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August 30, 1985

TMI Program Office
Attn: Dr. B. J. Snyder
Program Director
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Safety Evaluation Report for Core Stratification Sample Aquisition

Attached for your review and approval is Revision 1 to the Safety Evaluation Report (SER) for Core Stratification Sample Acquisition activities. The SER addresses activities such as the installation, operation and removal of the core boring machine and the acquisition and removal of core samples. Also addressed is the insertion of a camera into the void region created by sample removal for the purpose of viewing the lower vessel regions. The SER concludes that the proposed activities can be performed without undue risk to the health and safety of the public.

Per the requirements of 10 CFR 170, an application fee of $150.00 is enclosed.

Sincerely,

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

FRS/RBS/eml

Attachment

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PDR ADOCK 05000320
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D009 1/1 w/check $150.00 #00017425

Enclosed: GPU Nuclear Check No. 00017425

cc: Deputy Program Director - TMI Program Office, Dr. W. D. Travers

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SER 15737-2-G07-109 REV. 1

ISSUE DATE

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TMI-2
DIVISION
SAFETY EVALUATION REPORT
FOR

Core Stratification Sample

Acquisition

COG ENG A.K. Boldt DATE 7/2/85

RTR D.S. Williams DATE 7/2/85

COG ENG MGR. C.L. R... for R.L. Rider DATE 7/3/85

NO	DATE	REVISIONS	BY	CHECKED	GROUP SUPERVISOR	MGR DESIGN ENGINEERING
1	8/16/85	Revised and Reissued for Use	RLR	DJL	EDS	AK for RLR
0	7/3/85	Issued for Use	DJL	RLR		KL for RLR
				CHIEF ENGINEER		

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EPD-33611 10/84

Rev.	SUMMARY OF CHANGE
0	Issued for Use
1	Revised to incorpo[illegible] comments on Revision 0 and correct minor typographical errors

SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV	SHEET	LATEST REV
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REVISION STATUS SHEET

BECHTEL

DOCUMENT TITLE: Safety Evaluation Report for Core Stratification Sample Acquisition

JOB 15737	REV.
SPEC. NO. 2-G07-109	1
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1.0 Introduction

1.1 Purpose

The purpose of this Safety Evaluation Report (SER) is to demonstrate that the activities associated with the acquisition of the core stratification samples can be accomplished without presenting any undue risk to the health and safety of the public.

1.2 Scope

The scope of this SER includes the activities associated with the installation, operation and removal of the core boring machine, acquisition of the core samples, the transfer of the samples from the machine to the defueling canisters (provided for other debris removal operations, Reference 2) and viewing the lower vessel region through the bored holes. These activities will be performed after the defueling work platform and canister positioning system have been installed. Early defueling activities are planned prior to core stratification sampling (core bore) activities but this is not a prerequisite.

1.3 Background

In order to determine the extent and distribution of the various damage phenomena of the TMI-2 reactor core, removal and examination of core samples are desirable. Evidence collected and analyses performed since the accident indicate that the reactor core damage includes cladding oxidation, fuel liquefication as a result of decay heat from fission products, control rod failure and relocation of control material, interaction of AgInCd and stainless steel materials with fuel and cladding, and fragmentation upon quenching (Ref. 8). The core samples will provide a basis for establishing a correlation between these phenomena and fission product release from the fuel and fission product retention in the core. The removal of the core samples will also provide information to determine the maximum temperature reached and material interactions.

Finally, the core drilling will be used to gain access to the space below the reactor core support plate for remote visual inspection.

1.4 Organization

Section 2.0 of this SER describes the major activities and equipment needed for the Core Stratification Sample Task. In addition this section addresses the core samples, drilling locations, core boring operation, and the failure modes and effects analysis (FMEA).

Section 3.0 describes the radiological considerations of the planned activities including an assessment of the expected external and internal occupational radiation exposure. It also describes shielding considerations and other steps taken to maintain the occupational exposure ALARA.

Section 4.0 addresses the safety concerns associated with the planned activities including a 10 CFR 50.59 evaluation.

Sections 5.0 and 6.0 contain the conclusion of this SER and references, respectively.

2.0 Description of Activities

The activities that must be conducted prior and subsequent to the core stratification sampling, as well as the actual core sample drilling and removal, are described in this section.

2.1 Support Activities

Extensive operational testing prior to actual operation will be conducted under simulated conditions to assure successful core sample acquisition. A "dummy" fuel assembly has been constructed for these tests to verify drilling capabilities in the fuel assembly structure.

Concurrent with this testing, TMI personnel will be trained in the operation of this equipment. This training may include conducting planned operational steps in respirators and anti-C clothing where needed to obtain accurate time estimates and operational constraint information in order to project a reasonable ALARA review. These training sessions will also be used to verify that the operating procedures will result in safe equipment operation.

All equipment necessary to obtain the core sample will be transported into the reactor building through personnel airlocks. The core drilling equipment, support structure and interface platform will be staged and transported into the reactor building on the 305' level. Final assembly and staging of equipment will take place on the 347' level prior to hoisting the assemblies into place on the Defueling Work Platform (DWP). The Defueling Water Cleanup System will be operational prior to and during the core stratification sampling.

2.2 Core Samples

Four or more core samples will be obtained, each with a maximum design length of 8 ft. There will be two types of samples. The first type will consist of one control rod and two or more fuel rods plus any loose debris that may be captured. The second type of core sample will be centered on a vacant instrument tube and will not contain a control rod but will be used to gain access to the lower grid assembly, flow distributor, and reactor bottom head to provide a pathway for remote visual (i.e., TV) examination of the area below the core.

2.3 Drilling Locations

Figure 2.3-1 shows the candidate reactor fuel assembly locations within the TMI-2 core. Figure 2.3-2 shows two candidate drilling locations within a fuel assembly. It is planned that drilling locations will be selected from reactor fuel positions K-9, D-4, D-12, or N-12 and/or other alternative locations with fuel bundles not containing instrumentation strings (Note: later core data or evaluations could change the locations from those given here). For viewing holes, the hole shall align with the corresponding existing access path through the lower grid assembly and flow distributor in a manner that ensures access for a 2.0 inch diameter cylindrical instrument (TV) viewing package.

2.4 Core Drilling Equipment Description

The following equipment will be used for the core drilling operation: the core drilling machine, core barrel and drill bit, drill indexing platform, core sample transfer cask, underwater support structure, underwater clamp assembly, flush water supply tank, inert gas purge equipment, sample storage basket assembly, drill unit instrumentation, and video inspection system. The configuration of most of this equipment is illustrated in Figures 2.4-1 and 2.4-2. These are briefly described below. Additional equipment details are provided in Reference 10.

a. Core Drilling Machine

The drill unit is a self-contained machine consisting of a hydrostatically driven spindle and hydraulically actuated feed cylinders. The spindle is equipped with a hydraulically actuated drill chuck in order to apply controlled rotational torque ranges and speed to the drill string. The cylinders are used to apply the downward force on the drill bit and to move the drill and casing strings into and out of the hole by moving the spindle vertically. The working fluid for this unit consists of approximately 27 gallons of HOUGHTO-SAFE 620.

The hydrostatic drive system is powered by a three phase, 480 volt electric motor which will be fed by a portable power center. The spindle is driven through a multi-speed gear system in order to provide the capability to change the speed and torque ranges to the spindle. The same electric motor will provide power to a hydraulic pump which in turn will provide power to the cylinders, the spindle chuck and to two separately mounted clamps used in handling the drill rod and casing strings. The drill unit is instrumented with a control system which will be capable of monitoring and controlling the drilling process.

The drill unit will be operated automatically but will include an override and controls for manual drilling and rod handling operating modes. Details of the operation modes are provided in Reference 10. Instrumentation will provide visual indication of rotational speed and torque on the drill string and the weight (force) applied to the drill bit. The drill unit will be equipped with a data acquisition system to record information on the material being drilled, such as rubble, solidified mass, standing fuel arrays and voids. Reference 10 describes the data acquisition system in more detail. The data interpretation will provide elevation and thickness information on the material penetrated with a goal of locating boundaries within $\pm$ 1.00 inch vertically.

The drill unit will be used as the support for a TV camera manipulator to view through the core bore hole.

The drill unit instrumentation will provide safety monitoring and control safe equipment shutdowns. The instrumentation also provides information on the drill unit stabilizing structure to alert the drill unit operator when the structure has moved excessively in the horizontal plane (side loading).

The drill unit instrumentation will provide input to a computer controller which will monitor the following parameters: revolution per minute (RPM), weight on drill bit, torque, depth (rate of penetration) and the water flow rate (drill bit coolant). Any deviation from pre-set value ranges will cause an automatic shutdown of the unit.

If the surface that the drill bit encounters is very hard and on a slope from horizontal, the drill bit may move sideways causing a side loading on the stabilizing platform. The drill unit Out-of-Tolerance Indicator will monitor the horizontal deflection and provide visual alarm indication to the drill unit operator.

There is no potential of drilling through the reactor lower head due to the physical limitation of the casing and drill bit lengths available to the operator i.e., limited rack space in the drill rod and casing rack on the defueling platform.

The core drill drive and feed equipment will be designed to mount on the Defueling Work Platform (DWP) via an interface platform. A mounting platform will be configured to permit the drill to access all of the primary and alternate target positions and will be equipped with anchoring devices to prevent dislocation of the drill once it has been positioned over a given target. The equipment will be designed to meet the load limits of the DWP.

Triangulation will be used to position the drill unit within $\pm$ 0.125" horizontally prior to drilling, and to orient the drill string parallel within $\pm$ 0.04 degrees with the reactor axis as determined from measurements of the plane of the reactor vessel flange. During drilling the drill bit drift will be limited to $\pm$ 0.5" at the lower core support grid elevation.

b. Core Barrel & Drill Bit

The drill core barrel function is to contain and protect the core sample, support the drill bit, transmit drilling forces, and channel flush water to the bit. A double tube core barrel will be used to permit the inner tube to remain stationary around the core sample while the outer tube rotates. A swivel mechanism built into the top of the core barrel allows flush water to be channeled to the drill bit which keeps it clean and cool. A series of flutes (channels) in the drill bit allows water to pass back to the reactor vessel as it is displaced by the core sample.

The overall length of the bottom section of drill pipe containing the core barrel will be limited to 132 inches in order for the core barrel to completely fit into the fuel canister.

The drill bit has a cast matrix crown with cutter inserts made of tungsten carbide with synthetic diamond bonded to it.

c. Drill Indexing Platform

The function of the drill indexing platform is to support the drill unit, transfer cask, and underwater structure, and to accommodate positioning of these components at the proper locations for drilling. The platform mounts to an interface platform which bolts to the rotating Defueling Work Platform above the reactor vessel.

The Defueling Work Platform rotates about the reactor centerline and will be used to position the drill indexing platform in the approximate circumferential location for drilling.

The drill indexing platform is designed to translate horizontally (index) in both circumferential and radial directions as required for accurate positioning. The platform has two roller platforms, one platform for the drill unit and underwater structure and one platform for the transfer cask. These two platforms can be moved radially independently of each other by means of hand-cranked rack and pinion gear mechanisms. The cask can also be moved circumferentially independently of the other components by translation on slide bearings by means of a hand-operated lead screw. This will be used when positioning the cask off-center above a fuel canister when lowering a core sample or used casing section into the fuel canister mounted on the canister positioning system.

Four hydraulic jacks will be used to lift the drill roller platform off its tracks and clamp it in position. These jacks are part of the hydraulic system which is electrically powered and contains approximately 2 gallons of HOUGHTO-SAFE 620 as the working fluid, mechanical devices are provided to back up these hydraulic devices which limits operating time.

The drill indexing platform structure has removable grating to allow for multiple positioning of the drill unit and has two operator access (wing) platforms with handrails.

d. Core Sample Transfer Cask

The transfer cask allows the core barrel to be moved over the fuel canister and then lowered into the canisters. The cask incorporates a water manifold to supply borated rinse water around the circumference of the casing or drill pipe for decontamination as they are withdrawn from the reactor. The source of the borated rinse water for the transfer cask is the Borated Water Storage Tank (BWST).

e. Underwater Support Structure

Tests determined that stabilization of the drill casing is required at about the 314' elevation. Therefore, a 25 ft. 3 in. long tubular girder underwater stabilizing structure will be employed. The upper end terminates in a plate which bolts to the tilting platform. A plate at the lower end contains a tapered funnel guide and a 4.69 in. hole for guiding and stabilizing the drill casing. A casing clamp is also required approximately 4 ft. 8 in. under the reactor water level to separate the casing and allow the cask with sample specimen to be moved to a position above the fuel canister. The underwater stabilizing structure satisfies both of these requirements.

The underwater structure and tilting platform assembly will be lowered in position through, and bolted to the top of the drill indexing roller platform by the reactor building service crane or the polar crane. Alignment of the drill unit and underwater structure will be accomplished by four jacks that can be adjusted to correct the drilling axis by use of a hydraulic system. The stabilizing structure will be aided in providing the rigidity and alignment necessary for accurate drilling by use of strain gages that will alarm when the drilling axis has deflected out of tolerance.

f. Underwater Clamp Assembly

The lower casing clamp consists of a pair of diametrically opposed serrated jaws and funnel guide located approximately 4 ft. 8 in. under the reactor water level and welded to the underwater structure. The clamp is hydraulically operated from a remote position located on the drill platform. Using a demineralized water medium, a hand pump actuates a double acting cylinder which forces the jaws either closed to hold the casing section while engaging (disengaging) the adjacent threaded joint or open to allow free operations of the drill string. A relief valve is used to prevent overpressurization of the system. A manually operated tool has been designed and will be available to insert into the reactor vessel and operate the clamp should the primary clamp fail.

g. Flush Water Supply

During drilling operations, borated water will be required for flushing drill fines and cooling the bit. Borated water will also be used to rinse the drill tube and casing during removal from the reactor. This water will be provided by a standard 0.5 to 5 gpm positive displacement pump. A diversion valve will be provided so that pump suction can draw borated water from the 11F, beneath the DWP. The pump suction will be taken from an area remote from potential sources of unborated moderators. This is the primary source of flush water. A secondary source is the 55-gallon flush water supply tank, which is used to rinse the swivel supply line prior to breaking its connection to the drill string. This tank will be filled from the BWST via the canal fill system with a verification sample taken after filling the tank.

h. Inert Gas Purge Equipment

In order to protect the core bore samples from oxygen, the transfer cask will be purged with inert gas to protect the core barrel and sample as they are removed from the reactor. This will be done by inserting a wand into the lowest section of drill tube containing the sample. As the water drains out of the drill pipe and core barrel, it will be replaced by the inert gas. After the last section of drill tube is removed from the top of the core barrel, a plug will be inserted into the top of the core barrel. The total amount of available inert gas will be limited to an amount less than could accumulate in the reactor area and cause a personnel hazard.

i. Sample Storage Basket Assembly

After the core sample is raised into the transfer cask, the sample will be transferred horizontally and lowered into a basket assembly which would be installed in a fuel canister. These canisters are on the underwater rotating carousel that will be used to position the basket below the transfer cask's path. The basket assembly is self draining and is presently designed to receive two core barrels with samples and two contaminated casing sections per fuel canister. The core barrels and casing sections are lowered into the fuel canister baskets by means of lifting plugs threaded into their top ends and attached by a stainless steel lanyard to an overhead bridge crane.

j. Drill Unit Instrumentation

The drill unit will be instrumented with a control system which will be capable of controlling the drilling process from control parameters experimentally determined by EG&G testing. The principle method of drilling control will be to program in a specific drill bit rpm and utilize the weight on the bit as a variable to control torque within a predetermined control band.

The automatic operation can be overridden to control the drill unit manually, if required. The equipment safe shutdown feature described in section 2.4a will override both the automatic and manual operation modes.

k. Video Inspection System

In order to inspect the lower reactor head region, two cameras with cabling, a camera manipulator, and video recording system will be used. The camera head is equipped with a 16 mm lens.

The camera manipulator assembly consists of a shaft to provide camera support, indexing, and rotation, a set of clamps to lock the shaft to the drill unit, a rotating head to provide radial scanning in 30 degree increments, a water connection to provide borated flushing water to clear the viewing area of floating particulate, and a camera indexing fixture to assure camera indexing to a specific reactor compass heading.

The video recording system consists of a 6 Mhz bandwidth video recorder, a video distribution system, a pair of video printers, and a video quantitizer.

2.5 Core Boring Operation

The core drilling equipment will be staged and assembled onto the DWP and prepared for operation. The locations of the core samples will be predetermined and the drill unit and rotating work platform will be positioned at the desired coordinates over the reactor core.

To complete the drill unit alignment over the sample location a targeting system will be used in conjunction with the theodolite indexing equipment (i.e., surveying instrument). The targeting device consists of an upper and lower alignment fixture connected by a long steel wire, or plumb line. The lower fixture on the plumb line is lowered into the casing guide at the bottom of the underwater structure. The upper end of the plumb line is centered in the drill unit chuck and clamped. Targets are affixed to the plumb line and adjustments are made to the tilting platform hydraulic jacks as indicated by the theodolite sighting system until the entire drilling assembly is properly aligned over the fuel module target location. The tilting platform is then clamped rigidly in place and the target system is removed from the drilling unit.

The drill piping and casing piping sections are assembled in the drill chuck while being supported in place by the lower clamp assemblies. Core drilling starts at the top of the debris bed and continues until the lower fuel assembly end fitting is completely penetrated. If needed, the casing is then drilled down around the drill pipe until the casing shoe rests on or near the top of the lower end fitting grid. In order to prevent drilling into the reactor vessel wall (lower head), the casing length is limited to 132". The core drilling will be controlled from the defueling work platform. The drill unit is instrumented to provide continuous information on drilling parameters.

After the core drill penetrates the fuel assembly lower end fitting, the upper section of the casing, a minimum of one foot above the core debris, will be removed by remotely disconnecting a joint in the casing. The drill piping containing the core sample in the lower 11 foot pipe section is raised while rotating the drill string. While withdrawing the core sample the pipe and casing sections are removed until the section containing the sample has been withdrawn up into the lead transfer cask. The drill pipe sections being removed are sprayed down with borated water as they are retracted up through the transfer cask (to remove loose contamination) using a spray system piped into the cask.

The drill pipe section containing the core sample is purged by an inert gas blanket while in the transfer cask and then capped prior to transfer to the fuel canister.

The transfer cask is translated horizontally to a position directly over the fuel canister which has previously been located at the loading station by rotation of the canister positioning system. The core sample pipe is then grappled by the overhead bridge crane and lowered down into the fuel canister. When the canister is full, it is capped and the canister positioning system will be rotated to bring an empty canister into loading position.

After a core sample has been removed from the reactor, the hole in the fuel assembly end fitting will be sealed, if required, to prevent large particles from falling into the lower vessel. The casing, if used during the drilling operation, will stay in place, until the end fitting plug has been installed. The end fitting plug has a lead-in chamber to facilitate entry into the drilled end fitting hole. The plug also has a lifting eye and a wire rope to lower it into the hole. The wire rope will be cut and retrieved after the plug is installed, prior to casing removal. The casing pipe section is then withdrawn into the transfer cask and transferred to and lowered into a fuel canister. The lowering of the casing pipe sections into the defueling canister requires the use of a crane. Other raising and lowering operations may be completed by the use of the core drilling machine. Loaded fuel canisters will be transferred to the appropriate storage locations. The fuel canister transfer will be performed in accordance with the "Safety Evaluation Report for Early Defueling of the TMI-2 Reactor Vessel", (Ref. 2).

If the sample was drilled from an inspection location, the video inspection manipulator with camera and cable is lowered through the casing pipe. A video inspection is then performed of the lower vessel head area at that location.

If inspection of the lower vessel area indicates that a grab sample is justified, existing grab sample tooling will be utilized to obtain a sample. The sample will be placed in a special sample cask for shipment. After completion of the inspection, the hole can be sealed and the casing removed using the procedure described previously.

Upon completion of the core sample acquisition tasks, the core drilling equipment will be removed, disassembled and disposed of in accordance with GPU requirements for handling of contaminated and potentially contaminated materials.

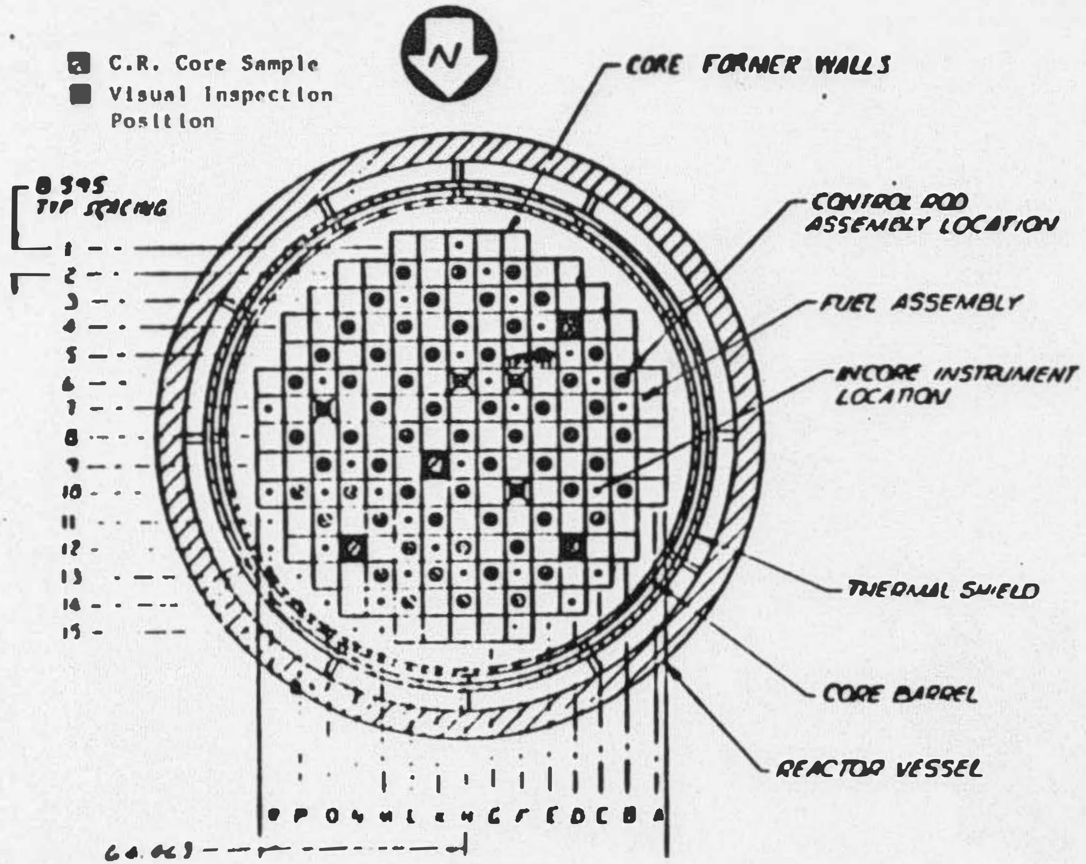
2.6 Failure Modes and Effects Analyses (FMEA)

Failure modes and effects analyses were performed for the following systems: drill unit, tilt platforms, underwater structure, drilling platform, drill unit indexing platform, transfer cask, cask indexing platform, drilling flush water, inert gas purge, appurtences, drill string casing, video examination system, drilling machine computer control, data acquisition system and theodolite system. The FMEA is described in detail in Reference 4.

The only failure mode with safety significance is a failure which could cause the core boring unit to drill through the lower vessel head and cause loss of the reactor water. The means to prevent this type of failure is to limit the length of drill bit and casing available to the operators. The drilling system design will insure that neither the drill bit nor the casing shoe can reach the reactor vessel pressure boundary. Total drill or casing length available to the equipment operators at any time will be insufficient to pass beyond the lower flow distributor plate.

Quality Control will verify the total length of the drill string taken inside containment and staged on the DWP.

FIGURE 2.3-1 PROPOSED CORE SAMPLE LOCATIONS & TV INSPECTION POSITIONS



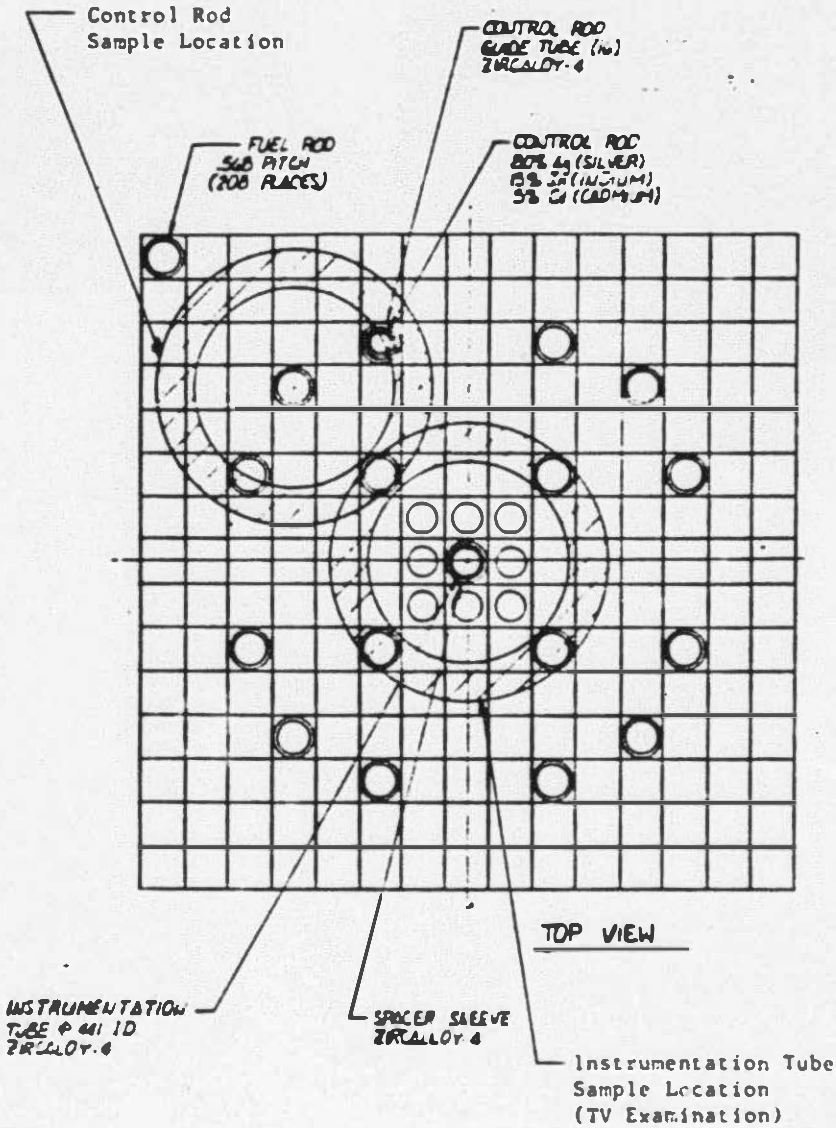


Figure 2.3-2 Fuel Assembly Drilling Locations

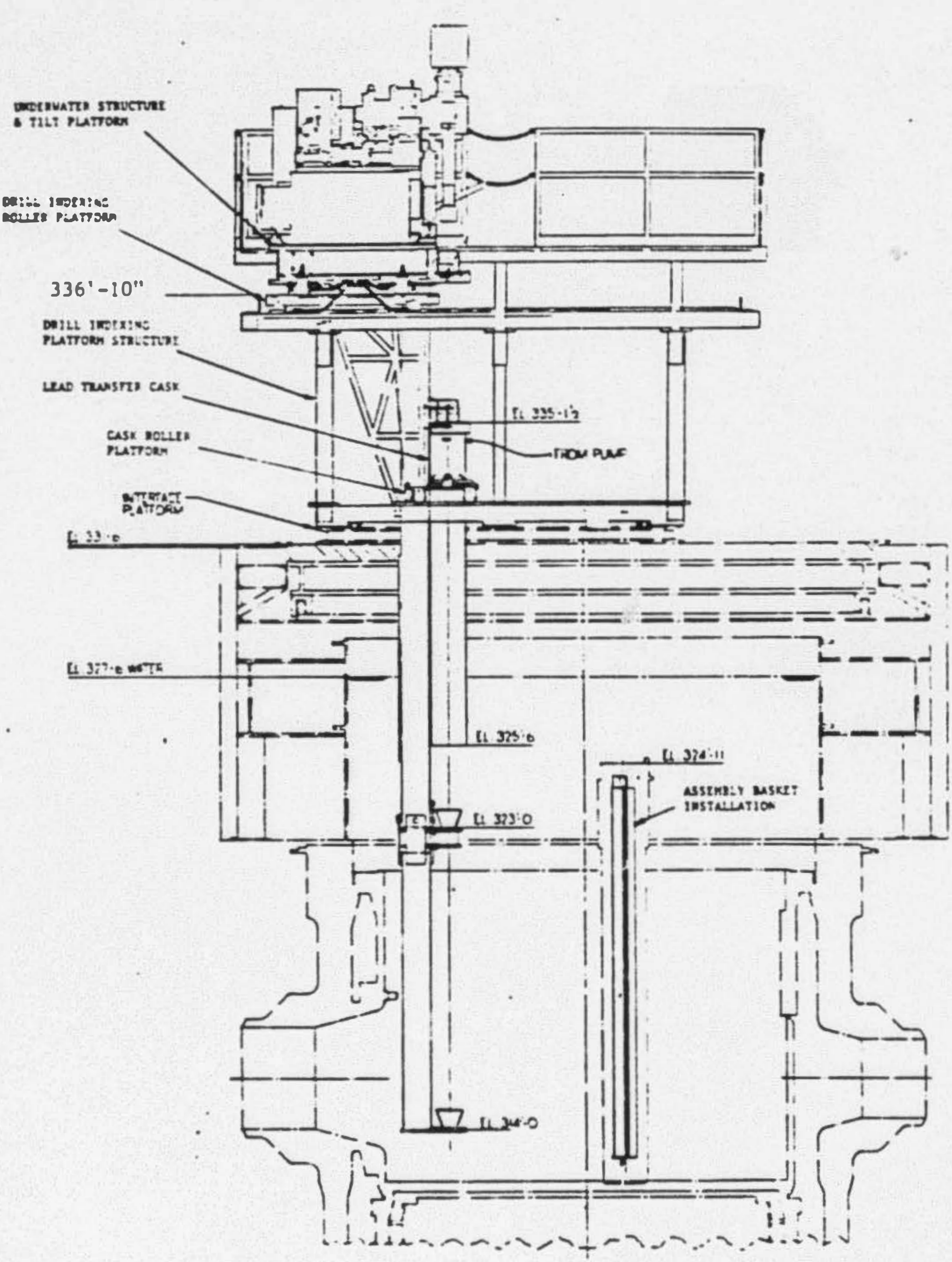


Figure 2.4-1 Core Stratification Sampling Equipment Assembly

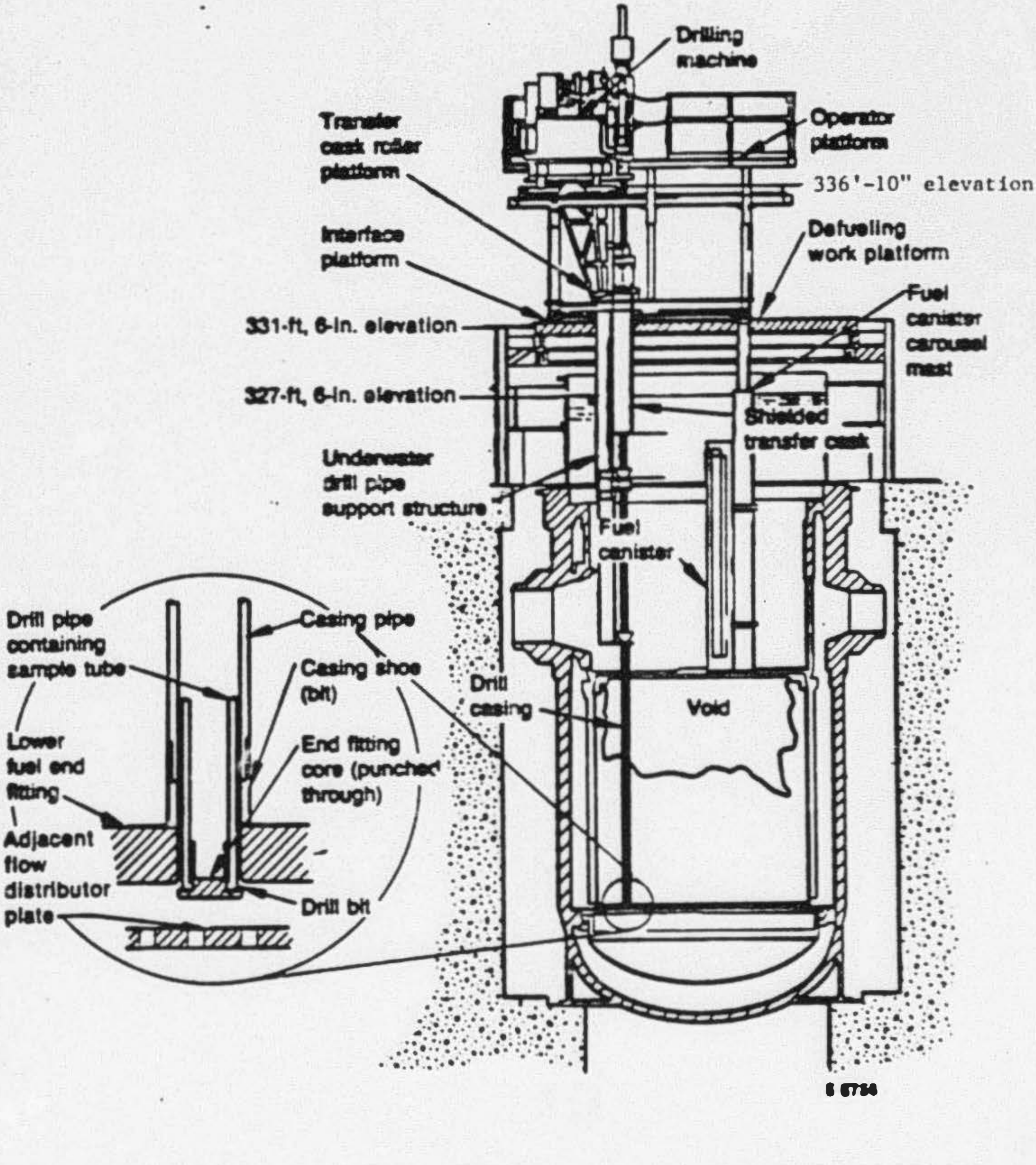


Figure 2.4-2 Core Stratification Sampling

3.0 Radiological Considerations

3.1 External Exposures

All individuals entering the reactor building will be monitored for external exposures in accordance with radiological control procedures to ensure personnel exposures are maintained ALARA and within 10CFR20 dose equivalent limits. Administrative control points in accordance with radiological controls procedures will be used in order to assure specified dose limits are not exceeded. Extremity monitoring will be performed as needed in accordance with existing procedures. Radiological Controls Department personnel will continuously monitor dose rates in the reactor building during the sample acquisition and supportive activities.

The collective personnel radiation exposure to workers during the core boring and sample transfer operations and during the supportive activities in the reactor building has been estimated. This estimate was developed based on projected person-hour requirements and reactor building exposure rates associated with these activities. The average dose rate during staging, assembly, disassembly and removal was taken as 75 mrem/hr. The average dose rate during core drilling operations and video inspection was estimated to be 12 mrem/hr. The collective dose is estimated to be 32 person-rem. This figure is based on 846 person-hours in the reactor building.

Person-rem for radiological controls support is not included in the above estimate. From a review of historical data it is assumed that person-rem for the radiological controls group will be 20% of that accummulated by other groups in containment. Based on this, the estimate for radiological controls support is 6.4 person-rem, and the total for all groups is estimated at 39 person-rem.

Due to the uncertainty in the person-hour estimate and the radiological conditions which will exist during the operation, it is estimated that the total exposure could vary by up to ± 30 percent. Considering these uncertainties, 27 to 50 person-rem has been selected to be used as the estimate for the performance of the activities scoped in this SER, including radiological controls support.

3.2 Internal Exposures

All individuals entering the reactor building will be monitored for internal radiation exposures according to established procedures. This monitoring will be accomplished by periodic whole body counting or bioassay, or both. All exposures to airborne radioactivity will be maintained ALARA and within the limits established in 10CFR20. Airborne radioactivity in work areas will be monitored according to established procedures. Air sampling for particulates will be performed using devices such as breathing zone air samplers and grab samples. Tritium grab samples will be taken as required according to established procedures.

Respiratory protection has been used to minimize the uptake and deposition of airborne radioactivity in the body. The use of respiratory protection devices can, by reducing uptakes of radioactive materials, result in overall dose savings (internal and external); however, if they impede work, total dose can increase by causing an elevated external dose. Current radiation protection guidance as expressed in International Commission on Radiation Protection Publication-26 (ICRP-26) considers both external and internal sources of exposure and recommends minimizing the sum of them.

For soluble cesium-137, the internal dose is 2.5 mrem (received over several years, T_{eff} 70 days) for each hour of exposure at MPC. For soluble strontium/yttrium-90, the bone dose is approximately 15 mrem (received over 50 years, T_{eff} 6400 days) for each hour of exposure at MPC. Even if there is no overall savings in the total dose due to elimination of a respirator for a given task (that is, the increased internal dose exactly offsets decreased external dose), the fact that the internal dose is calculated on a fifty year dose commitment whereas external dose is deposited instantly means that the rate of dose deposition is reduced on an overall basis.

The Radiological Controls Department, via the prework radiological review process, shall determine if the use of respiratory devices for a task is ALARA. This review will examine the current radiological conditions in the work area, the potential of the task or other concurrent tasks to perturb the radiological conditions and when available, review the results of previous airborne activity measurements in the work area for similar tasks.

3.3 ALARA Considerations

The objective of minimizing occupational exposure has been a major goal in the planning and preparation for all activities in the containment. The actions that have been taken or are being planned toward meeting this objective are summarized in this section. These actions will minimize the time personnel must work in radiation fields, maximize the distance between personnel and radiation sources to the extent practicable, and utilize shielding where appropriate to meet the ALARA objective. Protective clothing and respirators will be used as necessary to reduce the potential for external contamination and internal exposure of personnel.

Execution of individual tasks are maintained ALARA by a detailed radiological review by Radiological Engineering and mock-up training where appropriate. Training of workers on a mock-up will familiarize the workers with tasks to be performed. This training will result in less time and personnel exposure in the reactor building.

Equipment has been designed with the intent of keeping radiation exposures ALARA by minimizing in-containment assembly and simplifying operation.

3.4 Shielding

When the 3/8 inch thick stainless steel core barrel containing the sample is removed from the water, lead shielding with an approximate thickness of 3" will be used in the core sample transfer cask to minimize direct radiation levels. A radiological analysis performed for different source terms predicts exposure rates on the outside surface of the cask of 15 mrem/hr for cesium-leached fuel (Ref. 4). To prevent streaming, two temporary shielding inserts will be placed at the top of the transfer cask around the core barrel during sample transfer.

The cask incorporates a water manifold to supply borated rinse water around the circumference of casing or drill tubes for decontamination as they are withdrawn from the reactor.

4.0 Safety Concerns

To ensure that the sample acquisition operation is conducted in a safe manner, the following potential safety concerns have been evaluated.

4.1 Release of Radioactivity

The planned activities associated with the sampling operation are not expected to release any appreciable amounts of gaseous or particulate activity. Any potential releases of radioactivity are enveloped by the dose assessment performed for early defueling activities in the Safety Evaluation Report for Early Defueling of TMI-2 Reactor Vessel (Ref. 2). These analyses demonstrate that any potential release will be within allowable limits.

4.2 Criticality

The only credible means of attaining criticality of the fuel contained in the vessel is through deboration of the RCS water or introduction of "foreign" materials to the reactor vessel. The potential for boron dilution during defueling will be addressed in the "Hazards Analysis: Potential for Boron Dilution of Reactor Coolant System," (Ref. 3). The analysis for potential boron dilution during defueling will envelope the core sample acquisition activities.

Components of the core boring system which contain hydraulic fluid which could potentially cause local deboration in the core are classified important to safety to minimize the potential for failure of these components.

The main concern is leakage of hydraulic fluid from a hose break or from the reservoir attached to the core drilling machine. The closed hydraulic system on the drill unit contains about 27 gallons of HOUGHTO-SAFE-620 hydraulic fluid. HOUGHTO-SAFE-620 is a mixture of glycol and 95% water which although slightly heavier than water, also is completely miscible in water. Therefore, it is unlikely that hydraulic fluid entering the top of the reactor pressure vessel could move down to the core region without being significantly diluted in the water above the core. The only pathway for the hydraulic fluid is via leakage onto the surface of the vessel water from the top of the vessel.

There is a low level sensor on the hydraulic fluid reservoir which would initiate shutdown of the drill unit within 1 second of detecting a loss of 1/2 gallon of hydraulic fluid. Therefore, leakage from a hose break would be limited to 1 1/2 gallons. Also, because the high flow portions are within an enclosure, a failure of the level sensor would result in no more than 20 gallons of HOUGHTO-SAFE-620 being available to leak into the top of the vessel. A drip pan with a capacity of 8 gallons will be provided to collect any leakage.

The water used for drill bit flushing/cooling will be supplied from the reactor vessel; the flush water supply tank will be used as a secondary source. The water in the flush water supply tank will be borated to a concentration within the limits required by the Technical Specifications. To ensure that the flush water is adequately borated at the start of the core boring operation, a sample will be taken and analyzed for boron concentration. During the core boring operation the flush water supply tank will be refilled from the Borated Water Storage Tank.

A leak of hydraulic fluid from the drill unit could enter the RCS possibly causing deborated moderator to be injected as flush water into the drill bit. In order to prevent this, the relative location of flush water suction will be from an area remote from potential sources of unborated moderators and the drill's hydraulic fluid introduction will be such that insignificant deboration would take place in the event of a leak. The flush water suction line arrangement will also minimize possible deboration of the flush water in the unlikely event of deboration resulting from the wrong resins being added to the DWCS ion exchangers.

The addition of the steel drill casing and core barrel into the core region does not represent a configuration more reactive than that analyzed in the "Criticality Report for the Reactor Coolant System," (Reference 7). Additionally, the use of other "foreign" materials (e.g. cable, camera, etc.) during the sample acquisition activities will not increase the k_{eff} of the reactor coolant system above 0.99. The process used to review and control these materials is discussed in Section 4.2.1 of Reference 2.

The closed system for the manually operated underwater casing clamp contains 1.3 gallons of demineralized water. Leakage of this small amount of water would not be a criticality hazard.

4.3 Pyrophoricity

In order to avoid the possibility of a hypothetical pyrophoric reaction, core samples shall be maintained in an essentially oxygen-free environment following withdrawal from the RCS water. This will be accomplished by purging the core barrel and core sample with an inert gas as they are removed from the reactor. This will be done by inserting a wand into the lowest section of drill tube containing the sample as it is being raised from the water. As the water drains out of the drill tube and core barrel, it will be replaced by the inert gas. After the last section of drill tube is removed from the top of the core barrel, a plug will be inserted into the top of the core barrel prior to transferring it to the defueling canister. For a more detailed discussion of pyrophoric events in the RCS, see Reference 9.

The heat generated by drill bit friction will not increase the potential for a pyrophoric event since this heat will be readily dissipated by the boring tool flush water. The drill unit will be automatically shut down upon loss of flush water.

4.4 Reactor Coolant System Integrity

Load handling activities during the equipment installation, operation and removal will be performed in accordance with the "Safety Evaluation Report for Heavy Load Handling", (Ref. 5) and with the "Safety Evaluation Report for Heavy Load Handling over the Reactor Vessel", (Ref. 6). The analyses presented in these two references demonstrate that any potential drop accidents associated with the core sample acquisition activities will not impact the health and safety of the public.

During the installation and removal of the core boring equipment, some loads to be handled have been identified which will exceed the height/weight limitations presented in Reference 6. These loads have been evaluated to ensure that they do not cause the collapse of the DWP. Any additional load handling activities that are identified that exceed the limitations of Reference 5 and 6, will be evaluated on a case by case basis.

The core bore operation will exert a downward force on the debris bed and lower core support assembly. As a consequence of the debris configuration in the vessel lower head this downward force may be transmitted to one or more incore instrument nozzles in the lower head. However, this downward force is automatically controlled through a range of 0-2000 pounds and is less than the 5400 pounds force which could cause failure of the incore instrument nozzle welds (References 10 and 11).

4.5 10 CFR 50.59 Evaluation

10 CFR 50, Paragraph 50.59, permits the holder of an operating license to make changes to the facility or perform a test or experiment, provided the change, test, or experiment is determined not to be an unreviewed safety question and does not involve a modification of the plant 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.

The FSAR for TMI-2 evaluated a variety of Design Basis Accidents. In general each of those events represented a substantially more consequential accident than any that can be credibly postulated for boring into the TMI-2 core in its present condition.

Each of the questions for determining if core boring activities involve an unreviewed safety question are evaluated below.

<u>Has the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report been increased?</u>

The uncontrolled addition of unborated water to the reactor coolant system during core boring activities is addressed in Reference 3. It describes how the potential sources of unborated water are isolated from the reactor coolant system and the measures to be taken to detect a boron dilution event should one occur.

The introduction of foreign materials into the reactor core region is discussed in section 4.2

Any release of radioactivity during core boring activities will be to the containment. During core boring activities containment isolation capability will exist and the ventilation system for the containment will be operated in accordance with the technical specifications and will, therefore, not increase the probability of an uncontrolled release of radioactivity. As for the consequences of a release of radioactivity, as stated in Section 4.1 of this report the consequences of releases of radioactivity are not increased over previous analyses present in Reference 2.

A fuel handling accident related to core boring activities that could result in a release of radioactivity to the environment is the dropping of a fuel canister onto the dry portion of the refueling canal. An evaluation of this event was performed in Reference 2. The resulting offsite whole body dose is less than the limiting fuel handling accident whole body dose presented in the FSAR.

As described in this safety evaluation, core boring activities will not adversely affect equipment classified important to safety (ITS), thus the probability of a malfunction of ITS equipment is not increased. It is also concluded that the consequences of a malfunction of ITS equipment is not increased for the following reasons:

- the results of accident analyses described in Section 4 of this report are within the bounds of previous analyses presented in the FSAR,
- removal of decay heat is passive in nature, thus no impact should DHR system fail, and
- the existing RCS boron concentration will ensure subcriticality for all credible fuel configurations, not requiring any active system.

In summary, it is concluded that the core boring activities do not increase the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report.

<u>Has the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report been created?</u>

The various types of accidents which could occur during core stratification sampling are discussed in Sections 4.1 through 4.4. None of these accidents are of a different type than those previously analyzed.

<u>Has the margin of safety, as defined in the basis for any technical specification been reduced?</u>

Technical Specification safety margins at TMI-2 are concerned with criticality control and prevention of further core damage due to overheating. As demonstrated by this Safety Evaluation Report, Technical Specification safety margins will be maintained throughout the core boring process. Criticality is controlled by establishing a boron concentration at greater than 4350 ppm during the core boring process and ensuring that this concentration is maintained by monitoring the concentration and isolating potential deboration pathways. Also, the quantity of "foreign" materials that could be introduced to the vessel will be strictly controlled. The ability to prevent further core damage due to overheating is not affected by core boring as systems will continue to be in place to add borated cooling water to the core in the event of an unisolable leak from the reactor vessel.

In conclusion, the core stratification sampling activities do not

- o increase the probability of occurence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report, or
- o create the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report, or
- o reduce the margin of safety as defined in the basis for any technical specification.

Therefore, the core stratification sampling activities do not constitute an unreviewed safety question.

No Technical Specification changes are required to conduct the activities bounded by this SER.

5.0 Conclusions

The sample acquisition, transfer, and associated activities, have been described and evaluated. The evaluations have shown that the task and equipment employed follow the continued commitment to maintain radiation exposure levels ALARA. The evaluations have also shown that no detectable increase of radioactivity releases to the environment will result from the planned activities. The consequences of postulated accidents with respect to potential core disturbances and loadings on the reactor vessel have been shown not to compromise safety. The normal and accidental releases of radioactivity have been evaluated and are bounded by the analyses presented in Reference 2. It is therefore concluded that the core sampling acquisition and the associated activities, can be performed without presenting undue risk to the health and safety of the public.

6.0 References

1. "Safety Evaluation Report for Removal of the TMI-2 Reactor Vessel Head", Rev. 5, February, 1984.

2. "Safety Evaluation Report for Early Defueling of the TMI-2 Reactor Vessel", Rev. 0, March 5, 1985.

3. "Hazards Analysis: Potential for Boron Dilution of Reactor Coolant System," document 4430-84-U07R.

4. TMI-2 Core Stratification Sampling Project, Failure Modes and Effects Analysis (FMEA), EG&G Idaho, Inc., CSS-133, December 26, 1984.

5. "Safety Evaluation Report for Heavy Load Handling Inside Containment," Rev. 0.

6. "Safety Evaluation Report for Heavy Load Handling Over the TMI-2 Reactor Vessel", Rev. 0.

7. "Criticality Report for the Reactor Coolant System", Rev. 0, October 1984.

8. "Requirements Document for TMI Core Stratification Sampling Project", EG&G Idaho, Inc. Report No. PF-NME-84-004, Rev. 1, November 1984.

9. "Safety Evaluation Justifying the Non-Seismic Design of TMI-2 'Post-Accident' Systems", Rev. 0.

10. "TMI-2 Core Stratification Sampling Project System Design Description," EGG-TMI-6824, Vol. 1.

11. "Evaluation of the Structural Integrity of the TMI-2 Reactor Vessel Lower Head," B&W Document No. 77-1158426-00, June 1985.