Nuclear

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July 21, 1982
4400-82-L-0098

TMI Program Office
Attn: Mr. L. H. Barrett, Deputy Program Director
US Nuclear Regulatory Commission
c/o Three Mile Island
Middletown, PA 17057

Dear Sir:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Once Through Steam Generator (OTSG) Layup Recirculation System

Attached for your review and approval is the Technical Evaluation Report (TER) for the Once Through Steam Generator (OTSG) Layup Recirculation System. Current planning is to install this system to clean up the activity in the "B" OTSG and ensuring the appropriate chemical controls are in place on both OTSG's.

GPU is prepared to meet with members of your staff within two (2) weeks from the submittal of this document to discuss any questions you may have.

D009

Sincerely,

J. J. Barton
Acting Director, TMI-2

JJB/JJB/jep
Attachment
CC: B. J. Snyder, Program Director - TMI Program Office

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I. INTRODUCTION

The OTSG Recirculation System has two main functions, one of which is temporary in nature. The temporary function is the cleanup of radioactivity in the "B" OTSG; approximately 1.8 curies based on a sample taken in October 1979. After the "B" OTSG is decontaminated to levels below detectable limits based on a 100 ml sample the system will be used for periodic recirculation, sampling and chemical addition to both OTSG's for chemistry control.

The following documents were used as guidance in designing the OTSG Recirculation System:

1. Regulatory Guide 1.143
2. ANSI B31.1
3. ASME Section IX

II. DESIGN CRITERIA

1. SCOPE

This document provides the design criteria for the OTSG Recirculation System which is necessary for wet layup of the OTSG secondary sides and Main Steam lines.

2. INTRODUCTION

This temporary system is required for long term wet layup of OTSG 1A & 1B secondary sides (Figure 1 is a flow diagram for the system). The system will have the following capabilities:

a) Recirculation of the OTSG's at approximately 100 GPM.

b) Chemical addition by using the chemical pot feeder.

c) Particle filtration of 3, 10 or 30 microns depending on filter element installed.

d) Water treatment and cleanup by using the installed disposable demineralizer (to be installed later).

e) Radioactive water cleanup using installed flanged taps and remote 4X4 demineralizer package using existing, proven equipment and procedures from the Epicor II system. This package is shown in Figure 2. This feature is not integral to the system and is only intended to remove the residual contamination (principally Cesium 134 and 137 with a total activity of approximately 1.8 curies) presently in the shell side of OTSG 1B. The package will then be disconnected and removed from the system. The layup recirculation system is not categorized as a waste processing system, but will be evaluated in all radiation control aspects pertinent to its initial use for activity cleanup of OTSG 1B.

f) Appropriate sampling points including inlet and outlet flow to AXA demineralizer.

g) Instrumentation for total flow and flow through demineralizer is provided.

h) Provisions for makeup with deaerated demineralized water.

i) Following contamination cleanup of OTSG 1B, shell side water chemistry in both steam generators will be monitored in accordance with the specifications in reference 6.4.

The temporary tie-ins for the system do not violate containment integrity since they do not form a primary boundary between inside and outside containment nor comprise a pressure boundary for reactor coolant. These boundaries are provided by the MS and FW piping inside containment and the OTSG tubes and vessel shell. Portions of the system do, however, constitute secondary, or backup, containment isolation, and are designed to withstand all credible pressure and temperatures to which they may be subjected. Valves at the tie-ins points do not meet the definition of containment isolation valves per 10CFR50 Appendix J subsection II.H, however they do meet the pipe line specifications except for code classification and QA requirements. Since N-2 valves will not be used as containment isolation valves, the system is designed with a high pressure side (600#) and low pressure side (150#) and with a positive means of containment isolation. The boundaries between the two portions are established with sets of easily accessible 600# flanges which can be blanked off if a transient should occur. Designing the system in this configuration also eliminates the need for an overpressure protection device.

3. DESIGN REQUIREMENTS

3.1 Codes, Standards, and Guides

3.1.1 Design and fabrication of the new hard piped portion (excluding the 4X4 demineralizer package) shall be in accordance with the applicable portions of ANSI B31.1.

3.1.2 Welding shall be in accordance with ASME Section IX.

3.2 Design Pressure and Temperature

3.2.1 Design Pressure is 90 psig

3.2.2 Design Temperature is 120°F

3.3 Piping supports shall be in accordance with Burns and Roe typical piping support document. Spacing shall be 10-feet maximum for 2-inch diameter piping and 7-feet maximum for 1-inch diameter piping.

3.4 Any system leakage will be directed to plant sumps or tanks controlled for potentially contaminated water. Provisions shall be made to transport leakage water from these points to appropriate waste disposal facilities, if necessary.

3.5 The 4X4 demineralizer will be located in the Turbine Building and shielded as required to prevent unnecessary personnel exposure. The only airborne activity that will be released is tritium in proportion to the appropriate liquid concentration and the applicable vapor pressure.

4. TESTING

4.1 All welds shall receive a final visual examination.

4.2 The hard piped portion of the system shall be hydrostatically tested to 135 psig using ANSI B31.1 as a guide.

5. QUALITY ASSURANCE

5.1 Design, procurement, fabrication, and testing of portions of the hard piped sub-system transporting contaminated water from OTSG 1B are within Quality Assurance scope. QA requirements are established using the guidelines of Regulatory Guide 1.143, Rev. 1.

5.2 The temporary 4X4 demineralizer package is not a newly designed and constructed sub-system, but rather uses established and proven equipment and procedures. Installation and operation of this sub-system are within Quality Assurance scope. Program requirements will consist of installation procedure review and surveillance.

6. REFERENCES

6.1 Drawing JS012181-A

6.2 1410-Y46 Concrete Core Drilling of Class I, II & III floors, walls, and ceilings.

6.3 S-ECM 823

6.4 Procedure 2106-2.9, "Operating Procedure, Long Term OTSG Cooldown System.

6.5 B&R Dwg. #2606 - Flow Diag. OTSG Chemical Cleaning System.

NOTE: A critical item in the wet layup is the need for a complete fill to the upper tubesheet. This can be accomplished by venting via SV-V25A/B and SV-V26A/B during a Reactor Building entry.

III. DETAILED DESIGN

1.0 INTRODUCTION

1.1 System Functions

The functions of the temporary OTSG Recirculation System are to provide a means to recirculate and chemically treat the water in both OTSG's while they are in wet layup. The system has the following capabilities:

A. Recirculation of the OTSG's at approximately 100 GPM.

B. Chemical addition by using the chemical pot feeder.

C. Particle filtration of 3, 10 or 30 microns depending on filter element installed.

D. Water treatment and cleanup by using the installed disposable demineralizer.

E. Radioactive water cleanup using installed flanged taps reinforced rubber hose, quick disconnect fittings, and remote 4X4 demineralizer package. This feature is not integral to the system and is only intended to remove the residual contamination (principally Cesium 134 and 137 with a total activity of approximately 1.8 curies) presently in the shell side of OTSG 1B. The package will then be disconnected and removed from the system. The layup recirculation system is not categorized as a waste processing system.

F. Sampling points at two locations.

G. Instrumentation for total flow and flow through demineralizer is provided.

H. Provisions for makeup with deaerated demineralized water.

I. Following contamination cleanup of OTSG 1B, shell side water chemistry in both steam generators will be monitored.

The following systems have an interface with the Temporary OTSG Recirculation System (Drawing numbers refer to Burns & Roe, Inc., flow diagrams):

a. Demineralized Service Water (Dwg. #2007)

b. Main Steam (Dwg. #2002)

c. Feedwater (Dwg. #2005)

d. Waste & Contaminated Drains (Dwg. #2391)

1.2 Summary Description of the System

The major components of the system are located in the southwest corner of the Control Building area with the exception of the temporary 4X4 demineralizer which is placed in an out-of-the-way location in the Turbine Building and shielded while in operation. Tie in to the 4X4 demineralizer is via reinforced rubber hoses. In the OTSG "B" cleanup mode water is drawn from the OTSG, circulated through a 4X4 demineralizer and pumped back to the OTSG.

After OTSG "B" is cleaned up and the 4X4 demineralizer is removed, system flow is from the Main Stream (MS) lines through the system and to the OTSG via the Feedwater (FW) line. Provisions are made for filtering, water treatment with a demineralizer and chemical addition with a pot feeder. The vertical portions of the MS lines leading up to the main turbine are not filled with water and provide a surge chamber to accomodate system water volume changes due to temperature changes.

1.3 System Design Requirements

1.3.1 General

The OTSG Recirculation System is constructed with commercial quality piping, valves and components. The system is of non-Seismic (Seismic II) design. Any connection to Seismic I walls, floors, or ceiling are made with approved fasteners.

The system is sized to produce a flow in the straight recirculation path of 100 gpm. Design flow through the system demineralizer is 18 gpm.

The temporary tie-ins for the system do not violate containment integrity since they do not form a boundary between inside and outside containment. That boundary is provided by the MS and FW piping inside containment and the OTSG tubes and vessel shell.

The isolation valves at the tie-ins points do not meet the definition of containment isolation valves per 10CFR50 Appendix J subsection II.H. Therefore, they were not selected with that intention; but, do meet the pipe line specifications. Since the plant is shutdown and the drilled chemical cleaning flanges will be replaced with new blind flanges prior to plant restart, high energy pipe line breaks are not a consideration. Therefore, the recirculation system and the tie-ins to the existing N-2 safety class steam and feedwater piping are not designed to N-2 requirements.

1.3.2 Major System Components

a) One OTSG Recirculation System Pump

b) One OTSG Recirculation System Filter

c) One OTSG Recirculation System Water Treatment Demineralizer

d) One remote 4X4 demineralizer (removed after OTSG "B" cleanup)

e) One OTSG Recirculation System Chemical Pot Feeder

1.3.3 Codes, Standards, and Guides

Design and fabrication of the hard piped portion (excluding the 4X4 demineralizer package) is in accordance with the applicable portions of ANSI B31.1. Welding is in accordance with ASME Section IX.

1.3.4 Design Pressure & Temperature

The following is the calculation for the design pressure of the system:

MAXIMUM DISCHARGE PRESSURE OF PUMP (SHUT OFF HEAD)=120 FT.

ELEVATION HEAD OF OTSG = 64 FT.

TOTAL HEAD = 184 FT.

TOTAL SYSTEM PRESSURE = 184 FT./2.31 FT./PSI = 79.65 PSIG

FOR CONSERVATISM DESIGN PRESSURE = 90 PSIG

DESIGN TEMPERATURE IS 120°F

1.3.5

Piping supports are in accordance with Burns & Roe Typical Piping Support Document currently in use. Spacing is 10-feet maximum for 2-inch diameter piping and 7-feet maximum for 1-inch diameter piping.

1.3.6

Any system leakage will be directed to plant sumps or tanks controlled for potentially contaminated water. Provisions are made to transport leakage water from these points to appropriate waste disposal facilities, where necessary.

1.3.7

The 4X4 demineralizer is located in the Turbine Building and shielded as required. Local leakage retention features will be employed. The demineralizer will be vented to a controlled and radiation monitored system.

1.3.8 Testing

All welds received a final visual examination. The hard piped portion of the system was hydrostatically tested to 135 psig using ANSI B31.1 as a guide.

1.3.9 Quality Assurance

Design, procurement, fabrication, and testing of the hard piped portion of the system are within Quality Assurance scope, in consideration of its use to transport contaminated water from OTSG 1B. Quality Assurance requirements were established using the guidelines of Regualtory Guide 1.143, Rev. 1.

The temporary 4X4 demineralizer package is not a newly designed and constructed system, but rather uses established and proven equipment and procedures. Inclusion in Quality Assurance scope is not required to insure adequate containment of contaminated fluid during the OTSG 1B cleanup phase. Normally, only one OTSG is lined up for recirculation while the other is kept isolated. This precludes any large scale mixing of water between the OTSG's.

The piping within the OTSG Recirculation System (excluding 4X4 demineralizer package) is designed, fabricated, inspected and erected in accordance with ANSI B31.1.0, Power Piping, while valves are in accordance with applicable ANSI pressure temperature ratings. Piping design details are stated in B&R Specification 2555-64, "Pipe Fabrication, Nuclear and Conventional".

2.0 DETAILED DESCRIPTION OF SYSTEM

2.1 Components

2.1.1 OTSG Recirculation Pump DR-P-1

The pump is a horizontal, close-coupled, single stage, 5-1/2 inch enclosed impeller centrifugal pump driven by a 10 H.P. motor. The pump is of all iron constiuction to be compatible with the relatively high concentration of hydrazine in the water being pumped. The pump's rated total dynamic head is 115 feet (at shutoff).

A stuffing box with five packing rings is utilized to protect against leakage. If it is desired at a later time to switch to mechanical shaft seals, no machining of the case is required.

The pumps two wear rings are replaceable.

The pump is powered from Bus 2-3A.

2.1.2 OTSG Recirculation System Filter GR-F-1

The system filter is a 150 psig/250°F carbon steel housing which holds 5 replaceable elements. Elements can be obtained in 3, 10 and 30 microns ratings. Pressure drop across the filter when clean is 1.3 psi at 100 GPM.

2.1.3 OTSG Recirculation System Water Treatment Demineralizer GR-K-1

The demineralizer is 18-inches in diameter and 5-feet tall with a 36-inch resin bed depth. The vessel is constructed of ASTM A-285 carbon steel and is epoxy lined. Pressure rating for the vessel is 200 psig and is tested to 225 psig. It has 2-inch inlet and outlet connections and 1-inch vent and underdrain connections. The outlet line is fitted with a resin trap and the inlet has an internal flow distributor. Differential pressure at 18 gpm ranges from < 3 psi with clean resin to approximately 10 psi with dirty resin. The resin remains non-radioactive and can be manually replaced by removing the vessel top cover.

2.1.4 Chemical Pot Feeder GR-T-1

The chemical pot feeder is an approximately 15-gallon horizontally mounted carbon steel tank located in parallel with a line downstream of the system filter. The tank is fitted with a double valved funnel, and a double valved inlet and outlet. Connected to the outlet line is a drain/sample line. After the tank is filled with chemicals, flow is initiated through the tank by utilizing the differential pressure across a 2-inch globe valve in the system piping.

2.1.5 System Inlet and Outlet Isolation Valves GR-V1A, GR-V1B, GR-V7A and GR-V7B, respectively

These valves form the boundary between the OTSG Recirculation System and the Main Steam and Feedwater Systems. The valves are 2-inch 600# ASTM A-216 Grade WCB Cast Steel Gate Valves with Hand Wheel Operators.

2.1.6 Filter Inlet, Outlet and Bypass Valves GR-V2, GR-V3 and GR-V4, respectively

These valves are 2-inch 150#, ASTM A-105 Carbon Steel, Hand Wheel Operated Gate Valves.

2.1.7 Demineralizer Inlet, Outlet and Bypass Throttle Valves, GR-V12, GR-V16 and GR-V5, respectively

These valves provide flow control through the system demineralizer. The valves are 2-inch 150# ASTM A-105 Carbon Steel, Hand Wheel Operated Globe Valves.

2.1.8 Demineralizer Inlet and Outlet Isolation Valves GR-V13 and GR-V14, respectively

These valves are 2-inch 150#, ASTM A-105 Carbon Steel, Hand Wheel Operated Gate Valves. Their purpose is to provide maintenance isolation for the demineralizer.

2.1.9 OTSG Intermediate Isolation Valves GR-V6A and GR-V6B

These valves are 2-inch 150# ASTM A-105 Carbon Steel, Hand Wheel Operated Gate Valves. They provide isolation to their respective generator without requiring an operator to climb a ladder to the System Outlet Isolation Valves GR-V7A or GR-V7B.

2.2 Instruments, Controls, Alarms and Protective Devices

The OTSG Recirculation System is a locally controlled and monitored system consisting of two major portions. The main portion, which is hard piped and will remain installed until just prior to restart and the 4X4 demineralizer portion which is temporary and will be removed after cleanup of OTSG "B".

In the main portion there are pressure gauges on the inlet and outlet sides of the system filter. The filter inlet pressure gauge also indicates pump discharge pressure less approximately 2 psig. Also, in the main portion of the system there is flow instrumentation for total flow through the system and for flow through the water treatment demineralizer.

In the 4X4 portion there is a level switch which senses the water level in the 4X4 demineralizer. The level switch closes a motor operated inlet valve, a diaphragm operated solenoid actuated inlet valve and triggers a high level alarm. The diaphragm operated valve fails in the closed position to prevent overflowing the 4X4 demineralizer in the event of a loss of power.

The permanent system pump (GR-P-1) is controlled by a locally mounted pushbutton controller. There are no automatically operated switches or interlocks which control the pump.

3.0 PRINCIPLE MODES OF OPERATION

3.1 There are four principle modes of operation of the OTSG Recirculation System.

The first mode is the cleanup of OTSG "B". In this mode, a jumper is installed in place of GR-P-1. Water flows from the "B" Main Steam line tie-in, through the jumper, bypasses the filter and travels to the temporary 4X4 demineralizer via a flanged connection upstream of the water treatment demineralizer. A "sandpiper" pump then takes suction on the 4X4 and discharges to another flanged connection downstream of the water treatment demineralizer. The water then flows back to the feedwater line and into the OTSG. After the cleanup is completed the 4X4 will be removed and GR-P-1 will be installed.

The second mode is straight recirculation. In this mode GR-P-1 takes suction on either the "A" or "B" main steam lines and discharges through or bypasses the filter. The flow is then directed to the appropriate feedwater line via the full flow instrument (GR-FI-1).

In the third mode the system is lined up as in the recirculation flow path except that approximately 15 to 18 gpm is bypassed through the demineralizer.

In the fourth mode, chemical addition, chemicals are added to the chemical pot feeder via the double valved funnel. The pot feeder is then unisolated from the system and the demineralizer bypass valve is throttled to create flow through the pot feeder. After about 10-minutes the pot feeder is re-isolated and drained.

3.2 System Shutdown

To shutdown the sytem the only actions required are to stop the pump and isolate the system from the Main Steam and Feedwater lines.

3.3 Emergency

The significant emergency that can occur is a line break in the system. The actions to take for breaks in various portions of the system during different modes of operation are as follows:

If in mode 1 and the leak is in the 4X4 portion of the system upstream of the sandpiper:

1. Shut GR-V11.
2. Stop sandpiper pump.
3. Shut GR-V24.

If in mode 1 and the leak is in the 4X4 portion of the system downstream of the sandpiper:

1. Shut GR-V11.
2. Shut GR-V24.
3. Stop sandpiper pump.

If in mode 1 and the leak is in the hard pipe portion of the system upstream of GR-V5:

1. Shut GR-V1 A/B
2. Shut GR-V11
3. Stop sandpiper
4. Shut GR-V6 A/B

If in modes 2, 3, or 4 and the leak occurs downstream of the pump but upstream of GR-V6 A/B:

1. Stop pump GR-P-1
2. Shut GR-V1 A/B
3. Shut GR-V6 A/B

If in modes 2, 3, or 4 and the leak occurs downstream of GR-V6 A/B:

1. Stop pump (GR-P-1 or sandpiper as applicable).
2. Shut GR-V6 A/B
3. Shut GR-V7 A/B

If in mode 2, 3, or 4 and the leak occurs upstream of the pump:

1. Shut GR-V1 A/B
2. Shut GR-V6 A/B
3. Stop pump GR-P-1

If a primary to secondary leak is detected by periodic sampling the system shall be immediately isolated by shutting GR-V1 A/B and GR-V7 A/B. Then the radioactive water should be flushed back to the OTSG by displacing it with demineralized water via the demineralized water supply line.

In the event that system leaks develop, the leakage is either collected or runs to the Control Building area floor drains depending on the source of the leak. If the leak is considered severe enough the system shall be isolated and the leak repaired. If an RCS transient occurs concurrently with a primary to secondary leak the low pressure portion of the system shall be isolated by first shutting GR-V1 A/B and GR-V7 A/B and then installing blank flanges in the flanged connections downstream of GR-V1 A/B and upstream of GR-V7 A/B.

4.0 HAZARDS AND PRECAUTIONS

During mode 1, care must be taken to avoid spilling or releasing potentially contaminated water. If a leak occurs at the 4x4, leakage will be contained within the curb around the vessel and pump arrangement. Since an operator is present at all times during mode 1, leakage detection will be by visual observation.

During subsequent modes, leakage will run to the Control Building area sump via floor drains. The sump is a controlled sump and its contents may be pumped to the IWTS or to the MWHT as dictated by sampling results.

TABLE 1

OTSG RECIRCULATION SYSTEM PUMP

PUMP DETAILS

Identification	CR-P-1
Number Installed	1
Manufacturer	Goulds
Model No.	3655
Type	Horizontal; single suction, single stage centrifugal
Rated Speed, rpm	3500
Rate capacity, gpm	100
Rated Total Dynamic Head, ft	115
NPSH, ft	55
Design Pressure, Casing, psig	150
Design Temperature, °F	250
Lubricant/Coolant	Water/Water
Min. Flow Requirements, gpm	None

MOTOR DETAILS

Manufacturer	(Later)
Type	Squirrel Cage Induction
Enclosure	Drip Proof
Rated Horsepower	10
Speed, rpm	3600
Lubricant/Coolant	Grease/Air
Power Requirements	460V, 60 HZ, 30 amp (full load)
Power Source (for each pump motor)	MCC 2-3A

TABLE 2

CHEMICAL FEED TANK

Identification	CR-T-1
Manufacturer	N/A
Capacity - Gallons	15
Installation	Horizontal
Outside Diameter and Length, In.	12 3/4 X 36-inches
Shell Material	Carbon Steel ASTM A-105
Shell Thickness, in.	.375
Design Temperature, °F	120
Design Pressure, psig	90
Test Pressure, psig	135
Corrosion Allowance, in.	None
Design Code	None
Code Stamp Required	None

TABLE 3

DEMINERALIZER

Identification	CR-K-1
Number Installed	1
Manufacturer	Epicor
Capacity	72 Gallons
Installation	Vertical
Outside Diameter and Length	18-inch X 66-inch
Shell Material	Carbon Steel ASTM A-285 (Epoxy Lined)
Shell Thickness, in.	(Later)
Design Temperature, °F	120
Design Pressure, psig	200
Test Pressure, psig	225
Design Flow Rate	18 gpm

TABLE 4

OTSG RECIRCULATION SYSTEM FILTER

Identification	CR-F1
Number Installed	1
Manufacturer	Pall Trinity
Model Number	LCC 1015G33
Rated Capacity, gpm	100
Pressure Drop Clean, psi	1.3
Open Filtering Area, sq.	60
Straining Element Performation	
Size	30 micron
Design Pressure, psig	150
Test Pressure, psig	225
Design Temperature, °F	200
Code	ASME BPV-VIII-1

IV. RADIOLOGICAL ASSESSMENT

Radiological calculations have been performed for a 4 x 4 liner loaded with 1.8 curies of total cesium as projected for the OTSG"B" cleanup rig. Calculations were performed with the ISØSHLD computer code and were modeled to conform with the "as projected" configuration. The curie loading was conservatively assumed to be uniformly deposited within the top 15 cm. of the resin column. Radiological field values at various locations and for various circumstances are as reported below.

	Condition and/or Location	Radiological field strength
a)	At top surface of liner (undewatered)	1.16 R/hr
b)	At top surface of liner (dewatered)	2.2 R/hr
c)	At the side surface of liner opposite the loaded zeolite (no concrete shielding)	1.8 R/hr
d)	At the side and on the outside surface of a solid 8" concrete shield cylinder	21 mR/hr
e)	At a distance of 1 ft. from the 8" concrete shield	8.3 mR/hr
f)	At a distance of 3 ft. from the 8" from the 8" concrete shield	2.9 mR/hr
g)	At the outside of a 12" concrete shield	2.8 mR/hr
h)	At 1' from the 12" concrete shield	1.3 mR/hr
i)	at 3' from the 12" concrete shield	0.5 mR/hr

As indicated above, with an eight inch thick concrete shield placed around the liner, the area would need to be roped off and labeled as an RWP area at about 2 ft. The 12" concrete shield would eliminate having to rope off the 4 x 4 at any distance.

Inlet lines to the 4 x 4 will represent no radiological control problem because the concentrations of constituent radionuclides are expected to be of the order of 10^{-4} μCi/ml or lower.

SHIELDING - The liner will be surrounded with one thickness of solid concrete shielding 12-inches thick. However, if it is decided to use less shielding an appropriate radiological control area will be established.

NORMAL OPERATIONS CONSIDERATIONS - NONE. The system fluid in its normal configuration is isolated from the Turbine Building environment.

ABNORMAL OPERATION - Small leaks will be contained within the drip pan area. Large volume spills will be contained in the Turbine Building sump. Gaseous pariculate releases are calculated in the following. No significant releases are evident even in worst case casualties.

ASSUMPTIONS:

1) 1/2 Floor Area wetted
2) Air moving over wetted floor at no substantial velocity.
3) Water concentration is at 2.0×10^{-2} μCi/ml GROSS Beta/Gamma after dilution.
4) Building temperature is at 90°F with 50% R.H.
5) Water from steam generator is 90°F.

From MARKS ENGINEERING HANDBOOK, 4th Edition

EVAP. RATE (lbs/HR) = (K) (SURFACE AREA [FT^2]) (Ps - Pa)

WHERE:

K = 0.18786

Ps = SAT. VAPOR PRES. OF WATER (PSIA)

Pa = AIR VAPOR PRES. (PSIA)

From THERMO-FLUID PHENOMENA, 1st Edition

Ps = 0.6988

Pa = 0.3494

SURFACE AREA = 25700 SQ. FT.

THEREFORE:

EVAP. RATE = (0.18786) (25700) (0.6988 - 0.3494)

EVAP. RATE = 1687 lbs/HR

APPLYING AN ENTRAINMENT FACTOR OF 10^{-6} AND CONVERTING THE UNITS.

1687 lbs/HR X 1/3600 HR/SEC X 453.6 ML/LB

X 2.C X 10^{-2} μCi/ml X 10^{-6}

= 4.25 X 10^{-6} μCi/SEC

TOTAL VOLUME OF THE 281' ELEVATION OF THE TURBINE BUILDING IS 2.9 X 10^{10} ML

TOTAL VENTILATION TO THE AREA IS 5.5 X 10^{7} ML/SEC

Ae = GENERATION RATE/(VENT FLOW/VOLUME)

Ae = 2.25 X 10^{-3} μCi

AIRBORNE RADIOACTIVITY = Ae/VOLUME

= 7.75 X 10^{-14} μCi/ml

As evidenced by the preceding calculations, even a very significant "non-sprayed" spill of water would result in insignificant radiological airborne problems. However, such a spill would result in a considerable cleanup effort, and therefore preventative measures will be taken.

Since the system is under pressure, there is a potential for airborne activity to be created by a spraying leak. This potential has been assessed and is described below.

As the 1.8 curies of activity is currently thought to be contained mainly within the "B" steam generator, the secondary side of this steam generator and the applicable steam lines (to the isolation valves MS-V4B and/or MS-V7B) will have to be filled with water to flush out this activity. The resulting concentration is projected to be no greater than about 6.5 X 10^{-2} µCi/cc of total activity or about 5.9 X 10^{-2} for Cs-137 and about 5.9 X 10^{-3} µCi/cc for Cs-134. This estimated concentration assumes the 1.8 curies is evenly distributed in one leg of about 2.5 ft. of 29" diameter main steam line. Assuming that a leak sprays into the air and that the atmosphere in the vicinity of the leak is relatively stagnant, concentrations of the two isotopes could reach an upper limit of about 2.0 X 10^{-9} µCi/cc for Cs-134 and about 2.0 X 10^{-8} µCi/cc for Cs-137. Both of these concentrations are based on factors applicable to hydrolazing operations and resulting tritium airborne concentration and are, therefore, conservative. Both resulting concentrations for the hypothesized leak are lower than 10 CFR-20, Table I, Column 1, concentrations for the respective isotopes. With the potential to approach the Maximum Permissable Concentration in the area of such a leak, an Air Monitoring System will be operated in the close proximity of the cleanup equipment while the system is in Mode 1.

V. ENVIRONMENTAL IMPACT ASSESSMENT

Based on an unmonitored release of 10^{-14} µCi/ml a source term of 4.5E-6µCi/sec would be the result. Using Reg 1.109 calculation methods, a dose commitment from Cs-137 of 4.0AE-3 mRem/yr to child bone would result.

The PEIS (NUREG - 0683) Appendix R limit is 15 mRem during each calendar year to any organ, which when compared to 4.0AE-3 mRem/yr indicates that the postulated release would not present a significant dose to the maximum exposed individual.

VI. HAZARDS ANALYSIS

Since the OTSG Recirculation System is a low energy system, pipe line breaks are not considered likely, but were nevertheless analysed in Section 3.3 of the Detailed Design. System outleakage and primary to secondary leaks are also covered in Section 3.3 of the Detailed Design.

The most visible impact on core cooling would be inducement of a "burp" in the Reactor Coolant System due to feeding the B Generator approximately 100 gpm of water, which is at approximately 65°F. It is recognized that the hot legs in the RCS are 50°F warmer than that and the OTSG shell is 20°-30° warmer than that. Hence, feeding of the cooler water (cooler water lying in steam and feed lines in the Turbine Building and Auxiliary Building) would create a differential density resulting in the burp. This is not considered to be detrimental and, in fact, may be advantageous from the mixing standpoint.

In selecting the valves to be used as the containment isulation valves, it was necessary to meet the following installation criteria:

1) The valve is to be installed at the boundary of a 600# carbon steel line specification system, therefore, the valve must be a 600# carbon steel valve.
2) Since it is necessary to hot tap through this valve it must have an end to end dimension less than 12 inches and must allow a 1 7/8" cutter to pass straight through the seat. This limits the valve to a gate, ball or plug type valve.

Attempts to locate such a valve with a N-2 classification, as is required by 10CFR50, GDC-57, were unsuccessful.

To provide pressure isolation for the low pressure side of the system and eliminate the need for relief protection, 600# flanges will be installed at the first easily accessible location beyond the isolation valve and all piping up to the flanges will be in accordance with a 600# line specification. Due to the cold shutdown status of TMI-2 the potential for a high energy main steam or feedwater line break, and thus the motivation for N-2 level of piping, is very small. However, the valves chosen for the isolation of the recirculation system are of the same pressure class as the tie-in portions of main steam and feedwater (600 lb.). The capability to contain potential primary to secondary steam generator leakage is equivalent to the existing secondary systems.

Based on the above information, it can be concluded that the operations of OTSG Layup Recirculation System will not increase the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated nor will it create an accident or malfunction of a different type than any previously evaluated. Additionally, based on a review of the bases for the TMI-2 Technical Specifications the OTSG Layup Recirculation does not reduce the margin of safety contained therein.

VII. CONCEPT OF OPERATIONS

A description of the various modes of operation is included in Section 3.0 of the Detailed Design Description.