Supplement No. 1

to

Appendix No. 1

to

Submerged Demineralizer System
Technical Evaluation Report

REACTOR COOLANT PROCESSING PLAN
WITH THE REACTOR COOLANT SYSTEM
IN A PARTIALLY DRAINED CONDITION

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Chapter 1
Summary of Treatment Plan

1.1 Project Scope

The decontamination of the TMI-2 Reactor Coolant System (RCS) requires the processing of the radioactive contaminated water to reduce the activity therein. The present activity level of this water is given in Table 1.1. To date, approximately 250,000 gallons of water have been processed from the RCS. The feed and bleed operation via the Submerged Demineralizer System (SDS) has reduced the radionuclide concentration of the RCS water; specifically the Cs-137 concentration was reduced from 14.0 to 2.5 μCi/cc. Recent samples from the RCS, taken since the processing has been suspended have revealed a gradual increase in the radionuclide concentrations in the RCS water. The reasons for this increase are not fully understood, but they may continue in the future. Therefore, the need to achieve and maintain the radionuclide concentration goal of 1 μCi/cc requires further RCS processing.

The RCS,is at present, partially drained and opened to the reactor building atmosphere. This report describes the processing of the RCS by the SDS while maintaining the RCS in the partially drained,open condition. The design features of this processing method will utilize:

1. Proven processing capabilities of the SDS, and
2. Existing plant systems in support of the SDS.

This report is presented as an addendum to the previously submitted SDS Technical Evaluation Report (TER) including Appendix No. 1 dated March 1982, to provide for future processing of the RCS water.

1.2 Current RCS Radionuclide Inventory and Chemistry

Water samples have been taken continuously from the RCS to identify specific radionuclides and concentrations, and plant chemistry. Present activity results are listed in Table 1.1. This data is based on actual samples taken. RCS activity decreased during previous processing via the SDS, but now appears to be increasing. The Cs-137 activity has increased from 2.5 to 4.1 μCi/cc since RCS processing was terminated. Further increases are possible if processing is not continued in the future.

1.3 RCS Conditions

The RCS has been partially drained to a water level of 210" ± 6", the CRDM top closures are removed and the system is vented to atmosphere. This configuration is required to accommodate pending investigations within the reactor vessel. In the future, the RCS will have to be drained to below the reactor vessel flange to permit removal of the reactor vessel head. Processing of the RCS water through the SDS is desirable and may be mandatory in either condition.

Table 1.1
Present RCS Radionuclide and Chemistry Data

Isotope	Radionuclide Concentration μCi/cc
H-3	0.049
Kr-85	N/A
Sr-90	12.0
I-131	$<2.8 \times 10^{-3}$
Cs-134	0.32
Cs-137	4.1
Gross Beta	15.0
pH	7.70
Boron	3875 ppm
Na	820 ppm
Cl	1.2 ppm
H_2	N/A
N_2	N/A
O_2	N/A

1.4 RCS Processing Description

On a batch basis, radioactive RCS water is letdown to Reactor Coolant Bleed Tank (RCBT) "C" while clean water is injected into the RCS from RCBT "A". RCS water is then pumped from RCBT "C" through the prefilter and final filter, bypassing the SDS water storage tanks. RCS water then goes through the RCS manifold and the SDS ion exchangers. The effluent from the ion exchangers is routed through the post filter to RCBT "A" for chemical adjustment, if necessary, and injection back into the RCS as makeup. The above process is repeated until the RCS water is decontaminated. EPICOR II will not be used for processing RCS water unless needed for chloride control.

The processing of the RCS will use the existing filters and ion exchangers of the SDS. Existing sampling connections will be used on the influent and effluent of the filters and ion exchangers to determine radionuclide and chemical composition of the RCS before and after processing.

As described in the SDS TER, the prefilters and final filters consist of sand filters for the removal of particulate matter. These filters are followed by a series of ion exchange vessels containing about 8 cubic feet of zeolite ion exchange media. Location, operation, and handling of these vessels remains unchanged from the mode of operation used for processing of the Reactor Building sump water and the RCS water as described in the SDS TER and Addendum No. 1.

Chapter 2
RCS Processing Plan Design Criteria

2.1 Introduction

This modified RCS Processing Plan is designed to use the Submerged Demineralizer System (SDS) and portions of existing plant liquid radwaste disposal systems to decontaminate the RCS water. This will reduce plant personnel and off site radiation exposures. The design objectives of this processing plan are to utilize:

1. A system that is as independent as possible from existing radioactive waste systems at TMI-2. The SDS portion of this plan is a temporary system for the recovery of TMI-2. Only small sections of existing TMI-2 plant systems will be used.

2. A system that has proven performance in processing radioactive waste. The SDS portion of this processing plan has successfully decontaminated the Reactor Building sump and the RCS water.

2.2 Design Basis

2.2.1 Submerged Demineralizer System

The Submerged Demineralizer System was designed in accordance with the following regulatory documents:

1. Code of Federal Regulations, 10CFR20, Standard for Protection against Radiation.
2. Code of Federal Regulations, 10CFR50, Licensing of Production and Utilization Facilities.
3. U. S. Regulatory Guide 1.21, dated June 1974.
4. U. S Regulatory Guide 1.140, dated March 1978.
5. U. S. Regulatory Guide 1.143, dated July 1978.
6. U. S. Regulatory Guide 8.8, dated June 1978.
7. U. S. Regulatory Guide 8.10, dated May 1977.

The design basis for the SDS is presented in greater detail in Chapter 4 of the SDS Technical Evaluation Report.

2.2.2 Interfacing Systems

The interfacing systems with the SDS in the RCS Processing system are:

1. Radwaste Disposal (Reactor Coolant Liquid) System.
2. Reactor Coolant Makeup and Purification System.
3. Auxiliary and Fuel Handling Buildings Heating Ventilation and Air Conditioning Systems.
4. Nitrogen Supply System.
5. Decay Heat Removal System.
6. Waste Gas System.
7. Standby Pressure Control System
8. Spent Fuel Cooling System
9. Instrument Air System

The design criteria for these systems are presented in Chapter 3 of the TMI-2 FSAR. Conformance to these criteria is presented in the respective sections for these systems in the TMI-2 FSAR.

2.3 RCS Processing Plan Goal

The goal of the RCS Processing Plan is to reduce the total radionuclide concentration of Cs in the RCS to less than 1 uCi/cc. The RCS chemistry will be maintained as follows as a minimum:

Chlorides	<5 ppm
Oxygen	Approximately 8 ppm
pH	>7.5
Boron	>3500 ppm

The processing of water through the SDS is not expected to have any undesirable effect on the chemical characteristics of the RCS water. Maintaining proper chemistry of the makeup water will ensure that there will be no adverse effects on the RCS with respect to corrosion. The boron concentration of the makeup will also ensure that sufficient boron is present to maintain the core in a non-critical safe condition. Sampling of the RCS water will be continued by taking samples via the CRDM nozzle in accordance with TCN 2-82-362 to Operating Procedure 2104-10.7 because to obtain samples via the letdown system in this configuration is not possible without modifying the present sampling system.

Chapter 3
System Description and Operations

3.1 Introduction

The modified RCS Processing Plan is designed specifically for the controlled decontamination of the radioactive water in the RCS and the treatment of the radioactive gases and solid radioactive waste which are produced. This plan will use the SDS as the means of decontamination of the RCS with support from other existing plant systems.

3.1.1 Submerged Demineralizer System

The SDS consists of a liquid waste processing system, an off gas system, a monitoring and sampling system, and solid waste handling system. The liquid waste processing system decontaminates the RCS water by a process of filtration and demineralization. The off gas system collects, filters and absorbs radioactive gases produced during processing, sampling, dewatering and spent SDS liner venting. The sampling system provides measurement of process performance. The solid waste handling system is provided for moving, dewatering, storage, and loading of filters and demineralizer vessels into the shipping cask. The SDS will be unchanged from that described in the SDS TER.

3.1.2 Interfacing Systems

Interfacing with the SDS are existing plant systems, as given in Section 2.2. The Reactor Coolant Liquid Waste Chain provides a staging location for the SDS for collecting and injection of RCS water from and to the RCS. The Fuel Handling Building and Auxiliary Building HVAC systems provide tempered ventilating air and controlled air movement to prevent spread of airborne contamination with the plant and to the outside environment. The Nitrogen Supply system provides N_2 for blanketing the Reactor Coolant Bleed Tanks. The Makeup and Purification and Spent Fuel Cooling Systems provide piping for the transfer of the waste water. The Waste Gas System processes the gases from the vents from the RCBT's. The Instrument Air System provides air pressure for air-operated valves in the Interfacing Systems. The Standby Pressure Control System, installed as a temporary TMI-2 recovery system, will be used as a backup system to ensure a source of additional makeup to the RCS.

3.2 RCS Water Processing Preparation

3.2.1 RCS Preparation

The RCS will be maintained in a partially drained condition vented to atmosphere. Its water level may vary from Elevation 347' to 323'6" depending on the needs for access to the reactor vessel. The minimum water level is expected to be 323'6" (1' above the reactor vessel flange).

3.2.1 RCS Preparation (continued)

At this level and at all levels above this, the Waste Transfer pumps will be used to inject RCS makeup water into the RCS for the RCS cleanup process. The maximum discharge pressure of these pumps is 74 psig at a flow rate of 40 gpm. Flow to the RCS will be controlled by valve WDL-V-36A or 36B depending on which waste transfer pump is used for feed and, if necessary, MU-V-9. MU-V10 will also be open to permit makeup flow to the RCS. The flow rate to the RCS will be maintained at less than 5 gpm to match the letdown flow rate. Minor adjustments in flow rate will be made to maintain the RCS water level within the limits required.

The decay heat analysis as reported in Appendix B TMI-2 Decay Heat Removal Analysis, April 1982, submitted as a part of the Safety Evaluation for Insertion of a Camera into the Reactor Vessel Through a Leadscrew Opening Rev. 2 July 1982, is applicable for the RCS processing described herein. The average incore coolant temperature will be limited to less than 170°F. This criterion was adopted as a conservative value for the recovery program to maintain a positive margin to boiling.

3.2.2 SPC Operation

The Standby Pressure Control System (SPC) will serve as a backup system to ensure that the RCS level is maintained during RCS processing.

3.2.3 Reactor Coolant Liquid Waste Chain

Prior to starting RCS water processing, the RCBT "A" will be filled with more than 50,000 gallons of borated, suitable, processed water. The radionuclide and chemistry data for this water will be similar to that used for RCS makeup during the previous RCS processing period. Chemicals will be added to this water if required to ensure that this water complies with the plant chemistry specified in Section 2.3.

3.3 RCS Water Letdown and Injection

RCS letdown will be performed by a bleed and feed process of simultaneously removing the radioactive RCS water and injecting borated processed water at the same flow rate to maintain RCS water volume constant. The bleed and feed process will be controlled from the Control Room in coordination with the Radwaste Control Panel. The RCS water is letdown through the normal letdown line on the loop cold leg before Reactor Coolant Pump RC-P-1A. The letdown rate is 5 gallons per minute or less. The RCS water is letdown through the letdown coolers to RCBT "C". The plugged block orifice and isolated Makeup Demineralizers and Filters are bypassed. As the RCS water is letdown, simultaneously the borated processed water located in RCBT "A" is injected to the RCS. After RCBT "C" has been filled to more than 50,000 gallons, the letdown and injection of water from and to the RCS will be secured. RCBT "C" will be recirculated prior to processing. After recirculating, decontamination of the RCS radioactive water by SDS will commence.

3.4 RCS Processing by SDS

RCS filtering through the SDS will be the same as that described in Appendix 1 to the Submerged Demineralizer System Technical Evaluation Plan - Reactor Coolant Processing Plan March 1982. Radiation protection, dose assessment, accident analysis, and the conduct of operations are similarly the same as reported in this document.

4.1 RCS Processing Safety Assessment

Processing of the RCS while in a partially drained condition does not present a unique safety concern. The actual processing of Reactor Coolant is adequately addressed in the SDS Technical Evaluation Report and the maintenance of the Reactor Coolant System in a partially drained condition is adequately addressed in the Quick Look Safety Evaluation. The only evolution not previously addressed is the simultaneous feed and bleed of the Reactor Coolant System in a partially drained configuration. During this evolution, RCS water level will be monitored and maintained by operating procedures. Such procedures will maintain the water level to within six (6) inches of the predetermined level set point. At the present RCS level, to permit incore inspections, this level is 210" ± 6". This level is the same as that established for the Quick Look program and will be monitored in a similar fashion. Thus this evolution will not increase the probability of occurrence or consequences of an accident previously evaluated or create the possibility of a different type accident, nor will the margin of safety as defined in the basis for any Technical Specification be reduced.

APPENDIX C

REACTOR COOLANT SYSTEM (RCS) DILUTION SAFETY EVALUATION

I. INTRODUCTION

During the "Quick Look" testing, reactor shutdown (subcriticality) will be assured by the presence of boron in the reactor coolant. The Quick Look Safety Evaluation has shown that maintaining RCS boron concentrations of 3500 ppm or greater assures subcriticality under all credible conditions.

TMI Unit 2 operations during the past two years has demonstrated that it is possible to maintain a controlled boron concentration in the RCS. However, during the "Quick Look" testing the RCS conditions will differ from those that existed during the previous two years. The primary coolant level will be lowered and the primary coolant pressure will be reduced. In view of these differences it is necessary to evaluate the ability to continue to reliably maintain a controlled boron concentration in the RCS. The purpose of this appendix is to review the precautions that will be taken to assure that the required RCS boron concentraton will be maintained.

The Reactor Coolant System temperature and chemistry will not be significantly affected by the Quick Look test and, hence, boron solubility will remain essentially unchanged. The only way RCS boron concentration can be changed in an uncontrolled manner during this test is by dilution of the RCS coolant with water that is either, unborated or borated below 3500 ppm. This discussion will therefore review the methods that will be used to prevent boron dilution.

Uncontrolled boron dilution will be prevented by a combination of prevention, monitoring, and corrective actions.

The following discussion shows that the procedures in effect during the time the RCS is depressurized will prevent the uncontrolled addition of coolant to the RCS and, hence, prevent the uncontrolled reduction of the boron concentration. In addition, if for some unforeseen reason boron dilution should occur, the monitoring and corrective action procedures will preclude significant reductions in boron concentration and assure the reactor remains shutdown.

II. ACTIONS TAKEN TO PREVENT BORON DILUTION

As stated above, boron dilution will result if water containing boron concentrations less than 3500 ppm is added to the RCS. The sources of this water are the various systems connected to the RCS which includes the secondary system. Systems which potentially contain coolant with boron concentrations less than 3500 ppm have been reviewed to assure that they will not be creditable sources of boron dilution.

The following actions will be taken to prevent the unintentional dilution of the boron in the RCS. It is concluded that these actions will prevent the dilution of the RCS boron concentration during the time the pressure and water level are lowered.

1. Steam Generator

One potential source of dilution of the RCS boron is steam generator coolant leakage through the steam generator tubes. The potential for this leakage has been precluded in the past by maintaining the RCS pressure higher than the secondary coolant pressure, any leakage would be from the RCS to the secondary system.

During the "Quick Look" the primary system pressure will be reduced to atmospheric pressure. To preclude RCS dilution while the RCS pressure is reduced, procedures require that water levels in the secondary side of the steam generators will be maintained lower than the levels in the primary side. In this manner the preferred potential leakage path, from primary to secondary volumes, is maintained. Under these conditions the secondary volume of the steam generators will not be a credible source of RCS boron dilution.

2. Makeup and Purification Standby Pressure Control Systems

These systems are borated greater than 3600 ppm and will be operated by approved procedures to letdown, processing through the SDS System and makeup back to the RCS. The makeup pumps MU-P-1A/B/C will tagged "off" and portions or connections to these systems that are not used for makeup will be isolated. Should the RCS level decrease below the controlled range, letdown from the RCS will be secured until the level increases to the controlled range. Should the level continue to decrease, makeup will be initiated from the SPC System using approved procedures. Assurance that the makeup water is borated greater than 3600 ppm will be provided by analysis of a sample taken from the appropriate Reactor Coolant Bleed Holdup tank of each batch used for makeup.

3. Demineralized Water System

The demineralized water system has been reviewed and where possible spool pieces in the flow path to the RCS have been removed. Where this could not be done, isolation valves in the flow

paths have been tagged shut.

4. Submerged Demineralizer System

During the RCS processing period, the SDS will be operated to process the water letdown from the RCS. This will not create a dilution problem because the SDS will be isolated from the Reactor Coolant System except via the appropriate Bleed Holdup Tank which will be monitored for boron content.

5. **Other Systems**

TABLE 1

Decay Heat Removal
Mini Decay Heat System
Core Flood System
Intermediate Closed Cooling Water
Nuclear Services Closed Cooling Water
Decay Heat Closed Cooling Water
Chemical Addition
Steam Generator Feed Water
Spent Fuel Cooling

The following actions will be taken to prevent dilution of RCS boron by unintentional transfer from the systems in Table 1 of coolant containing boron concentrations less than 3500 ppm to the RCS.

A. The systems in Table 1 have been reviewed and isolation valves in the flow paths have been tagged shut.

B. A checklist has been prepared listing all valves that are to be used for isolation during the time the RCS is at reduced pressure (including those in Section II.2, 3, and 4). The position of these valves will be confirmed every 24 hours during this period.

C. **All pumps in these systems; except nuclear services closed cooling water which cools the instrument air compressors and waste gas compressors; will be tagged out to further preclude the inadvertent transfer of coolant to the RCS.**

D. **The levels of all storage tanks that could be sources of water into the RCS will be monitored and logged once every 24 hours.**

E. The systems in Table 1 will not be operated in any manner, except for emergencies where plant safety is involved, while the control drive mechanisms are open during the Quick Look. All other times their operation will be limited to those actions necessary to support plant operation. Such operations will require the written approval of the Shift Foreman and will be conducted under his direct surveillance. During this period any change in status or operation of the systems in Table 1 will be entered into the control room log. Surveillance testing for the systems in Table 1 will be postponed during the time the RCS is at atmospheric pressure.

III. ACTIONS TAKEN TO DETECT AND TERMINATE INADVERTENT BORON DILUTION

The actions described in Section III will prevent the inadvertent dilution of the boron in the RCS. However, even though such dilution is unlikely, procedures have been established to assure the early detection of a dilution event. In such a case, action can be taken to find the source of the dilution and stop it or to inject additional boron.

The boron concentration will be monitored by monitoring the RCS coolant level. After the RCS level has been reduced, a base system leakage rate will be established. Using this leakage rate a plot of predicted level versus time will be given to the operations staff. Superimposed on this predicted level will an ± alarm and + action level limit. The alarm levels will be 24 inches above and below the base levels. The action level is 12 inches above the base level. If it is assumed that unborated water is being added to the RCS, the RCS boron concentration will still be above 3500 ppm at the higher alarm level. The lower alarm level is used as a precaution to indicate a possible increase in plant leakage and, hence, a need change the level.

Procedures will require the following action in the event the high action level is exceeded.

1. The control room operation log discussed in Section II 2E will be reviewed to attempt to determine the source of dilution.
2. The position of all isolation valves and status of all pumps discussed in Sections II 2B and C shall be checked.
3. Storage tank levels (Section II 2D) will be checked to determine the source of coolant dilution.
4. Quick Look operations shall be temporarily terminated and the mechanism seal shall be replaced if the high alarm level is reached.

If the above actions do not stop the incraase of RCS coolant level and high alarm level is reached, the TMI Unit 2 Emergency Procedure 2202-1.2 "Unanticipated Boron Dilution" will be used to increase the RCS boron concentration.

In the event the lower alarm level is reached, a new base level curve will be established with appropriate alarm and action level limits.

In addition to monitoring the RCS coolant levels and the alarm and action levels discussed above, the source range neutron instrumentation will be monitored. A base count rate will be established after the coolant level has been lowered. An increase in count rate for more than one minute, of two times the base count rate shall be considered an alarm limit. An increase of five times the count rate for less than one minute shall also be considered an alarm limit. On reaching these limits the response will be the same as for the RCS coolant high level alarm.

V. SUMMARY

The actions discussed above are considered sufficient to preclude inadvertent boron dilution. In the unlikely event such dilution were to occur, procedures will permit its detection and provide the information needed to terminate the coolant transfer. Based upon the use of these plant limits and procedures, reactor shutdown is assured and criticality is not considered credible.