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May 31, 1984

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

Internals Indexing Fixture Processing System Safety Evaluation Report

Attached for your review and approval is a copy of the Safety Evaluation Report (SER) for operation of the Internals Indexing Fixture (IIF) Processing System. A description of the hardware was previously submitted as Appendix 2 to the Submerged Demineralizer System (SDS) Technical Evaluation Report (TER) via GPU Nuclear letter 4410-83-L-0122 dated July 6, 1983, from Mr. B. K. Kanga to Dr. B. J. Snyder and approved via Mr. L. H. Barrett's letter to Mr. B. K. Kanga dated November 8, 1983.

This SER has been determined to constitute a single safety issue as specified by 10 CFR 170.22; thus, a fee of \$4,000. is applicable. Therefore, enclosed please find a check for \$4,000.

If you have any questions concerning this information, please call Mr. J. J. Byrne of my staff.

Sincerely,

B. K. Kanga
B. K. Kanga
Director, TMI-2

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Attachment: Check No. 00112964

cc: Deputy Program Director - TMI Program Office, Mr. L. H. Barrett

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SAFETY EVALUATION REPORT
for the Operation of the
IIF Processing System

Three Mile Island Unit 2

Revision 1
May 1984

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Table of Contents

	<u>Page</u>
1.0 Introduction	1
1.1 General	1
1.2 Organization	1
1.3 Conclusions	1
2.0 Functioning of the System	1
2.1 Detailed System Description	1
2.2 System Performance Characteristics	2
2.3 Instrumentation and Control	2
2.4 System Physical Arrangement	3
2.5 Normal Operation	3
2.6 Additional Design Features	3
2.7 Systems Directly Supporting the IIF Processing System	4
2.8 Other Systems Required to Support the IIF Processing System	5
3.0 Safety Concerns	6
3.1 General	6
3.2 Decay Heat Removal	6
3.3 Boron Dilution	6
3.4 Radiological Considerations	12
4.0 10CFR50.59 Evaluation	17
5.0 Conclusions	18
6.0 List of References	19

Revision 1

1.0 Introduction

1.1 General

This safety evaluation report (SER) addresses operation of the Internals Indexing Fixture (IIF) Processing System.

After removal of the TMI-2 reactor vessel head the IIF will be placed on the vessel flange and the reactor coolant level will be raised to partially fill the IIF. The IIF processing system is designed to provide reactor coolant water processing capability during the time between head removal and plenum removal. The need for the IIF processing system is determined based on limited reactor coolant processing capability in the drained down condition and the desire to provide adequate water cleanup capacity to minimize radiation dose rates around the IIF.

The purpose of this SER is to identify and evaluate safety issues relating to the operation of the IIF processing system to assure that this system may be operated without presenting undue risk to the health and safety of the public.

1.2 Organization

Section 2.0 of this SER provides a description of the IIF processing system, including a detailed system description, a physical description, and a list of major systems required to support the IIF processing system. Section 3.0 addresses safety concerns including boron dilution potential and radiological considerations. Section 4.0 provides the 10CFR 50.59 evaluation, Section 5.0 contains the summary and conclusions, and Section 6.0 is a list of references.

1.3 Conclusions

Based on the evaluation of safety concerns given in this SER, it is concluded that the IIF processing system does not constitute an unreviewed safety question and may be operated without presenting undue risk to the health and safety of the public.

2.0 Functioning of the System

The IIF processing system is designed to use the submerged demineralizer system (SDS) and portions of existing plant liquid radwaste disposal systems to decontaminate reactor coolant. The IIF processing system consists of a submersible pump located inside the IIF which transfers water from the IIF through the SDS to a reactor coolant bleed holdup tank. Reactor coolant grade water is concurrently returned to the reactor vessel from a second bleed tank by a waste transfer pump to maintain the RCS level.

2.1 Detailed System Description

The IIF processing system uses a commercially available, submersible pump (IIF Processing Pump, DWC-P-1) to transfer reactor coolant from the IIF, through the SDS to a reactor coolant bleed holdup tank. This detailed system description assumes that reactor coolant bleed holdup tank A

(WDL-T-1A) is being used for makeup and that tank C (WDL-T-1C) is receiving letdown from the SDS. However the roles of these tanks may be reversed. The pump is supported from the IIF and takes suction approximately 2 1/2 feet above the reactor vessel flange.

The discharge of the pump connects to the fuel transfer canal drain manifold by means of a 1 1/2 inch ID rubber hose having quick-disconnect fittings with two-way shutoff at each end. The manifold serves as a tie-in point for three systems: the reactor building basement pump system, the fuel transfer canal drain system, and the IIF processing system. Double isolation of the IIF processing system from these two systems is provided by disconnection of the remaining two hoses from the manifold and by closure of the branch valves. From the manifold the system uses an existing flow path through reactor building penetration R-626, fuel handling building penetration 1551, and the SDS to WDL-T-1C.

Makeup to the RCS is accomplished by transferring reactor coolant grade water to the reactor vessel by the normal makeup flow path: from WDL-T-1A via a waste transfer pump and an existing flow path through the liquid waste disposal and makeup systems to a cold leg of the reactor vessel.

The IIF processing system may be operated continuously (exclusive of administrative requirements such as RCS leak rate checks) until bleed tank A is drained to the desired level. The roles of bleed tanks A and C may then be reversed by properly realigning valves. Before transferring water to the RCS, however, bleed tank C must be recirculated and sampled according to plant operating procedures. Tank recirculation and sampling is assumed to take approximately 2 days which results in a maximum system availability of 70%. No simultaneous transfer of water is permitted to the bleed tank being used for RCS makeup.

2.2 System Performance Characteristics

The original goal of this system was to achieve a flow rate of 30 gpm through the SDS (see Appendix 2 of Reference 1). Upon review of the SDS it was determined that this flow could not be practically obtained. Therefore, the IIF processing pump was selected based on having a shutoff head approximately equal to the design pressure (150 psig) of the SDS with flow/head characteristics in the range of 0-30 gpm that will maximize the flow through the SDS. It is expected that flow through the SDS will not exceed 15 gpm and will normally average 10-12 gpm.

2.3 Instrumentation and Control

The IIF processing system may be operated in either an automatic or a manual level control mode.

RCS level monitoring for input to the IIF processing system operation is provided by the "bubbler" system described in Reference 2. The RCS level in the IIF can be maintained automatically by valve MU-V9. The control signal to valve MU-V9 is provided by the bubbler system through proportional controller RC-LIC-102 which is located on control room panel SPC-PNL-3.

The IIF processing system may also be operated in the manual level control mode. In this mode the previously described flowpath will still be used. Makeup flow will be manually balanced to match letdown flow to maintain RCS level.

The bubbler also has high and low level alarm points to prevent an unacceptable increase or decrease in the water level. In the event of a high or low level alarm, makeup and letdown are both automatically terminated by closure of valves WDL-V40 and FCC-V003. Closure of valve FCC-V003 automatically trips the IIF processing pump. Level indication and high and low level audible and visual alarms are provided locally on the bubbler control panel as well as remotely on the SDS panel in the fuel handling building and on SPC-PNL-3 in the main control room. Emergency stop switches are provided at the IIF to close valves FCC-V003 and WDL-V40 thereby stopping flow to and from the IIF.

2.4 System Physical Arrangement

The IIF pump is supported by the IIF and will be installed with the IIF. The fuel transfer canal drain manifold is located in the reactor building on the 347'-6" elevation near reactor building penetration R-626 location at the north end of the reactor building. Approximately 50 feet of 1 1/2" inch rubber hose will connect the IIF pump to the manifold. The hose is routed along the edge of the fuel transfer canal at the 347'-6" elevation.

2.5 Normal Operation

To start the IIF processing system the following conditions must be met: valves must be aligned to permit flow from a bleed tank through the waste transfer pump to a reactor vessel cold leg, the SDS must be configured for reactor coolant processing, the automatic trip switches must be in the not-blocked position, the basement pump system and the fuel transfer canal drain system must be isolated by valve closure and hose disconnection at the fuel transfer canal drain manifold, and the bleed tank being used for makeup must contain reactor coolant grade water.

IIF processing is begun by starting the waste transfer pump and opening valve WDL-V40. Valve FCC-V003 is opened from SDS control panel CN-PNL-1, which automatically starts the IIF processing pump transferring water to the SDS. Flow then will be manually balanced or automatically controlled by MU-V9 to maintain the RCS level in the IIF.

2.6 Additional Design Features

The system has incorporated two hand switches (DWC-HIS-1A and DWC-HIS-1266-1) which are located on SDS control panel CN-PNL-1 which can be used to block automatic shutdown of the system for high or low levels. These switches will allow the operators to fill or drain the IIF to the desired water level as needed. These switches must be in the not-blocked position for operation of the IIF processing system in the automatic or manual level control mode.

Relocation of the IIF pump within the IIF may be required to avoid interferences with post head removal activities. By using flexible hose with two-way shutoff quick disconnect couplings on the pump discharge, and the overlapping hanger design for the pump support, movement of the pump can be accomplished using overhead material handling equipment.

2.7 Systems Directly Supporting the IIF Processing System

2.7.1 Fuel Transfer Canal Fill and Drain System (FCC system)

The IIF processing system ties into the fuel transfer canal drain manifold inside the reactor building. Valve FCC-V003 terminates letdown from the IIF when closed manually or on alarm level signal from the bubbler system. Closure of valve FCC-V003 automatically trips the IIF processing pump.

2.7.2 Make Up and Purification System (MU system)

The MU system provides the flow path from the liquid waste disposal system to the reactor vessel. For automatic level control makeup valve MU-V9 acts as the flow controller to maintain RCS level based on level indication from the bubbler system. Manual level control is achieved by positioning valves in the MU system to ensure makeup flow matches letdown flow.

2.7.3 Reactor Coolant Level Monitoring System (Bubbler system)

The bubbler system provides RCS level indication and is required for operation of the IIF processing system. In the automatic level control mode flow to the IIF is automatically controlled based on IIF water level sensed by the bubbler. In both the automatic and manual level control mode the bubbler system will terminate supply and discharge flows automatically in the event of unacceptable water level in the IIF. The bubbler system will not initiate makeup from a bleed tank, but will only adjust flow once the IIF processing system is operating.

2.7.4 Reactor Coolant System (RCS)

The IIF processing system transfers reactor coolant from the IIF to the SDS for decontamination. The safety function of the RCS is to maintain a sufficient volume of adequately borated water for decay heat removal and for maintenance of subcriticality of the core. In addition the reactor coolant serves as a water shield for the radiation sources inside the vessel. The RCS level will be maintained within a controlled range during operation of the IIF processing system.

2.7.5 Submerged Demineralizer System (SDS)

The IIF processing system uses the SDS as the means of decontaminating the reactor coolant. The SDS is comprised of a liquid waste processing system, an off gas system, a monitoring and sampling system, and a solid waste handling system. The liquid waste processing system uses sand type filters for the removal of solids and a series of ion exchange columns for the removal of soluble contaminants. SDS effluent is returned to a bleed tank which is not being used for makeup. The off gas system collects, filters and absorbs radioactive gases during processing, sampling, dewatering and spent SDS liner venting. The sampling system provides the capability of obtaining samples of reactor coolant at several points in the processing stream. The solid waste handling system is provided for moving, dewatering, storing and loading of filters and demineralizer vessels. The operation of the SDS is described in Reference 1.

2.7.6 EPICOR II System

The EPICOR II system will be used to remove antimony-125 from the reactor coolant if this isotope becomes a significant dose contributor for workers on the IIF. This system will be used for reactor coolant processing on a batch basis only. Water processed by EPICOR II will be chemically adjusted before being used as RCS makeup.

2.7.7 Liquid Waste Disposal System (WDL system)

The WDL system components used to support the IIF processing system are the reactor coolant bleed holdup tanks, the waste transfer pumps, and the flow path from the bleed tanks to the makeup system. Valve WDL-V40 also provides automatic termination of makeup in the event of a high or low level alarm signal from the bubbler system.

2.8 Other Systems Required to Support the IIF Processing System

2.8.1 Mini-Decay Heat Removal System (MDH system)

During IIF processing system operation decay heat removal from the core will be by the loss-to-ambient cooling mode. However, should forced circulation of reactor coolant through the core be required, the MDH system will provide this capability. In addition, the MDH system is capable of injecting borated water into the RCS to assure that the reactor coolant will be maintained within the required boron concentration limits.

2.8.2 Standby Reactor Coolant Pressure Control System (SPC system)

During IIF processing system operation, the SPC system is capable of injecting borated water into the RCS to assure that reactor coolant will be maintained within the required boron concentration limits.

3.0 Safety Concerns

3.1 General

The IIF processing system will be operated in accordance with detailed approved procedures. To assure that the system can be operated safely, an evaluation of safety considerations was made. The safety issues identified were

- o decay heat removal
- o boron dilution
- o radiological considerations.

These issues are discussed below. Safety issues related to the operation of the SDS are identified and evaluated in Reference 1.

3.2 Decay Heat Removal

During operation of the IIF processing system the RCS level will be maintained well above the plenum cover plate elevation. In the past the bulk RCS temperature has been maintained at less than 100°F by the loss-to-ambient cooling mode with the water level below the plenum cover plate. Therefore no reduction in decay heat removal capability is expected during IIF processing system operation.

In the event that the water level decreases and the low level alarm should fail, the RCS level could only be lowered to the pump suction point approximately 2 1/2 feet above the plenum cover plate, which is above the reactor vessel nozzles. Adequate decay heat removal capability has been demonstrated for the RCS level lowered to the nozzles (Attachment 1 of Ref. 2). Therefore it can be concluded that adequate decay heat removal capability will be available in the event of failure of level control and low level trip.

3.3 Boron Dilution

The TMI-2 core is maintained in its safe shutdown condition by virtue of the soluble boron present in high concentrations in the reactor coolant. Conservative analyses have been performed which show that a recriticality of the core is prevented by maintaining a boron concentration of 3500 ppm (Refs. 2 and 3). These analyses bound fuel configurations associated with planned work activities and credible accidents during the period through head removal. These analyses should also bound any possible configuration for the period of IIF processing system operation. The evaluation of the worst credible boron dilution event is therefore based on the assumption that 3500 ppm provides an adequate poisoning of the system for criticality prevention for all activities during IIF processing system operation. Boron dilution concerns during operation of the IIF processing system will require reevaluation if the lower boron concentration safety limit of 3500 ppm is revised.

To prepare for future defueling activities, the boron concentration is being increased to an operating level of 5050 ± 100 ppm. This provides an even greater margin of safety during the period of IIF processing system operation. The reactor coolant temperature and chemistry will be maintained

within Technical Specification limits during IIF processing. The only credible way the RCS boron concentration could be changed in an uncontrolled manner during IIF processing system operation is by the dilution of the reactor coolant with water that is either unborated or borated below the operating level.

To provide adequate assurance that a return to criticality of the fuel is precluded, measures have been taken to prevent the reduction of boron concentration, to detect a reduction in boron concentration, and to provide the capability to restore the reactor coolant to the operating boron concentration.

A reduction in the RCS boron concentration could result if water containing less than the operating boron limit were added to the RCS. The potential sources of this water are the various systems connected to the RCS, including the secondary system. Systems which potentially contain underborated water have been reviewed and isolated. Two isolation boundaries are provided for potential inleakage paths. An isolation boundary is defined as a closed tagged out valve, a removed spool piece, a heat exchanger tube boundary, or an electrically locked out pump. An electrically locked out pump may be considered an isolation mechanism whenever the pump represents a pressure driving head. Where gravitational flow through a pump body has a potential for adding underborated water a minimum of two additional isolation boundaries are provided.

Specific actions to prevent the addition of underborated water to the RCS from the various systems are described in Reference 2.

Operation of the IIF processing system presents additional potential deboration pathways and concerns, which are addressed in this SER.

3.3.1 Operation of the IIF Processing System in the Automatic Level Control Mode

During operation of the IIF processing system in the automatic level control mode the inadvertent addition of underborated water to the RCS is considered extremely unlikely, due to preventive measures taken. Potential flow paths of underborated water are double isolated, the position of isolation valves is confirmed visually or administratively every 24 hours and the levels of tanks containing underborated water are logged every 24 hours. However, to further protect against a reduction of boron concentration several methods of detection of a deboration event are employed: a) RCS level monitoring, b) RCS sampling, and c) RCS inventory monitoring.

a) RCS Level Monitoring

During this mode of operation of the IIF processing system the RCS level is automatically maintained by valve MU-V9 which is controlled by the bubbler system. The level is maintained at a given level and alarm points are set above and below the desired level to prevent an unacceptable increase or decrease

in the water level. If the RCS level reaches an alarm point, makeup and letdown are both terminated and alarms sound in the control room, at the IIF, and on the SDS panel in the fuel handling building.

Maximum letdown from the IIF through the SDS is calculated to be 15 gpm and normal flow rates are expected to be 10-12 gpm. Leakage into the RCS of flow rates greater than these will result in an increase in IIF level until the alarm point is reached, at which time the IIF processing system will be automatically shut down and the source of inleakage can be identified and terminated. Inleakage less than 15 gpm may not be detected by the RCS level monitoring system.

Normal plant RCS level monitoring, using level transmitter RC-LT-100, is also available and is also equipped with alarms in the main control room to signal unacceptable water levels. RCS level is monitored and logged regularly by control room operators.

b) RCS Sampling

RCS sampling is performed once per week while the RCS is in the normal drained down depressurized condition, that is, the "level control mode." While the plant is in this mode inleakage into the RCS will cause an increase in RCS level, which will be indicated in the control room by RC-LT-100. However during the operation of the IIF processing system in the automatic control mode the RCS level is automatically maintained without operator action. Any inleakage into the RCS from potentially underbored sources may add to the makeup flow. In this case the bubbler system may sufficiently throttle MU-V9 to permit the continued dilution without an observable increase in RCS level. Thus any inleakage into the RCS from potentially underbored sources may be difficult to identify quickly by control room operators. The detection of any deboration event then must not depend on RCS level monitoring alone.

By increasing the frequency of RCS sampling adequate detection capability can be provided. The frequency of sampling is based on the time required for the boron concentration to be reduced from the operational level to the minimum level which has been shown to be adequate for the prevention of criticality for core configurations postulated for the period through head removal. These configurations should bound activities for the period until plenum removal.

To define a sampling frequency based on normal operation of the IIF processing system the following items are important.

1. The greater the dilution flow rate the shorter the sampling frequency must be.

2. The maximum letdown flow rate through the SDS dictates the maximum dilution flow rate, since greater dilution flow rates will cause an RCS level increase. RCS level increases can be identified by control room operators before significant dilution could take place.

The calculation of the dilution time intervals for a range of SDS flow rates is performed using the following assumptions.

1. The initial boron concentration is 4950 ppm. This is the lower operational limit, where normal operations require 5050 ± 100 ppm.
2. The final boron concentration should be 3500 ppm.
3. The combined water volume of the reactor vessel-IIF is 36,000 gallons. No mixing of water in the vessel legs is assumed.
4. The dilution flow is unborated water.
5. A constant volume is assumed; that is, a feed and bleed condition exists. Instantaneous, uniform mixing in the dilution volume is assumed.

To calculate the time interval required to dilute the vessel-IIF volume the following expression is used

$$C_1 = C_0 e^{-\left(\frac{Q}{V}\right)t}$$

where

C_1 = boron concentration at time t
 C_0 = initial boron concentration
 Q = dilution flow rate
 V = vessel-IIF volume

The following time intervals are calculated for several dilution flow rates.

<u>Dilution flow rate</u>	<u>time (min)</u>	<u>time (hrs)</u>
10 gpm	1248	20.8
12 gpm	1040	17.3
15 gpm	832	13.9

The sampling frequency is then derived from the dilution time interval, with the following considerations:

1. Boron sample analysis normal turnaround time is assumed to be 4 hours.
2. The extension of the sampling interval of up to 25% of the interval may be permitted.

3. The sampling frequency should be such that the worst case dilution event will be detected (i.e., sample analysis completed) before the reactor coolant concentration goes below 3500 ppm boron.

Sampling frequencies for a range of SDS flow rates are given below based on a 4 hour turnaround time for sample results.

<u>SDS flow rate</u>	<u>sampling interval</u>
10 gpm	13 hours
12 gpm	10 hours
15 gpm	8 hours

With the increase in sampling frequency, a method of sampling is needed that can be easily performed without requiring reactor building entry. Since the increased frequency is required only during IIF processing system operation, it is most convenient to obtain a sample in conjunction with its operation. The SDS is equipped with sampling capability at various points in the process stream. The reactor coolant sample will normally be taken from the high rad filter glove box at sample point A. This location is upstream from all filters and ion exchangers and allows a rapid transit time from the IIF to the sample point. Alternatively samples may be drawn from the intermediate level sample box, if required. This sample point is downstream of the filters and ion exchangers. This processing does not affect boron concentration in the reactor coolant. The transit time for a representative letdown flow to reach this sample location is approximately 100 minutes based on a 10 gpm flow rate.

Since the sample is taken at the IIF processing pump suction point, the sample comes directly from the water volume of the vessel and IIF. Based on experiments performed during feed and bleed operations with the RCS drained down, it was concluded that there is significant mixing of the total volume of water in the reactor vessel. It is judged that sufficient mixing of the reactor coolant in the vessel and IIF will occur to provide a reasonably representative sample from the IIF system, and that samples taken from the IIF will satisfactorily indicate any decrease in RCS boron concentration.

c) RCS Inventory Monitoring

To monitor the RCS inventory the following calculations are performed at given intervals.

- o Currently, procedures require that in the level control mode, an RCS leak rate check is performed every 24 hours for a period of four hours. During the four hour period all makeup and letdown to the RCS is secured. During reactor coolant processing leak rate checks are performed every 72 hours for a period of two hours. During IIF processing system operation, the RCS leak rate monitoring will be

performed every 72 hours. The monitoring period, however, may be increased to four hours if required to provide an adequate interval for leak rate measurement in the unpressurized condition.

- o Boron mass balance calculations are currently performed once every 24 hours during normal processing with the RCS pressurized or in the level control mode. These calculations are used to assure an adequate boron concentration exists even assuming any inventory discrepancy is unborated water. The frequency of the boron mass balance calculation will remain the same during operation of the IIF processing system.
- o Using tank level checks, the bleed tanks being used for makeup and receipt of reactor coolant are checked for any discrepancy in RCS inventory. To reduce the reactor coolant boron concentration from 4950 ppm to 3500 ppm requires the addition of greater than 10,000 gallons of unborated water. Discrepancies greater than 10,000 gallons require a temporary termination of processing until the discrepancy is investigated. During operation of the IIF processing system, RCS inventory calculations will be performed at the same frequency as RCS sampling to provide a verification of the RCS inventory for detection of a boron dilution event.

It is concluded that a recriticality due to a deboration event during operation of the IIF processing system has been precluded.

- o Adequate prevention of boron dilution has been provided by double isolation of potential pathways.
- o Adequate detection of a boron dilution event is possible by increased RCS sample frequency in conjunction with level monitoring and RCS inventory checks.
- o In the unlikely event that a boron dilution were to occur procedures require actions which provide the information needed to terminate the dilution transfer and will provide the mechanisms to return the RCS to the operating boron concentration.

3.3.2 Operation of the IIF Processing System in the Manual Level Control Mode

During manual level control operation of the IIF processing system the potential for boron dilution does not differ significantly from automatic level control operation. The sampling frequency and inventory calculation frequency during manual operation is specified as the same as that for automatic level control operation.

3.3.3 IIF Processing System in the Shutdown Condition

The installation of the IIF processing system introduces the following flow paths for the potential introduction of underborated water to the RCS.

- o From the reactor building basement pump system through the fuel transfer canal drain manifold to the discharge line of the IIF processing pump to the IIF.
- o From the fuel transfer canal drain pump through the fuel transfer canal drain manifold to the discharge line of the IIF processing pump to the IIF.

Both of these sources could contain underborated water. To provide double isolation, quick disconnect hoses and branch valves are provided at the fuel transfer canal drain manifold. When the IIF processing system is operating the two other branch hoses will be disconnected and the branch valves will be closed. This will provide double isolation from these sources. In addition a check valve in the IIF processing system branch line at the manifold will provide added assurance that these two pathways are not credible sources for boron dilution.

During the shutdown condition the configuration of the RCS is not significantly different than in the level control mode before head removal. Therefore those requirements for RCS sampling and inventory monitoring remain unchanged. These requirements are:

- o RCS will be sampled once per week. Sampling may be performed using a dedicated remote sampling system. This system will provide a means of obtaining a sample from outside the reactor building in the event that reactor building entry is precluded or deemed undesirable.
- o RCS leak rate determination will be performed once every 24 hours.

3.4 Radiological Considerations

3.4.1 Normal Operations

The IIF processing system is designed to provide increased water processing capability during the period between head removal and plenum removal. This increased capability is required to reduce radioactive contaminants in the RCS and to thereby reduce radiation dose rates for workers on and around the IIF.

The RCS level in the IIF will be maintained above the control rod guide tubes to provide adequate shielding of the strong plenum source. Reducing the radioactivity in the water will further reduce dose rates for workers on the IIF.

Without RCS processing the concentration of radioactive contaminants in the coolant increases. The concentration of cesium-137 reached levels of 6-8 $\mu\text{Ci/ml}$ after several months without processing with the RCS in the drained down condition. It is a goal to have reactor coolant concentrations at approximately 1 $\mu\text{Ci/ml}$ at the time of head removal. Based on the capability of the SDS with the IIF processing system operating at 10 gpm, reactor coolant concentrations of 0.1 $\mu\text{Ci/ml}$ and lower may be achieved. This is based on a system availability of 70%, which accounts for bleed tank recirculation and sample time.

Calculated radiation dose rates are used here to illustrate the benefits which may be attained by reducing the radioactive materials in the coolant. Based on data from the underhead characterization program, the anticipated dose rate contribution from the plenum and the reactor coolant in the IIF have been calculated. The dose rate increases for workers on the IIF cover were calculated assuming that the IIF cover holds 1 inch of lead shielding and that the water level in the IIF is 5' above the vessel flange. Note that decreasing the water level in the IIF decreases the shielding of the plenum and results in an increase in dose rate. The increases in general area dose rates were calculated for before the IIF processing system is available, i.e., with a reactor coolant (RC) concentration of 1 $\mu\text{Ci/ml}$, and after IIF processing has been operating, i.e., with an RC concentration of 0.1 $\mu\text{Ci/ml}$. The contribution from the plenum was based on the information contained in Reference 4. These dose rate increases are shown below.

<u>RC cesium-137 concentration</u>	<u>Dose rate on IIF cover (excluding background)</u>
0.1 $\mu\text{Ci/ml}$	5 millirem/hr
1.0 $\mu\text{Ci/ml}$	16 millirem/hr

During plenum inspection tasks workers may remove shielding plates from the IIF cover to provide tool and camera access into the vessel. Dose rates calculated as above, but assuming no shielding from the IIF cover, are given below.

<u>RC cesium-137 concentration</u>	<u>Dose rate above opening in IIF cover (excluding background)</u>
0.1 $\mu\text{Ci/ml}$	120 millirem/hr
1.0 $\mu\text{Ci/ml}$	610 millirem/hr

The entire IIF processing system has been examined for radiological impact to the reactor building environment. Considering the long hose lengths which will carry reactor coolant through the reactor building, the potential increase in general area dose rates due to this new source was evaluated. The following dose rates were calculated and show that the increase in worker exposures due to the hose is negligible.

RC cesium-137
concentrationDose rate 4' from hose
(excluding background)

0.1 $\mu\text{Ci/ml}$
1.0 $\mu\text{Ci/ml}$

0.1 millirem/hr
1.0 millirem/hr

Calculated dose rates do not consider any isotope in the reactor coolant except cesium-137. Other isotopes which may contribute significantly to gamma dose rates are cesium-134 and antimony-125. The cesium-134 concentration is normally an order of magnitude less than that of cesium-137. Antimony-125 is not removed from the coolant with a reliable decontamination factor by the SDS in its current configuration. However the dose rate for antimony-125 is less than that of cesium-137 for a given concentration. Current concentrations of antimony-125 are approximately 0.2 $\mu\text{Ci/ml}$. In addition, if antimony-125 in the reactor coolant becomes a significant dose contributor to workers on the IIF cover, the IIF processing system may be used to transfer water to the EPICOR II system in a batch processing mode. EPICOR II will remove the antimony-125 with a satisfactory decontamination factor.

3.4.2 System Failures

During normal operations the IIF processing system will function to reduce dose rates on the IIF cover to minimize worker exposures. However, to provide assurance that system failures will not result in unacceptable radiological conditions, consequences of system failures were examined. Failures which could potentially result in significant changes in radiological conditions are:

- o hose leakage
- o hose blockage
- o pump failure
- o bubbler failure
- o valve failure

Hose breakage or leakage may occur during IIF processing system operation. Hose is routed in the refueling canal, along the edge of the canal at the 347'-6" elevation, and along the floor at the 347'-6" elevation to the fuel transfer canal drain manifold at the north end of the reactor building. From the manifold, the hose leads a short distance directly to the reactor building penetration. Leakage from hose lines would either collect in the refueling canal or on the floor at the 347'-6" elevation.

To prevent possible leakage from the hoses all discharge hose and pipe will be leak tested in accordance with ANSI B31.1. Periodic visual inspection of the hose will be used to assess its condition. The pressure rating of the hose and couplings are higher than the IIF processing pump shutoff head (approximately 150 psig). An emergency shutoff switch is located on the handrail next to the

bubbler panel in the reactor building, to stop the system in case of hose breakage. Although precautions to prevent hose leakage have been taken, it has been determined that even significant leakage of reactor coolant onto the floor or in the canal would not increase radiation dose rates enough to prevent access to the area for cleanup of the spill. Conservative analyses have been done which indicate that large puddles of reactor coolant do not result in large increases in general area dose rates around the spill. These analyses assume cesium-137 concentrations greater than 1 $\mu\text{Ci/ml}$.

In the event the IIF discharge hose is blocked the effect would be similar to closing a valve downstream of FCC-V003. This would result in the pump either shutting down on thermal overload or on high level trip. In either case no unacceptable consequence results.

The pump used in the IIF processing system is a commercially available pump which has been shown to be highly reliable. It is expected that the IIF pump will operate successfully for the operational lifetime of the IIF processing system. However in the event of failure of the IIF pump the bubbler system will act to prevent overflow of the IIF as discussed previously.

In addition the pump installation has been designed such that removal of the pump for repair or replacement can be easily accomplished while minimizing worker exposures. Specifically, steps to remove the pump are

- o Remove the IIF cover shield plate from above the pump location
- o Loosen a single hold down bolt on the pump
- o Lift the pump using overhead lifting equipment.

In the event of pump failure the water processing capability would be greatly reduced, and some increase in radioactivity in the coolant may result. However, since the pump is easily removed and the pump is commercially available, this reduction in water processing capability would be minimized.

Bubbler system failures may cause one of two accident conditions: overflow of the IIF or reduction of the RCS level to the pump suction level. It should be noted that for the RCS level to go outside of the alarm setpoint levels there must be two independent instrumentation failures in the bubbler system during the automatic level control mode. Based on the reliability of these instruments this is an extremely unlikely event.

The bubbler system is designed as an Important to Safety system. Testing of all components will be performed prior to installation in the reactor building. Instrumentation is accurate to within ± 3 inches of water. Redundant level monitoring instrumentation is available (RC-LT-100) and is also equipped with setpoints which will sound an alarm in the control room in the case of unacceptable water level. RC-LT-100 has no control function over the IIF processing system, but will provide level indication in the control room and will alert operators to a potential overflow or low level condition.

Overflow of the IIF will not cause radiological conditions which would prevent access to the area for cleanup operations. All overflow from the IIF would be contained in the refueling canal. If IIF overflow is indicated by level monitoring instrumentation, the canal area can be easily monitored by closed circuit TV from areas outside the reactor building, so that IIF overflow could be verified and terminated. If a large overflow did occur, the fuel transfer canal drain system could be started to pump out the canal. Entry into the reactor building to connect the canal drain system to the manifold would not be precluded by reactor coolant in the canal, and airborne radioactivity would be no worse than that experienced when high activity water was present in the reactor building basement. An emergency stop switch located in the reactor building could be used to terminate overflow from the IIF.

The pumping of the IIF down to the pump suction point would reduce the water shield over the tops of the control rod guide tubes. The top of the pump suction is located at approximately the 325'-4" elevation. The top of the control rod guide tubes is at approximately the 324'-4" elevation. Therefore there exists approximately 12 inches of water above the guide tubes. This 12 inches of water along with the IIF cover, which consists of 3/4 inches of steel and approximately 1 inch of lead, still provides adequate shielding of the plenum source to permit access to the IIF cover.

Valves controlled by the bubbler system are MU-V9, used only during the automatic level control mode, WDL-V40 and FCC-V003. Failure of the controller valve MU-V9 may result in change of RCS level. However if an alarm level is reached the IIF processing system operation is automatically terminated. Valves FCC-V003 and WDL-V40 will both fail closed on the loss of air or electricity. Closure of valve FCC-V003 automatically trips the IIF processing pump, and the closure of WDL-V40 would simply terminate makeup which would soon cause a low level alarm condition and a termination of processing.

3.4.3 Dose Assessment

The dose assessment for operating the SDS in conjunction with the IIF processing system is given in Appendix 2 of Reference 1. No increase in release of airborne radioactivity to the reactor building atmosphere or from the reactor building to the environment from use of the IIF processing system is expected. In fact, the IIF processing system will help reduce the reactor coolant radioactive materials concentration which should minimize any airborne radioactivity release from the RCS in the reactor building.

3.4.4 ALARA

A major goal in the design of the IIF processing system has been to assure that radiation exposure to workers is maintained as low as is reasonably achievable. The purpose of the IIF processing system is to reduce radioactive materials in the reactor coolant and thereby

reduce radiation dose rates for workers on and around the IIF. Specific design features for the IIF processing system were incorporated to implement the ALARA concept. These features have been discussed previously and are summarized below.

- o The IIF pump is designed to be installed with the IIF immediately after head removal. This eliminates the need for personnel access to the IIF cover for this purpose before reactor coolant cleanup.
- o The IIF pump is a commercially available model, which requires short lead time if replacement becomes necessary, and thereby minimizes the amount of time with reduced water processing capability.
- o The IIF pump is equipped with lifting eyes and a single hold down bolt to simplify removal or movement, which permits operational flexibility.
- o Sufficient hose to the pump is provided to allow relocation of the pump if post head removal activities require it.
- o Evaluation of impact on reactor building dose rates due to the hose routing was performed to assure minimal increase in the general area dose rates, and hoses will be routed to maximize distance to work areas and to take advantage of existing structures for shielding as much as possible.
- o Failures of the IIF processing system components will not result in unacceptable radiological conditions for workers in the reactor building.

All work performed in the reactor building is reviewed by the Radiological Controls Department and is evaluated to assure that personnel radiation exposures are minimized according to established procedures.

In-containment work required by the operation of the IIF processing system involves hose disconnections at the fuel transfer canal drain manifold. Realignment of the flow path to the SDS is expected to be infrequent. All hose connections are equipped with quick disconnect fittings to facilitate connection and disconnection, which will minimize time required.

4.0 10CFR50.59 Evaluation

According to 10CFR50, paragraph 50.59, the holder of an operating license may make changes to the facility or perform a test or experiment, provided the change, test or experiment does not involve a change in the plant technical specifications or an unreviewed safety question. A proposed change involves an unreviewed safety question a) if 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) if a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created, or c) if the margin of safety as defined in the basis for any technical specification is reduced.

The operation of the IIF processing system does not present an unreviewed safety question as discussed below.

- a) Accidents presented and analyzed in the TMI-2 Safety Analysis Report, Technical Evaluation Reports, Systems Descriptions, and Safety Evaluation Reports address events which bound by a wide margin the potential consequences of any planned or postulated unplanned event that might occur in connection with the operation of the IIF processing system. Potential system failures and their consequences are discussed in Section 3.0 of this report.
- b) The possibility of an accident or malfunction of a different type than any previously evaluated in the safety analyses is not created by the operation of the IIF processing system. The IIF processing system is essentially a liquid radioactive waste system used to maintain the reactor coolant at low specific activities. As such the possibility of an accident or malfunction is of the same type as previously evaluated for other liquid radioactive waste systems, including the SDS. Since the potential source term in the RCS to be processed by the IIF processing system is much smaller than other liquid radioactive waste streams processed by SDS, any consequences of accidents or malfunctions would be bounded by a large margin by other safety analyses.
- c) Operation of the IIF processing system does not result in a reduction in the margin of safety as defined in the basis for any technical specification. Possible releases of radioactive effluents to the environment will be bounded by a large margin by those resulting from the use of the SDS for cleanup of the reactor building basement water which was constrained by Appendix B of the Technical Specifications.

Based on the above the operation of the IIF processing system does not present an unreviewed safety question. No change in plant technical specifications is required by operation of the IIF processing system.

5.0 Conclusions

Based on the safety evaluations contained in this report the following provisions have been demonstrated.

- o Adequate measures for the prevention of an RCS boron dilution event will be taken.
- o Adequate detection capability exists in the unlikely event that a boron dilution event does occur.
- o Subcriticality of the core will be maintained.
- o Occupational exposures will be maintained as low as is reasonably achievable.
- o Radiological consequences of system failures are acceptable.
- o Activities addressed do not present an unreviewed safety question.

In conclusion, the operation of the IIF processing system does not present undue risk to the health and safety of the public.

6.0 List of References

1. Submerged Demineralizer System Technical Evaluation Report, June 1983.
2. Safety Evaluation Report for Removal of the TMI-2 Reactor Vessel Head, Rev. 5, February 1984.
3. Safety Evaluation for Insertion of a Camera into the Reactor Vessel Through a Leadscrew Opening, Rev. 2, July 1982.
4. TPO/TMI-042 Rev. 1, "Dose Modeling of Underhead Source".