loading of debris baskets but that no defueling canisters would be loaded with fuel debris nor could there be any core debris removed from the reactor vessel. The conclusions of that safety evaluation and their bases also apply to all the defueling activities covered herein.

This letter and the attached safety evaluation address all proposed early defueling activities including the removal of accident generated core debris from the reactor vessel and storage of that debris in defueling canisters placed in storage racks located in the fuel transfer canal and "A" spent fuel pool. This also includes the use of two canister handling bridges (CHB) and a canister transfer system (CTS) which is used to transfer defueling canisters to the flooded deep end of the Reactor Building fuel transfer canal through the CTS to the Fuel Handling Building.

In our review, we considered the information provided in 1) the subject SER, 2) discussions with your staff, 3) responses to our docketed questions, and 4)

OFFICE	8511200288 851112					
SURNAME	PDR ADOCK 05000320					
DATE	P PDR					

other related defueling documents some of which were subjects of separate NRC reviews and approvals (these are all referenced in the attached SER). We also observed testing and checkout of the major defueling equipment and monitored your operator training program. Both canister handling bridges have been operationally inspected, load tested and subjected to a full integrated test. Based on our reviews and as detailed in the enclosed safety evaluation we find that: 1) there is little potential for core recriticality due to fuel reconfiguration or a boron dilution event, and that the design of defueling canisters provides adequate assurance that loaded fuel will remain subcritical with a substantial shutdown margin for all postulated canister conditions; 2) "loss-to-ambient" cooling of the RCS will provide adequate decay heat removal; 3) there is little potential for a pyrophoric reaction; 4) adequate methods of combustible gas control are provided through defueling canister design and dewatering and off-gas system operation; 5) appropriate measures for the handling of heavy loads have been implemented to minimize the probability and consequences of postulated accidents; 6) existing fire protection measures are acceptable; 7) there is little potential for a release of radioactivity significantly greater than the trace amounts which have been typically discharged throughout the cleanup; 8) there is little potential for worker overexposure and GPUN has implemented a program to maintain occupational exposures ALARA; and 9) early defueling activities do not constitute an unreviewed safety question. We also find that the proposed activities fall within the scope of those analyzed in the PEIS. We, therefore, conclude that the proposed early defueling activities can be safely conducted with minimal risk to the health and safety of the onsite workforce and offsite public.

Based on these findings and the NRC licensing of five (5) Fuel Handling Senior Reactor Operators (FHSRO's), we approve the proposed preliminary defueling activities described herein. These activities may commence upon staff approval of the applicable defueling procedures pursuant to Technical Specification 6.8.2. Additionally it should be noted that until we have taken action on the Heavy Load SER (Rev. 2) your are prohibited by your technical specifications from lifting heavy loads over any defueling canisters which contain core debris.

Sincerely,

ORIGINAL SIGNED BY
William D. Travers

William D. Travers
Acting Director
TMI Program Office

Enclosure: As stated

cc: T. F. Demmitt
R. E. Rogan
S. Levin
W. H. Linton
J. J. Byrne
A. W. Miller
Service Distribution List
(see attached)

OFFICE	TMIPO	TMIPO	TMIPO				
SURNAME	RHall:wa	PJGrant	WDTravers				
DATE	11/12/85	11/12/85	11/12/85				

THREE MILE ISLAND PROGRAM OFFICE

SAFETY EVALUATION OF EARLY DEFUELING

OF THE TMI-2 REACTOR VESSEL

By letter dated May 20, 1985, GPU Nuclear submitted the safety evaluation report (SER) for early defueling of the TMI-2 reactor vessel. This SER was subsequently revised by letter dated October 10, 1985 (Reference 1). Following our meeting with GPU staff on July 25, 1985, we requested additional information on early defueling activities in letters dated July 29 and August 13, 1985. GPU responded to those requests in letters dated October 3 and October 23, 1985. Our review of early defueling activities also incorporated our reviews of related defueling documents, including the technical evaluation reports (TER) for the Defueling Water Cleanup System (DWCS) and Defueling Canisters, the Boron Dilution Hazards Analysis, and the SER for Heavy Load Handling. NRC evaluations of those documents are referenced, as appropriate, in this report.

By letter dated October 24, 1985, GPU requested NRC approval to conduct limited preliminary defueling activities inside the reactor vessel. This approval was granted in a letter dated October 29, 1985, with a supporting safety evaluation. The conclusions of that safety evaluation still apply to all reactor vessel defueling (in-vessel) activities which are covered in this Safety Evaluation. Based on the above information, discussions with GPU Nuclear staff, and our first-hand observation of training, equipment checkout and system testing, we have completed our review of the proposed early defueling activities. This safety evaluation documents the results of our review of the proposed activities.

Description of Early Defueling Activities

As described in Reference 1, the proposed early defueling activities involve the removal of accident-generated core debris from the TMI-2 reactor vessel and the storage of that debris in defueling canisters placed in storage racks located in the spent fuel pool of the Fuel Handling Building (FHB) and the fuel transfer canal (FTC) in the Reactor Building (RB). The debris, consisting of partial fuel assemblies, fuel rods, end fittings, structural materials, and loose granular fuel and structural fines, will be deposited into the specially designed defueling canisters by operators using long-handled tools and a vacuum system. During these canister loading operations, personnel supervised by a specially trained and licensed Fuel Handling Senior Reactor Operator (FHSRO), will be working from a shielded rotating work platform positioned over the reactor vessel. All in-vessel defueling activities will be conducted under water. The water level in the modified internals indexing fixture (IIF) will be maintained approximately five feet above the reactor vessel flange to provide additional radiation shielding. Physical and administrative controls will be implemented to prevent the inadvertent lifting of core debris out of the vessel.

8511200291 851112
PDR ADOCK 05000320
P PDR

Three types of canisters will be used in defueling operations: fuel, knockout and filter canisters. Fuel canisters will be filled with larger core debris and rubble that can be picked up with the manual or hydraulic long-handled tools. Knockout and filter canisters will be used in the vacuuming system to collect loose fines and other small debris. Filter canisters will also be used in the DWCS and dewatering systems. The canisters will be supported in the vessel by the Canister Positioning System (CPS), the single canister support bracket (SCSB) or the vacuum system support structure. The defueling canisters are described in more detail in the Defueling Canister TER and in the staff safety evaluation for defueling canisters (References 2 and 3).

Other in-vessel early defueling activities will consist of movement of large debris to allow equipment installation and vacuuming of small debris, loading of debris into baskets for more efficient packing of fuel canisters, and weighing and partial dewatering of filled canisters prior to removal from the reactor vessel. Although partial dewatering of canisters in the vessel is planned, it is not a requirement for their transfer and storage. A second dewatering system will be available in the Fuel Handling Building (FHB) for dewatering stored canisters prior to shipment.

The reactor building canister handling bridge (CHB) will be used to remove loaded canisters from the reactor vessel. The CHB and canister transfer shield (CTS) will be positioned above the appropriate canister removal port in the defueling platform and the canister will be lifted into the CTS. The CHB will then transfer the shielded canister through air to the flooded deep end of the fuel transfer canal (FTC), where it will be placed in the canal fuel storage racks or in one of the two modified fuel transfer system upenders for transfer into the FHB. Following transfer into the FHB, a second canister handling bridge will lift the canister from the upender and lower it into a submerged storage rack location or the FHB dewatering station in spent fuel pool "A". The CHB will also be used to transfer canisters between the storage racks and the FHB dewatering station. The fuel canister storage racks are described in detail in GPUN Fuel Canister Storage Rack Technical Evaluation Report and NRC's Safety Evaluation Report (references 4 and 5). Eventually, the defueling canisters will be removed from storage and shipped offsite; however, that activity is outside the scope of early defueling operations which are addressed in this safety evaluation.

Early Defueling Equipment

The following sections describe some of the unique systems and equipment that have been specially designed for the defueling of TMI-2. Additional details are provided in Reference 1 and in the appropriate design descriptions and drawings.

Defueling Work Platform

The rotatable defueling work platform, positioned directly over the reactor vessel, is approximately 17 feet in diameter and includes 6 inches of stainless steel shielding, a full diameter, 18-inch wide tool slot with a 24-inch wide T-shaped extension, and three canister transfer ports. The platform is supported at a height of 9 feet above the vessel flange by a support structure erected around the IIF on the refueling canal floor. The support structure also provides shielding, piping penetrations and an off-gas seal. The platform supports defueling operators and the long-handled tools, including two jib cranes to assist the operators in manipulating the tools. The platform is rotated by a cable drive system which limits its speed of rotation and is equipped with a manual disc-type brake. An alignment hole and pin are provided to assure proper platform orientation for canister removal and a torque limiter will prevent platform rotation when the brake is engaged or the alignment pin installed. A cable management system is provided to prevent binding of cable and hose assemblies used in defueling. Various electrical, hydraulic and pneumatic lines are routed through a powertrack which can be reeled in or let out as the defueling platform is rotated. The decontamination spray system, mounted to the underside of the defueling work platform, provides the ability to flush radioactive debris from canisters and tools as they are removed from the reactor vessel, while confining the flush water and debris to the vessel and IIF. Borated flush water will be provided from the FTC fill manifold through a hose connection to a manifold on the defueling work platform. An off-gas system, consisting of a 4000 scfm filtration unit equipped with HEPA filters and a moisture-separating prefilter, will be operated as needed to prevent radioactive gases that could collect under the defueling platform from affecting defueling personnel. The system can maintain an airflow of 150 fpm through the work platform support structure via two flexible ducts into the filtration unit, which discharges the filtered effluent to the reactor building atmosphere, away from the defueling platform.

Auxiliary Work Platforms

Stationary auxiliary work platforms are located at the defueling work platform elevation, on the north and south sides, to provide additional staging area for defueling personnel and equipment. The south platform also supports the control consoles for defueling equipment and is provided with shielding to allow continuous manning throughout defueling activities. The control system provides hydraulic and electrical power and controls and instrumentation for the viewing system, defueling work platform drive system, and the hydraulic system for defueling tools. The defueling viewing system consists essentially of the same video equipment used for plenum inspections. Operators can use long-handled tools to manipulate cameras and lighting for best viewing during defueling activities.

Long-Handled Tools

Long-handled tools will be used extensively during early defueling for movement or cutting of core debris, loading debris into fuel canisters, and positioning of defueling equipment in the reactor vessel. The tool handles will be up to 30 feet long and will be sectioned to provide easy handling and assembly. Several different end effectors will be attached to the ends of the handles to perform a variety of functions including pulling, cutting, scooping, and grappling the core debris. Powered end effectors will be hydraulically operated. The operators will rely on the viewing system to monitor their work as they manipulate the tools through the tool slot in the defueling work platform. Most tools will be supported by an overhead service crane to provide vertical and lateral motion, although some can be hand-held.

Canister Positioning System

The canister positioning system (CPS) is a rotating carousel installed in the reactor vessel that can hold up to five fuel and knockout canisters. The CPS will interface with the vacuum system when supporting knockout canisters for use with that system. The height of canisters in the CPS can be adjusted to three discrete elevations to allow the canisters to be positioned closer to the debris bed as it gets lower. The CPS is manually rotated to allow canisters to be lifted or lowered by the canister handling bridge through the transfer port in the defueling work platform.

Single Canister Support Bracket

The Single Canister Support Bracket (SCSB) may be used to support a single fuel canister prior to CPS installation and could also be used to support a knockout canister in conjunction with vacuum system operation, if necessary. The SCSB, if used, will be mounted on rails below the tool slot in the defueling work platform, which will allow it to be manually moved to any position along the slot. A brake will be provided to prevent movement of the SCSB when positioned. Canisters supported by the SCSB can also be repositioned at other elevations to facilitate loading of debris.

Fines/Debris Vacuum System

The fines/debris vacuum system is composed of a pump, piping, valves and knockout and filter canisters. The system is designed to remove small loose debris up to the approximate size of a fuel pellet. The vacuum system is supported from the underside of the defueling work platform and is controlled from the console on the south auxiliary work platform. The vacuum pickup nozzle is connected to a canister by a flexible hose and is manipulated using a long-handled tool. Debris is picked up and passed first through a knockout canister, then any remaining debris larger than 0.5 microns is collected in a filter canister. Knockout and filter canisters will be weighed in the vessel to assure that they do not exceed the weight limitations for loaded canisters.

Canister Handling Bridges

Two canister handling bridges have been provided for canister transfer during defueling activities, the reactor building CHB and the fuel handling building CHB. These CHB's were constructed using existing fuel handling bridges and modified canister handling trolleys with canister transfer shields (CTS). The modified trolleys also include controls for bridge, trolley and hoist movement as well as hoists, grapples, grapple guiding tools, cable and hose reels, and load cells. The CTS is made of stainless steel encased lead and has a retractable collar to provide shielding when canisters are raised or lowered, as well as during transfer. The CHB grapples are air-operated single-point devices which engage a machined socket in the upper head of the defueling canister to lift the canisters into the CTS. During canister transfer, redundant canister retention mechanisms on the bottom of the CTS provide a secondary means of supporting canisters. The CHB's are designed in accordance with ANSI 830.2 - 1983 and 830.16 - 1978 and were load tested to meet the requirements of ANSI 830.2 and the TMI-2 Lifting and Handling Program.

Fuel Transfer System

The Fuel Transfer System (FTS) has been modified to handle the transfer of defueling canisters weighing up to 3355 lbs. from the reactor building to the fuel handling building. Canisters will be handled similarly to normal fuel assemblies; canisters will be lowered into a modified upender in the flooded deep end of the fuel transfer canal, turned into a horizontal position and moved through one of the fuel transfer tubes into the spent fuel pool, where a second upender will raise the canister to a vertical position. The fuel handling building CHB will then be used to lift the canister from the FTS and position it in a storage rack location or in the FHB dewatering station. The FTS will be fully tested prior to use.

Defueling Water Cleanup System (DWCS)

The DWCS will be used to process water in the reactor vessel during early defueling and subsequently will be available to process the deep end of the FTC and in spent fuel pool "A". The system was designed to reduce activity and improve water clarity through the removal of radioactive ions and particulate matter. The DWCS is composed of two subsystems; the Reactor Vessel Cleanup System and the FTC/Spent Fuel Pool Cleanup System. In the event that these systems are not operational at the start of early defueling activities, water processing could be accomplished by using the Submerged Demineralizer System; however, DWCS operation will provide the capability for continuous and more efficient processing. More detail on the DWCS is provided in References 6 and 7.

Dewatering Systems

The reactor vessel and FHB dewatering systems are designed to purge water from submerged defueling canisters so that sufficient recombiner catalyst is exposed to prevent the buildup of combustible gases in the canisters. Typically, loaded canisters will be partially dewatered in the reactor vessel using bottled inert gas located on or near the defueling work platform. Water discharged from the canisters during in-vessel dewatering will remain in the vessel and be processed by DWCS. Any inert gas released by dewatering process will be vented through the off-gas system. The FHB dewatering station is located under water to provide shielding from radiation.

Cranes

Cranes that will be used during early defueling include the reactor building polar crane, reactor building service crane, and the two jib cranes installed on the defueling work platform. The polar crane will be used to lift heavy loads during installation of defueling equipment, but will not lift loaded canisters. The service crane will be used to handle tools, equipment, shielding and empty canisters as well as weighing loaded fuel canisters, as needed. The jib cranes will be used to assist operators in manipulating long-handled tools in the reactor vessel. The two jib cranes are oriented to lift or support tools at any position along the tool slot.

Safety Issues

The safety issues relevant to the proposed early defueling activities are similar to those issues addressed for previous cleanup activities. Specific safety issues relating to early defueling are addressed in staff evaluations of defueling components and systems, including defueling canisters and the defueling water cleanup system. The conclusions of other staff safety evaluations, as they apply to early defueling safety issues, will be summarized in this evaluation.

Criticality

The potential for a criticality event during early defueling activities involves fuel in the reactor vessel and fuel transferred and stored in canisters.

The safety evaluation for preliminary defueling activities, dated October 28, 1985 (Reference 8), referenced the staff's approval of GPUN's Reactor Coolant System Criticality Report (Reference 9).

In References 8 and 9, the staff concluded that during all reactor disassembly and defueling activities, at an RCS boron concentration of 4350 ppm, the damaged core will remain subcritical with a shutdown margin of at least one percent for any postulated fuel configuration. The actual RCS boron concentration during defueling activities will be at least 4950 ppm, the administrative limit, thereby providing a substantially greater shutdown margin to preclude the potential for recriticality of the core. The staff also concluded in Reference that, based on GPUN's analysis and administrative controls, the potential for introduction of foreign materials into the RCS during early defueling is very small and that the resulting effect on RCS reactivity will not significantly reduce the existing shutdown margin. Therefore, based on our evaluations in References 8 and 9, we conclude that adequate safety margins exist to minimize the potential for recriticality of the fuel in the reactor vessel during early defueling activities.

The NRC staff has independently verified the calculations performed by GPU to demonstrate that fuel in canisters will remain subcritical during normal and postulated accident conditions. Using conservative assumptions, the cases analyzed included all three types of canisters; alone, in a stored array, and deformed from a worst-case drop accident. Two fuel configurations were analyzed for knockout and filter canisters, and the effect of the canister transfer shield on the reactivity of undamaged, loaded canisters was also analyzed. Calculations were also performed to analyze the case where the entire contents of a loaded canister was dropped around a filled, stored canister. All of the cases analyzed yielded K_{eff} values below 0.95. Based on the conservative assumptions employed and our independent verification of the calculations, we concur with the licensee's criticality analysis for fuel in defueling canisters. Therefore, we conclude that the potential for a criticality event in the reactor vessel or defueling canisters during early defueling activities is acceptably low.

Boron Dilution

Recriticality of the fuel in the reactor vessel is prevented by maintaining a high boron concentration in the RCS. GPU recently submitted a revised boron dilution hazards analysis (Reference 10) to demonstrate that the potential for a boron dilution event leading to recriticality of the core is extremely low during the proposed early defueling activities. This analysis evaluates all potential RCS dilution pathways and their isolation barriers and describes provisions for RCS sampling and level monitoring for early detection and mitigation of a potential dilution event. Other precautions will be taken to minimize the potential for dilution, including the isolation of potential sources of unborated or underborated water using multiple barriers, and the boration of hydraulic fluid used in the operation of defueling equipment. Based on our review of Reference 10 and other actions taken to prevent a dilution event, we conclude that the potential for a boron dilution event during early defueling is small; early detection of a dilution event is likely, due to sampling and monitoring capability and the large margin provided by the operating RCS boron concentration; and that effective remedial action can be taken to terminate the dilution and provide borated makeup water to the RCS.

Decay Heat Removal

The decay heat in the damaged reactor core (currently about 12 Kw) continues to be removed in the loss-to-ambient mode. Defueling activities are not expected to cause a significant increase in the current RCS temperature of 85°F; however, the RCS temperature will be monitored in accordance with the Technical Specifications and the Recovery Operations Plan.

The conclusions of Reference 8 with respect to decay heat removal are applicable throughout early defueling activities and the loss-to-ambient mode will adequately dissipate the small amount of decay heat generated.

Heavy Load Handling

The handling of heavy loads during early defueling activities are addressed by GPU in two SER's: the SER for handling of heavy loads over the reactor vessel, and the SER for handling of heavy loads inside containment (References 11 and 12). In the staff's safety evaluation for heavy load handling over the reactor vessel (Reference 13), the worst-case accident identified for all loads anticipated to be lifted over the vessel through completion of defueling, was the postulated drop of the plenum assembly (PA). For this bounding case, it was postulated that a drop of the PA would cause the simultaneous failure of all 52 incore instrumentation tubes resulting in a total RCS leakage rate of 20 gpm. As described in Reference 8, the staff concludes that reliable sources of borated makeup water will be available to substantially exceed the worst case RCS leakage rate and that adequate leak detection capability is provided. GPU also performed a bounding analysis to calculate offsite doses due to an instantaneous release of all unaccounted for Kr-85 resulting from a load drop. That conservative analysis yielded offsite doses several orders of magnitude below the accident limits specified in 10 CFR Part 100. In addition, the licensee has developed a lift height/weight matrix to control the lifting of defueling equipment so that a load drop will not cause the defueling platform to collapse. As specified in Reference 13, the licensee must analyze alternative load paths in determining that the best pathway for movement of a heavy load is over the vessel. On the bases of our evaluations provided in References 8 and 13, we conclude that the licensee has met the requirements of NUREG-0612 and has implemented adequate measures to prevent a heavy load drop over the reactor vessel and to mitigate the consequences of a potential load drop accident over the vessel during early defueling activities.

The movement of heavy loads in other parts of the reactor building and in the fuel handling building is addressed in GPUN's SER for heavy load handling inside containment, currently under staff review. The movement of heavy loads over loaded defueling canisters will require NRC approval of that SER.

Hydrogen Control

During in-vessel early defueling activities, including dewatering of canisters, any hydrogen or other gases generated or released will collect in the air space below the defueling work platform. The defueling off-gas system will be operated as needed to create an airflow through the work platform, into the IIF enclosure, where the air will mix with collected gases, and out to the reactor building after passing through a filtration unit. Operation of the off-gas system will dilute any accumulated hydrogen gas, preventing a combustible concentration from being reached. Provisions for controlling hydrogen gas buildup in loaded defueling canisters are addressed in detail in References 2 and 3. Each type of canister is designed with catalytic recombiners to limit the concentration of hydrogen gas in order to prevent combustion or canister overpressurization. Dewatering of canisters is necessary to expose sufficient catalyst for recombination to be effective. Loaded defueling canisters will be provided with two relief valves, with setpoints at 25 psig and 150 psig, in preparation for their removal and storage. If the canisters are not dewatered prior to transfer to the FHB, the radiolytic decomposition of water will result in the generation of hydrogen and oxygen; however, the relief valves will open to prevent canister over-pressurization. Except for a brief time during transfer, the canisters will be under water, thus the opening of the relief valves would release small quantities of combustible gas to the water in the spent fuel pool or the FTC. These small quantities of gas will be diluted by the large volumes of air in the reactor building and FHB and therefore will not reach a combustible concentration. In Reference 3, the staff concluded that the design of defueling canisters is acceptable for the control of combustible gases. The staff also concluded that the consequences of an unlikely combustion event inside a canister or in the CTS during canister transfer will not pose an unacceptable risk. Therefore, we conclude that acceptable methods of combustible gas control will exist during early defueling activities.

Fire Protection

Fire protection during early defueling activities will be provided in accordance with the current TMI-2 fire protection program and associated procedures for control of combustible materials. Fire extinguishers and detection equipment will be available in the reactor building to mitigate the consequences of a potential fire. It is not anticipated that defueling operations will significantly increase the potential for a fire.

Pyrophoricity

Based on tests conducted on core debris samples and the experience of earlier cleanup activities, the staff concluded in previous safety evaluations that the potential for submerged core debris to sustain a pyrophoric reaction was extremely remote. During early defueling activities, core debris collected in canisters could be exposed to gases following dewatering. Argon, an inert gas, will be used in the dewatering process to purge excess water and act as a cover gas in the canister. Some hydrogen and oxygen is likely to be generated in canisters due to radiolytic decomposition of water. Despite the fact that some debris may be exposed to oxygen, the potential for a pyrophoric reaction is still very small for the following reasons: significant quantities of potentially pyrophoric material (zirconium hydride) are not postulated to exist in sizes small enough to spontaneously ignite (10 microns); unoxidized surfaces must be newly exposed to an oxygen environment to undergo a pyrophoric reaction and any new surfaces exposed in the course of defueling will be in contact with water, thus oxidizing before canister dewatering occurs; and the rate of oxidation must exceed the heat transfer rate of the material for ignition to occur. We conclude that the potential for a pyrophoric event during early defueling activities is extremely unlikely. If a pyrophoric event were to occur in a canister, there is a high probability that the canister will be submerged, providing additional protection against the consequences of such an event.

Occupational Exposure

In Supplement 1 to the PEIS (NUREG-0683, Supplement No. 1 drafted in December 1983, final published in October 1984), the staff estimated that under the current cleanup plan, Reactor Disassembly and Defueling could result in 2,600 to 15,000 person-rem. Although not separately listed, defueling activities alone would account for over half of the estimated occupational exposure. Since 1983, the licensee has made substantial progress through the Dose Reduction Program to reduce the radiation levels in the reactor building, especially in areas where defueling workers will spend most of their time. For example, the present dose rate at the defueling platform is less than 10 mrem/hr. The licensee has a continuing program to further reduce the ambient dose rate in the reactor building and the staff expects that while defueling is in progress, the background radiation levels will continue to decrease. Considering this improvement, along with the ALARA program the licensee will implement during defueling, the staff now estimates that the occupational dose resulting from defueling operations is likely to be close to or fall below the lower range estimated in the PEIS Supplement 1.

Along with the Dose Reduction Program to reduce ambient dose rate levels, the licensee has a program to maintain dose rates ALARA during defueling. This ALARA program is to be achieved through design features, operator training and operating procedures.

Except during the transfer of loaded canisters from the reactor vessel to the fuel transfer canal (FTC), the fuel and debris will be shielded by submergence under water. Dose to defueling workers would mainly result from Cs-137 activity in the water. This activity, currently at about 0.05 uCi/ml, will be kept low by processing through the DWCS/SDS systems. Additional shielding for workers at the defueling platform will be provided by the shield plates in the shielded work platform (SWP) and the closure heads of loaded canisters. Other design features provide shielding during the transfer of loaded canisters to the FTC. Examples of these are the shield boot under the SWP, the canister transfer shield with an extendable shield collar, and the shielded canister handling bridges in the reactor and fuel buildings.

The licensee has a full scale mockup outside of the reactor building, the Defueling Test Assembly (DTA), to provide training for every defueling worker. For each defueling tool, a duplicate is available at the DTA and the use of all defueling tools is practiced at the DTA. Through this training, where actual in-vessel situations are simulated, the operators will be able to perform the defueling manipulations more efficiently, resulting in reduced radiation exposure.

Operating procedures for defueling incorporate considerations to promote the ALARA concept. For example, procedures preclude the raising of fuel debris outside of the four foot water coverage zone unless Radiological Controls personnel have appropriately monitored the situation to determine that such action is ALARA. Procedures also require the flushing of debris from defueling tools as they are withdrawn from the vessel to prevent the spread of contamination. More importantly, the operating procedures were developed, in part, based on the experience of defueling tools operations at the DTA. This feedback promotes efficiency and shortens overall stay times in the radiation area.

Based on the review of the above ALARA considerations, the staff concludes that the licensee has an acceptable program to maintain the collective defueling occupational dose ALARA and that the occupational dose incurred during early defueling should be within or below the range discussed in the staff's PEIS Supplement 1. Average dose rates at the defueling work platform are expected to be relatively low (approximately 15-25 mrem/hr).

The staff has reviewed the radiation monitoring system that will be in place during defueling. The staff has determined that this system will provide adequate data and appropriate alarms should radiation levels be significantly higher than those expected. The staff has calculated radiation levels at worker occupied areas during unplanned events and/or accident circumstances (e.g., raising of the fuel debris above the normal four feet of water coverage, canister drop over the work platform). The staff has determined that the radiation monitoring system and the continuous monitoring by the Radiation Controls personnel should enable the workers to properly respond to those situations and that the estimated radiation levels are such that the workers will be able to exit the reactor building without endangering their health and safety.

Release of Radioactivity

Reference 1 describes the potential for radionuclide release to the reactor building atmosphere, the FHB atmosphere, and to the environment for normal and accident conditions during early defueling activities. Potential releases to the environment would be in the form of gaseous effluents as early defueling activities will not create pathways for liquid effluents. All gaseous release pathways to the environment from the reactor building and the FHB will be filtered and monitored and building ventilation controls will be maintained in accordance with the Technical Specifications.

During in-vessel defueling activities, defueling canisters, tools, and other equipment will be flushed as they are removed from the water to prevent the spread of radioactive contamination. The off-gas system will be operated to filter particulates and to disperse radioactive gases that may collect under the defueling platform. The DWCS will be operated as needed to limit particulate and ionic activity in the RCS, spent fuel pool "A" and FTC water. The filter systems in the reactor building and fuel handling building will prevent a significant release of particulate activity to the environment. New sources of tritium will not be produced by defueling activities, but a slight increase in tritium concentrations in the reactor building and in tritium releases to the environment may result from an increased evaporation rate. These slight increases will not cause a significant increase in radiation doses to workers or the public. GPUN has estimated the offsite dose contribution due to a postulated release of Kr-85 during normal defueling activities. The calculated doses are several orders of magnitude below the dose limits required by the Technical Specifications. GPUN also analyzed potential offsite doses for two bounding accident scenarios; the instantaneous release of all unaccounted for Kr-85 from the reactor vessel, and a canister drop accident where the entire canister contents are spilled on the dry canal floor. The instantaneous release of all unaccounted for Kr-85 (31,300 Ci) was discussed earlier in this evaluation and in previous safety evaluations. The resulting offsite doses to the whole body are less than 1% of the accident dose guidelines of 10 CFR Part 100. The canister drop accident also yielded offsite doses well below the guidelines of 10 CFR Part 100. In addition, the likelihood of a canister drop accident is extremely small for the following reasons:

1) When a canister is transported over the dry portion of the FTC, it will be held in place by the CHB grapple and by redundant canister retention mechanisms on the bottom of the CTS. The possibility of failure of both supporting mechanisms is remote.

2) The design of the canister transfer shield, the canister itself, and the lift height involved make it unlikely that a postulated drop would result in both the failure of the canister pressure boundary and the entire contents of a canister being spilled onto the canal floor.

However, this postulated accident represents the worst-case since other postulated canister drops would occur over water and the consequences would be less severe. Based on our review, we conclude that: adequate methods will be implemented to minimize the release of radioactivity during normal early defueling activities; the likelihood of potential accidents will be low; and the offsite radiological consequences of postulated accidents will be within the guidelines specified in 10 CFR Part 100.

10 CFR 50.59 Evaluation

In Reference 1, the licensee concluded that the proposed early defueling activities do not constitute an unreviewed safety question, nor do they involve changes to the plant technical specifications. This evaluation is based on the comparability of the proposed defueling activities and activities analyzed in the TMI-2 FSAR. The worst-case accidents analyzed in Reference 1; a canister drop on the dry FTC and the release of the entire inventory of Kr-85, are compared to a fuel handling accident and the rupture of a waste gas decay tank, as analyzed in the FSAR. The dose consequences for both of the postulated defueling accidents are less severe than those for the corresponding accident analyzed in the FSAR. In addition, the current condition of the TMI-2 core and its associated fission product inventory reduces the consequences of most postulated accidents in comparison to those postulated for operating reactors. The RCS is highly borated and protected against dilution to prevent recriticality of the fuel, radioactive source terms are reduced, decay heat is so low that only passive heat removal is necessary, and the RCS is depressurized.

Based on our review of the licensee's evaluation, we conclude that the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety (ITS) as previously evaluated in the FSAR will not be increased. The proposed activities also do not create the possibility for an accident or malfunction of a different type than any evaluated previously. The consequences of the postulated worst-case defueling accidents were shown to be bounded by accidents analyzed in the FSAR. The special design of defueling equipment and systems and extensive worker training will tend to decrease the probability of an accident or malfunction of ITS equipment. Also, no margins of safety will be reduced as defined in the basis for any technical specification as a result of defueling activities.

Conclusions

In our review of the proposed early defueling activities, we have considered health and safety issues including criticality, boron dilution, decay heat removal, pyrophoricity, hydrogen control, heavy load handling, fire protection, releases of radioactivity and occupational exposure. We also considered whether the proposed activities constituted an unreviewed safety question per 10 CFR 50.59. Based on our review, we find that; 1) there is little potential for core recriticality due to fuel reconfiguration or a boron dilution event, and that the design of defueling canisters provides adequate assurance that loaded fuel will remain subcritical with a substantial shutdown margin for all postulated canister conditions; 2) "loss-to-ambient" cooling of the RCS will provide adequate decay heat removal; 3) there is little potential for a pyrophoric reaction; 4) adequate methods of combustible gas control are provided through defueling canister design and dewatering and off-gas system operation; 5) appropriate measures for the handling of heavy loads have been implemented to minimize the probability and consequences of postulated accidents; 6) existing fire protection measures are acceptable; 7) there is little potential for a release of radioactivity significantly greater than the trace amounts which have been typically discharged throughout the cleanup; 8) there is little potential for worker overexposure and GPU has implemented a program to maintain occupational exposures ALARA; and 9) early defueling activities do not constitute an unreviewed safety question. We also find that the proposed activities fall within the scope of those analyzed in the PEIS. We, therefore, conclude that the proposed early defueling activities can be safely conducted with minimal risk to the health and safety of the onsite workforce and offsite public. As described in this evaluation, our review of early defueling activities is based in part on concurrent staff reviews of defueling-related equipment, systems, and analyses. Our approval of early defueling activities incorporates any conditions or restrictions imposed by the staff in the supporting safety evaluations.

<u>References</u>

1. Early Defueling Safety Evaluation Report - Revision 4, October 10, 1985 (GPUN)

2. Defueling Canister Technical Evaluation Report, September 10, 1985 (GPUN)

3. Defueling Canister Safety Evaluation, November 5, 1985 (NRC)

4. Fuel Canister Storage Rack Technical Evaluation Report, February 27, 1985 (GPUN)

5. Fuel Canister Storage Rack Safety Evaluation Report, May 3, 1985 (NRC)

6. Defueling Water Cleanup System Technical Evaluation Report - Revision 7, October 1985 (GPUN)

7. Defueling Water Cleanup System Safety Evaluation, November 1985 (NRC)

8. Preliminary Defueling Activities Safety Evaluation, October 29, 1985 (NRC)

9. Reactor Coolant System Criticality Report Evaluation, March 15, 1985 (NRC)

10. Boron Dilution Hazards Analysis - Revision 2, September 1985 (GPUN)

11. Safety Evaluation Report for Heavy Load Handling Inside Containment, September 11, 1985 (GPUN)

12. Safety Evaluation Report for Heavy Load Handling Over the TMI-2 Reactor Vessel, April 19, 1985 (GPUN)

13. Safety Evaluation for Heavy Load Handling Over the Reactor Vessel, May 2, 1985 (NRC)

TMI-2 SERVICE LIST

Dr. Thomas Murley
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

John F. Wolfe, Esq., Chairman,
Administrative Judge
3409 Shepherd St.
Chevy Chase, MD. 20015

Dr. Oscar H. Paris
Administrative Judge
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dr. Frederick H. Shon
Administrative Judge
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Karin W. Carter
Assistant Attorney General
505 Executive House
P.O. Box 2357
Harrisburg, PA 17120

Dr. Judith H. Johnsrud
Environmental Coalition on
Nuclear Power
433 Orlando Ave.
State College, PA 16801

George F. Trowbridge, Esq.
Shaw, Pittman, Potts and
Trowbridge
1800 M. St., NW.
Washington, D.C. 20036

Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Atomic Safety and Licensing Appeal Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Secretary
U.S. Nuclear Regulatory Commission
ATTN: Chief, Docketing & Service Branch
Washington, D.C. 20555

Mr. Larry Hochendoner
Dauphin County Commissioner
P.O. Box 1295
Harrisburg, PA 17108-1295

John E. Minnich, Chairperson,
Dauphin County Board of Commissioners
Dauphin County Courthouse
Front and Market Streets
Harrisburg, PA 17101

Dauphin County Office of Emergency
Preparedness
Court House, Room 7
Front & Market Streets
Harrisburg, PA 17101

U.S. Environmental Protection Agency
Region III Office
ATTN: EIS Coordinator
Curtis Building (Sixth Floor)
6th & Walnut Streets
Philadelphia, PA 19106

Thomas M. Gerusky, Director
Bureau of Radiation Protection
Department of Environmental Resources
P.O. Box 2063
Harrisburg, PA 17120

Dan Kennedy
Office of Environmental Planning
Department of Environmental Resources
P.O. Box 2063
Harrisburg, PA 17120

Willis Bixby, Site Manager
U.S. Department of Energy
P.O. Box 88
Middletown, PA 17057-0311

David J. McGoff
Division of Three Mile Island Programs
NE-23
U.S. Department of Energy
Washington, D.C. 20545

William Lochstet
104 Davey Laboratory
Pennsylvania State University
University Park, PA 16802

Randy Myers, Editorial
The Patriot
812 Market St.
Harrisburg, PA 17105

Robert B. Borsum
Babcock & Wilcox
Nuclear Power Generation Division
Suite 220
7910 Woodmount Ave.
Bethesda, MD. 20814

Michael Churchhill, Esq.
PILCOP
1315 Walnut St., Suite 1632
Philadelphia, PA 19107

Linda W. Little
5000 Hermitage DR.
Raleigh,NC 27612

Marvin I. Lewis
6504 Bradford Terrace
Philadelphia, PA 19149

Jane Lee
183 Valley Rd.
Etters,PA 17319

J.B. Liberman, Esquire
Berlack,Israels, Liberman
26 Broadway
New York, NY 10004

Walter W. Cohen, Consumer Advocate
Department of Justice
Strawberry Square, 14th Floor
Harrisburg, PA 17127

Edward O. Swartz
Board of Supervisors
Londonderry Township
RFD #1 Geyers Church Rd.
Middletown, PA 17057

Robert L. Knupp, Esquire
Assistant Solicitor
Knupp and Andrews
P.O. Box P
407 N. Front St.
Harrisburg, PA 17108

John Levin, Esquire
Pennsylvania Public Utilities Comm.
P.O. Box 3265
Harrisburg, PA 17120

Mr. Edwin Kintner
Executive Vice President
General Public Utilities Nuclear Corp.
100 Interpace Parkway
Parsippany, NJ 07054

Ad Crable
Lancaster New Era
8 West King Street
Lancaster, PA 17603