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July 24, 1986
NRC/TMI-86-072

Docket No. 50-320

F. R. Standerfer
Vice President/Director, TMI-2
GPU Nuclear Corporation
P. O. Box 480
Middletown, PA 17057

Dear Mr. Standerfer:

Subject: Commencement of Bulk Defueling Activities

References: 1. Letter dated May 15, 1986 from F. R. Standerfer, GPUN to W. D. Travers, NRC, "GPU Defueling Safety Evaluation Revision 10."

2. Letter dated July 23, 1986 from F. R. Standerfer, GPUN to W. D. Travers, NRC, "Use of Core Stratification Sample Acquisition Tool for Defueling."

By letter dated May 15, 1986, (Reference 1 above) General Public Utilities Nuclear Corporation (GPUNC) requested NRC approval of Revision 10 to the Defueling Safety Evaluation (SER). The revision modifies the Early Defueling SER to address those defueling activities necessary for removal of the remaining fuel and structural debris located in the original core volume and in other regions of the reactor vessel. The purpose of this letter is to issue our approval for the commencement of bulk defueling operations limited to the core region, (i.e., above the grid support structure) while we complete our review of the full scope of defueling activities proposed in the referenced SER.

Based on our review, we conclude that the tools, equipment, and operations previously approved for use in conjunction with early defueling activities are acceptable for continued use in bulk defueling. In addition, we approve the use of equipment and the conduct of activities as proposed in Reference 1, with the exceptions and limitations stated herein.

As stated in Reference 1 and amplified by Reference 2, you propose to use the existing core boring equipment for defueling purposes. The use of this equipment has been approved by the NRC staff for sample acquisition in the core region and in several locations of the lower vessel head. It is our understanding that your intended use of this equipment as a defueling tool will involve the use of a solid face drill bit as opposed to the hollow bit



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used in the earlier sampling application. We further understand that you intend to make several perforations in the hard crust layer of the damaged core, so that other defueling tools can be more effectively used in breaking up and removing the remaining core debris. We approve the use of the core bore equipment for defueling subject to the following restrictions: 1) the maximum allowable drill depth will be limited to the top of the lower grid support structure; 2) the drill bit will be continuously cooled with flush water during drilling; and 3) the location of drilling will be procedurally controlled to prevent the direct application of the drill on an incore instrumentation string, unless the string and supporting guide tube have been cut. The control of drilling boundaries will utilize the theodolite system as described in the core stratification sampling SER unless an alternate system is subsequently approved by the NRC. These restrictions are discussed in the enclosed safety evaluation. Approval for defueling activities below the lower grid support structure is expressly omitted at this time.

As stated in our enclosed safety evaluation, we conclude that the defueling activities described in References 1 and 2, except as noted above, can be conducted without significant risk to the health and safety of the public. We further conclude that the approved activities fall within the scope of activities considered in the staff's Programmatic Environmental Impact Statement for the Cleanup of TMI-2, and that these activities do not constitute an unreviewed safety question per 10 CFR 50.59. The approved core region defueling activities may commence upon our approval of the related procedures in accordance with Technical Specifications 6.8.2.

Sincerely,

ORIGINAL SIGNED BY
William D. Travers

William D. Travers
Director
TMI-2 Cleanup Project Directorate

Enclosures: As stated

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## SAFETY EVALUATION FOR TMI-2 CORE REGION

## BULK DEFUELING ACTIVITIES

### INTRODUCTION

By letter dated May 15, 1986, GPU Nuclear Corporation (GPUNC) requested NRC approval of Revision 10 to the Defueling Safety Evaluation Report (SER) (Reference 1). Additional information regarding the use of the core boring equipment was provided by GPUNC on July 23, 1986 (Reference 5). This evaluation addresses those defueling activities proposed in References 1 and 5 that are restricted to the core region and the area down to the lower grid forging. The remaining activities proposed in Reference 1, such as core support assembly and lower head defueling, will be addressed in a subsequent NRC safety evaluation.

### SAFETY ISSUES

The safety issues associated with the proposed core region bulk defueling activities are similar to those analyzed for early defueling activities, and the potential consequences of bulk defueling activities are bounded by previously evaluated activities. This safety evaluation references previous NRC approvals as appropriate and analyzes the unique aspects of core region defueling, as proposed in References 1 and 5.

### CRITICALITY

The potential for a recriticality event during defueling activities is effectively minimized by maintaining a high boron concentration in the Reactor Coolant System (RCS). In the NRC Safety Evaluation for Early Defueling (Reference 2), the staff referenced an earlier conclusion that, 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. Additional margin exists since GPU will administratively maintain the actual RCS boron concentration at 4950 ppm. Experience in defueling efforts to date has also demonstrated the effectiveness of this approach to maintaining subcriticality.

In Reference 2, the staff also concluded that sufficient margin existed to maintain subcriticality in case of the inadvertent introduction of foreign materials into the RCS. The tools and equipment to be used for bulk defueling have been analyzed to ensure that a one percent shutdown margin will exist for all credible events. We therefore conclude that appropriate means are being employed to assure adequate margins exist to minimize the potential for recriticality of the remaining fuel in the TMI-2 reactor vessel.

Canister handling and storage procedures will not differ significantly from those currently in use; therefore, the conclusions of Reference 2 also apply to core region bulk defueling activities, i.e., the potential for a



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criticality event in the handling and storage of defueling canisters is acceptably low.

BORON DILUTION

In Reference 2, the staff concluded that GPU had implemented acceptable controls to minimize the potential for a boron dilution event and to effectively mitigate the consequences of such an event during early defueling. These controls, which will remain in effect during bulk defueling, include the use of multiple barriers to isolate potential dilution sources and the boration of the hydraulic fluid used in defueling equipment. Additional potential sources of boron dilution during core region defueling that were not evaluated for early defueling activities are the hydraulic systems for the core bore equipment and the ultrahigh pressure decontamination water. In the NRC safety evaluation for Core Stratification Sample Acquisition (Reference 3), the staff concluded that the two unborated hydraulic fluids used with the core bore equipment did not present a credible source for a dilution event resulting in advertent criticality of the core. This conclusion was based on the following: 1) the sources were of small volume (1.4 and 27 gallons), compared to the large volume of borated RCS water above the core region (20,000 gallons); 2) the fluids would tend to mix well with the borated RCS water; and 3) the fluids would be introduced near the surface of the RCS water, away from the core. This conclusion also applies to the use of the core bore equipment for defueling purposes.

In Reference 1, GPU describes the physical and administrative controls that will be in place to prevent a boron dilution event resulting from improper alignment of the ultrahigh pressure pump. This pump is used with a borated water supply when in-vessel abrasive/water jet cutting is performed. When used for reactor building decontamination, the pump is supplied with unborated (or under borated) water. Consequently, GPU has adopted procedures to prevent the inadvertent introduction of this water into the RCS. The two separate supply hoses are permanently coupled to their respective nozzles, with a common mating fixture attached to the pump. The set of hoses used for decontamination will be permanently tagged with a warning to personnel not to use those hoses for in-vessel operations. Procedures will require verification of proper hose alignment prior to use of the ultrahigh pressure pump.

Following the use of this pump in the decontamination mode, approximately 5 gallons of unborated water could remain in the system and could be injected into the RCS when the pump is used in the in-vessel cutting mode. Administrative controls will require that the discharge from the in-vessel cutting nozzle be directed upward, away from the core and other system suction lines for a minimum of five minutes following the use of the pump in the decontamination mode. Additionally, the RCS boron concentration will be verified to be at or above 4950 ppm prior to use of the pump in this manner.

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We conclude that, with these precautions, the potential for boron dilution due to the introduction of unborated water used with the ultrahigh pressure pump is acceptably low. Therefore, we further conclude that the potential for a boron dilution event resulting in core recriticality during core region defueling activities is acceptably low.

RELEASE OF RADIOACTIVITY

Although the proposed core region defueling activities will involve the displacement of core debris to a greater extent than early defueling activities, it is not expected that significant increases in reactor building radiation levels or in off-site releases will result, based on previous defueling experience. The systems equipment and procedures used to minimize the potential for, and consequences of, a release of radiation during early defueling activities will continue to be used during bulk defueling. All gaseous release pathways to the environment will be monitored and filtered, and all reactor building exhaust points can be isolated as needed. Monitoring for Kr-85 and alpha-emitting particulates will be conducted. The off-gas system will be operated, as necessary, to filter particulates and disperse gases that may collect under the defueling work platform (DWP). All equipment and tools will be flushed upon removal from the reactor vessel to limit the spread of contamination. A water cleanup system will be operated to maintain the RCS at an acceptable activity level. The analyses approved in Reference 2 for potential releases of radiation during normal and accident conditions are also bounding for any release scenario associated with bulk defueling. We therefore conclude that potential releases of radioactivity within the reactor building or to the environment as a result of bulk defueling activities will be maintained at acceptable levels in compliance with applicable regulatory limits.

PYROPHORICITY

Bulk defueling activities will include considerable sizing and cutting operations, resulting in the creation of smaller particles of core debris, including zirconium compounds. Despite the generation of more finely divided particles, the potential for a pyrophoric reaction remains very low. During pilot ignition tests conducted on debris samples and previous defueling operations, no pyrophoric characteristics were observed. Although smaller particles are expected to be created, the increase in the volume of particles in the range of concern, below 50 microns, is not expected to be great. Bulk defueling activities will be conducted underwater; as discussed in Reference 2 and 3, this condition effectively prevents pyrophoric events even if finely divided zirconium compounds are present. In Reference 2, the staff also concluded that the potential for a pyrophoric event in a filled, dewatered, defueling canister was acceptably low. Canister loading, handling and storage will be conducted in a similar manner during bulk defueling, therefore, our previous conclusion is applicable. In Reference 3, the staff concluded that the use of the core bore drill would not present an unacceptable potential for

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a pyrophoric event, provided the drill bit is continuously flushed to rapidly remove the heat generated by drilling. The drill unit is designed to shutdown upon loss of flush water; therefore, removal of the frictional heat generated by drilling is assured. We conclude that the potential for a pyrophoric event is acceptably low for the proposed core region defueling activities.

OCCUPATIONAL EXPOSURE

In Reference 2, the staff approved the licensee's program for maintaining radiation exposures to workers as low as reasonably achievable (ALARA). This comprehensive program will continue to be implemented through defueling activities. This program limits occupational exposure through decontamination of work areas, design of defueling equipment, training of defueling workers, and development of appropriate operating procedures. Due to earlier decontamination activities in the reactor building, measured dose rates in work areas are currently at or below the licensee's target levels for early defueling.

Bulk defueling tools are designed to be compatible with existing tooling (e.g. hydraulic systems, long-handled tool extensions) which permits defueling activities at a safe distance from the core debris. Radiation shielding for defueling workers is provided by the water in the reactor vessel and by the lead shield plates on the DWP. The design of the defueling canisters and handling equipment provides additional shielding when the canisters are transferred in air between the vessel and spent fuel pool "A".

The level of activity in the RCS is controlled to limit its contribution to area dose rates. The Defueling Test Assembly (DTA), a full-scale mock-up of the reactor vessel and DWP is used to train defueling workers in the use of new tools and procedures, thereby reducing time spent in radiation areas and limiting exposure. As defueling continues, existing procedures will be revised or new procedures developed as needed to maintain exposures ALARA.

Defueling experience to date has demonstrated the effectiveness of the licensee's ALARA program in minimizing occupational exposure. In Reference 1, the licensee reported that 213 person-rems of radiation exposure had been incurred from defueling activities through March 31, 1985. The licensee currently estimates that an additional 1200 person-rems will be incurred through the completion of defueling operations. Although measured dose rates are generally lower than predicted, the licensee's revised exposure estimate of approximately 1400 person-rem for defueling activities is higher than earlier estimates due to an increased estimate of job hours required for completion of defueling. This increase is based on a more accurate assessment of the remaining activities and the time required for performing those activities. As discussed in Supplement 1 to NUREG-0683, the Programmatic Environmental Impact Statement (PEIS) for TMI-2 cleanup, the staff estimated that reactor disassembly and defueling activities would result in a total exposure of 2600 to 15,000 person-rem, over half of which would occur from

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defueling activities alone. Therefore, the licensee's revised estimate, based on the most recent defueling experience, still falls at the lower end of the range of the staff's estimate. Based on our earlier conclusion in Reference 2 and on the effectiveness of the licensee's ALARA program as evidenced by defueling experience to date, we conclude that the licensee has established an acceptable program for maintaining worker exposures ALARA during bulk defueling activities.

REACTOR VESSEL INTEGRITY

The use of the core boring equipment for core region defueling creates a potential for imparting loads to the incore instrumentation nozzles that could result in weld failure and an unisolable leak of RCS water. In previous approvals for the use of this equipment in core sampling applications, the staff imposed appropriate limitations to minimize the potential for failure of the incore nozzle welds.

Reference 1, the licensee states that a solid face drill bit will be used with the core boring equipment for defueling. Such use is clarified in Reference 5, which details the technique and restrictions to be applied. The general protocol for core boring was previously addressed in Reference 4. Reference 5 restricts core drilling operations to non-instrumented fuel assemblies to a depth above the lower grid support structure. We conclude that core bore defueling activities can be safely conducted in the core region, subject to the following restrictions. 1) The maximum allowable drill depth will be limited to the top of the lower grid support structure. Such depth will be sufficient for core region defueling and will provide assurance that significant loads will not be imparted to the incore nozzles and welds. 2) The drilling locations will be procedurally controlled to prevent the direct application of the drill to existing incore instrument stings, unless that string and supporting guide tube are verified to have been cut. Such location control will rely on the theodolite system as described in Reference 5, unless an alternative method is approved by the NRC.

These precautions reduce the potential for unisolable RCS leakage due to failure of an incore weld resulting from the proposed core bore defueling activities. In the unlikely event of such leakage, the licensee has provided equipment and developed procedures to quickly identify the leak and establish sufficient makeup or recirculation of borated water to the RCS to maintain subcriticality of the core.

OTHER SAFETY ISSUES

Other safety issues, specifically heavy load handling, decay heat removal, hydrogen control, and fire protection have been addressed in earlier NRC safety evaluations. The proposed core region defueling activities do not present an increase in the likelihood or consequences of potential accidents beyond the bounds of those analyzed in References 2 and 3 for these issues.

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CONCLUSIONS

Our review of the licensee's Defueling Safety Evaluation Report - Revision 10 (Reference 1) and the licensee's supplemental information (Reference 5) has been limited to those activities to be conducted in the core region, i.e., above the lower grid support structure. The remaining activities addressed in Reference 1, including debris removal from the CSA and lower vessel head regions are currently under staff review and will be the subject of a separate safety evaluation.

In our review of the proposed core region defueling activities, we have evaluated the safety issues of criticality, boron dilution, release of radioactivity, pyrophoricity, occupational exposure, and reactor vessel integrity. We have determined that the safety considerations of heavy load handling, decay heat removal, hydrogen control, and fire protection have been adequately addressed in previous NRC safety evaluations, and that our earlier conclusions are applicable to the proposed activities. Based on our review, we find that; 1) acceptable precautions are in place to assure that a sufficient margin will be maintained to prevent recriticality due to fuel reconfiguration or boron dilution; 2) potential releases of radioactivity to the reactor building and to the environment during normal or postulated accident conditions will not pose a significant risk to the work force or public; 3) radiation exposure to workers will be maintained ALARA; 4) there is little potential for a pyrophoric event; and 5) the restrictions imposed on the use of the core bore equipment for defueling in the core region provide adequate assurance that the likelihood of unisolable RCS leakage resulting from an incore instrument nozzle weld failure will be minimized, and that adequate borated RCS makeup sources are available if needed. We also find that, 1) the proposed activities fall within the scope of those analyzed in the PEIS, and 2) these activities do not constitute an unreviewed safety question per 10 CFR 50.59. Therefore, we conclude that the proposed core region defueling activities, subject to the limitations stated herein, can be safely conducted with minimal risk to the health and safety of the onsite work force and off-site public.

REFERENCES

1. GPU Defueling Safety Evaluation Report, Revision 10, May 15, 1986.

2. NRC Safety Evaluation for Early Defueling, November 12, 1985.

3. NRC Safety Evaluation for Core Stratification Sample Acquisition, May 5, 1986.

4. GPU Safety Evaluation Report for Core Stratification Sample Acquisition, Revision 3, December 31, 1985.

5. Letter dated July 23, 1986 from F. R. Standerfer, GPUN to W. D. Travers, NRC, "Use of Core Stratification Sample Acquisition Tool For Defueling."

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