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May 14, 1985

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

Dear Dr. Snyder:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Reactor Building Sump Recirculation System

Attached is the system description for the Reactor Building Sump Recirculation System. This system description is being transmitted for your information and to assist in your review of Technical Specification Change Request No. 46.

Also, please note Section 1.6.3, "Electric Power". This section provides clarification regarding the classification of the power source for the sump recirculation pumps. This issue was referenced in the GPU Nuclear response to Question No. 6 of your inquiry regarding Technical Specification Change Request No. 46.

Sincerely,

Thomas J. Demmitt for

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

FRS/RDW/eml

Attachment

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

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ISSUE DATE

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DIVISION

SYSTEM DESCRIPTION

FOR

Reactor Building

Sump Recirculation System (RRS)

(GPUN Drawing No. 2E-3510-1024)

COG ENG Bob Reaser DATE 2/13/85

RTR Robert J. Jo DATE 2/11/85

COG ENG MGR. R.E. Gallagher DATE 2/14/85

FORM 4000-ENG-7310.06-1 (5/84)

Rev.	SUMMARY OF CHANGE	Approval	Date
0	Initial Issue		

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1.0 SYSTEM DESCRIPTION

1.1 SUMMARY

The Reactor Building Sump Recirculation System (RRS) is a non-seismic contingency system ready for installation in the event of an unisolable leak from the reactor vessel. The system uses two 200 gpm submersible pumps, associated hoses and controls to transfer water from the reactor building basement to the reactor vessel. The RRS is designed to maintain sufficient water in the reactor vessel to keep the core covered for leak rates up to 400 gpm. The system components are staged in a clean, dedicated area of the turbine building. Electrical connections for each pump are preinstalled in the reactor building with breakers and remote starters located in the relay room.

1.2 REFERENCES

1.2.1 Engineering Change Authorization (ECA) 3510-84-151, Reactor Building Sump Recirculation System.

1.2.2 Engineering Change Authorization (ECA) 3510-85-164, Reactor Building Sump Recirculation System Electrical Power.

1.2.3 General Arrangement, Reactor Building Sump Recirculation System General Arrangement and Control Manifold Details, Drawing 2E-3510-1025.

1.2.4 GPU Nuclear Memorandum, 4410-84-L-0154, Technical Specification Change Request No. 46, November 6, 1984.

1.2.5 TMI-2 Technical Specifications.

1.2.6 GPUN Instrument Index.

1.2.7 Instruction Manual, WEDA Pump Model # L707.

1.2.8 Instruction Manual, Universal LN Series Flow Monitor

1.2.9 Site Engineering Calculation, Reactor Building Sump Recirculation System Pumps, 4340-3510-85-0009.

1.2.10 Burns and Roe Recovery Equipment List

1.2.11 P and ID, Reactor Building Sump Recirculation System, Drawing 2E-3510-1024.

1.3 DETAILED SYSTEM DESCRIPTION

1.3.1 Design Requirements

The RRS is an emergency system designed to transfer water from the reactor building basement to the reactor vessel. Its objective is to keep the core covered during an unisolable reactor vessel leak. The system is staged in a radiologically clean area of TMI-2 and is required by the Technical Specifications.

The system design is based on the following requirements and assumptions per reference 1.2.4:

- The most probable reactor vessel leak is a corrosion type failure of an incore tube. The corresponding leak rate is 17 gpm. An additional tube fails each month increasing the vessel leak rate to 200 gpm one year after the first failure.
- Access to the reactor building is permitted during the leak.
- The reactor building sump must be borated to 4350 ppm minimum, recirculated, and sampled prior to injection into the reactor vessel.
- The BWST can be used to makeup the leak until the sump is adequately borated and the RRS installed.
- The RRS should be capable of delivering up to 400 gpm and have backup to cover postulated single active failures. Both the primary and backup system should be staged on site and be as simple as possible.

The RRS is intended as a temporary means of emergency makeup. If the vessel leak cannot be repaired or the fuel cannot be removed within 6 to 12 months after the initial leak, it is assumed that a permanent recirculation system will be designed and installed or an existing plant system reactivated.

1.3.2 System Operation

The RRS consists of an "A" and "B" train, each capable of delivering up to 200 gpm. Each train is comprised of a 200 gpm submersible pump (RRS-P-1A and RRS-P-1B), a flow indicator (RRS-FI-1A and RRS-FI-1B), a throttle valve (RRS-V-1A and RRS-V-1B), a sample valve (RRS-V-2A and RRS-V-2B), a check valve (RRS-V-3A and RRS-V-3B), a pressure indicator (RRS-PI-1A and RRS-PI-1B), and approximately 150 feet of 2 1/2" ID rubber hose. The valves and instrumentation are mounted on a mobile frame referred to as the control manifold. A spare pump and spare hose are also provided.

Submersible pumps RRS-P-1A and RRS-P-1B are used to either recirculate the reactor building sump water or to transfer sump water to the reactor vessel. The pumps take suction directly off the reactor building basement floor and are capable of pumping all solids that can pass through their inlet strainers. The pumps are connected to the inlets on the control manifold by separate 2 1/2" ID discharge hoses. The control manifold provides throttling, flow indication, and sampling capabilities for each pump.

If desirable, the pumps and hose can be used without the control manifold; flow could be controlled by starting and stopping the pumps as required.

Hoses are also connected to the two outlets on the control manifold. These hoses initially are routed back to the reactor building basement to provide for recirculation of the sump water. Sump water is recirculated at a rate of up to 400 gpm using two trains. When the sump is adequately mixed, the hoses are rerouted to the reactor vessel to provide for continuous makeup of a reactor vessel leak.

Reactor vessel leaks of less than 200 gpm require only the "A" train for makeup. The "B" train serves as backup for single active failures. Leaks exceeding 200 gpm require both trains for makeup. The spare pump and spare hose provide backup for single active failures.

The system pumps are operated from remote starters located in the relay room. Each starter is supplied from a Class 1E power source.

1.3.3 System Components (see reference 1.2.3)

1.3.3.1 Pumps (see Appendix A, Table 1 and Figure 1)
Two WEDA model no. L707 submersible pumps (RRS-P-1A and RRS-P-1B) provide the pumping power to recirculate the reactor building sump water or to transfer sump water to the reactor vessel. The pumps are single stage, top discharge, vertical shaft centrifugal type. Each pump weighs 210 pounds. The pump motors and starters are contained in the pump housing. Built-in thermal motor protection automatically breaks the motor current if the motor temperature exceeds 105°F. The pumps are free standing and are provided with 66 feet of electrical cord. The pump discharges have female cam locking type quick couplings for connection to the system hoses. A third, identical pump is provided as a spare.

1.3.3.2 Hose

Three hundred feet of Goodall N-2427 EPDM Agricultural hose is used to transport the sump water. The hose has a rated working pressure of 150 psig, a minimum bend radius of 10 inches, and is 2 1/2" ID. The hose is provided in two 50 foot and two 100 foot lengths. The ends of each hose are fitted with male stainless steel cam locking type quick couplings. Two additional 50 foot lengths and one 100 foot length are provided as spares.

1.3.3.3 Control Manifold

A control manifold is provided for throttling, monitoring, and sampling the discharge of RRS-P-1A and 1B. The manifold has an independent flow section for each pump. Each flow section consists of a 0 to 200 gpm flow indicator (RRS-FI-1A and RRS-FI-1B), a 0 to 300 psig pressure indicator (RRS-PI-1A and RRS-PI-1B), a 2 1/2" globe valve (RRS-V-1A and RRS-V-1B), a 2 1/2" check valve (RRS-V-3A and RRS-V-3B), and a 1/2" sample valve (RRS-V-2A and RRS-V-2B). Female cam locking type quick couplings are provided on the inlet and outlet of each flow section for connecting to the system hoses. All components are stainless steel and are mounted on a mobile frame.

1.4 SYSTEM PERFORMANCE CHARACTERISTICS

System performance characteristics are as follows:

a) design flow rate is 400 gpm (200 gpm per train)
b) normal system operating pressure at the design flow rate is 70 psig maximum (see Appendix A, Figure 1 for pump head curves)
c) design pressure is 150 psig
d) design temperature is 100°F.

1.5 SYSTEM ARRANGEMENT

1.5.1 Staging Arrangement

When the RRS is not required, the hoses, pumps, and control manifold are staged in a radiologically clean, dedicated area of TMI-2. An electrical outlet for each pump is permanently installed in the reactor building near the 305 hatch by the air coolers. Starters located in the relay room provide power to the electrical outlets.

1.5.2 Operating Arrangement (see reference 1.2.3)

During a reactor vessel leak, the pumps are located on the 282' elevation of the reactor building, directly below the hatch at elevation 305'. The control manifold is located near the hatch on the 305' elevation. Two 50 foot hoses are routed between the pumps and the control manifold. Two 100 foot hoses are routed from the control manifold to either the seismic gap in the northwest portion of the reactor building to recirculate sump water or to the IIF to transfer sump water to the reactor vessel. A spare pump and spare hoses are staged in the turbine building.

1.6 INSTRUMENTATION AND CONTROLS

1.6.1 Flow Indicators

Flow indicators, RRS-FI-1A and RRS-FI-1B, are provided to monitor the flow rates of pumps RRS-P-1A and RRS-P-1B respectively. Their range is 0 to 200 gpm in increments of 20 gpm. Flow rates exceeding 200 gpm will not affect calibration nor damage the flow indicators.

1.6.2 Pressure Indicators

Pressure indicators, RRS-PI-1A and RRS-PI-1B, are provided for verification of pump head characteristics. Their range is 0 to 300 psig.

1.6.3 Electrical Power

Electrical power for the pumps is provided through outlets installed near the 305 hatchway. Each outlet is energized from a separate starter located in the relay room. Power for each starter is obtained from a Class 1E Power Distribution Panel. Class 1E and non-Class 1E isolation is provided at the panels by circuit breakers.

1.7 SYSTEM INTERFACES

The RRS interfaces with the following systems:

a) Defueling Test Assembly (DTA) or other suitable tank for testing
b) a temporary power supply in the turbine building
c) Reactor Coolant System
d) a Class 1E electrical system

1.7.1 Interfaces with the DTA tank, or other suitable tank, and a temporary power supply occur only during performance of the Technical Specification Surveillances. These interfaces allow for convenient testing of the pumps and instrumentation.

1.7.2 Interfaces with the RCS and the Class 1E electrical system is required if the RRS is placed in service. Plug type connectors are used to tie-in to previously installed, dedicated electrical outlets. The power supply is controlled from starters located in the relay room. The electrical connections will provide power to operate RRS-P-1A and 1B. Two hoses, placed in the IIF, provide for transfer of sump water to the reactor vessel and are the interface with the RCS.

2.0 SYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

2.1 To ensure proper cooling, the system pumps should not be operated at less than 5 gpm.

2.2 All hoses should be adequately supported/anchored to prevent whip when the pumps are started.

2.3 Bends in hoses should be minimized.

2.4 The system pumps should not be operated unless they are at least 2/3 submerged in water.

2.5 The system pumps should be operated on a level surface in an upright position.

2.6 Prior to installing the RRS, personnel should be aware of the radiation levels in the vicinity of the 305' elevation hatch and the IIF.

2.7 Prior to pumping reactor building sump water into the reactor vessel, the following sequence of events should be performed.

a) add an appropriate quantity of boron, as determined by a mass balance, to the sump water to raise the sump boron concentration above 4350 ppm.

b) mix the sump water by recirculating a minimum of 3 sump volumes.

c) obtain and analyze sump samples to verify that the sump water boron concentration is greater than 4350 ppm.

3.0 OPERATIONS

3.1 OPERATION IN THE TURBINE BUILDING (Technical Specification Surveillance)

This section provides instructions for periodic surveillance testing of the RRS and is intended only as a guide. If the DTA tank is unavailable for testing the RRS, another setup will be used.

3.1.1 Setup

RRS-P-1A and RRS-P-1B, hose, and control manifold are removed from the staging area. All components are inspected for damage and replaced or repaired if required. A 100 foot section of the hose is connected to the discharge of each pump. Each pump is then rigged by its handle to the 1 ton gantry crane and lowered into the DTA tank until it rests on the bottom of the tank (elevation 282'). The opposite end of the discharge hoses and pump electrical cords are retained on the turbine deck. The discharge hoses are connected to the inlets on the control manifold. A 50 foot section of hose is connected to each outlet on the manifold and the other ends are placed in the DTA. The electrical cords are connected to a temporary power-supply.

3.1.2 Normal Operation

Once the system is setup for testing, the breaker is closed for the temporary power supply to energize RRS-P-1A and RRS-P-1B. Discharge pressures are measured at RRS-PI-1A and RRS-PI-1B and recorded at a flow rate of 200 gpm. The data is corrected for elevation and compared to the pump head curves to verify proper pump performance. Flow rate indication is provided by RRS-FI-1A and 1B. During pump operation, hoses, fittings, and the control manifold are inspected for leakage. Repairs/Replacement of components is performed in the time frame specified in reference 1.2.5.

The electrical outlets, located in the reactor building, are tested by energizing them in the relay room and measuring the voltage at the outlets.

3.1.3 Shutdown

When testing is completed, the pumps are stopped and removed from the DTA tank and the hoses are uncoupled and drained. All components are returned to the staging area.

3.2 OPERATION IN THE REACTOR BUILDING

This section provides guidance for setting up and operating the RRS during an unisolable reactor vessel leak.

3.2.1 Setup

If an unisolable reactor vessel leak occurs, RRS-P-1A, RRS-P-1B, the control manifold, and hose are removed from the staging area and transported into the reactor building to the hatch on the 305' elevation. A 50 foot section of discharge hose is connected to the quick coupling on each pump. Using the hoist provided for the robotics program, the pumps are lowered through the 305' hatchway to the basement where they rest in a vertical, freestanding position. The other ends of the discharge hoses and the electrical cords remain on the 305' elevation. At this location, the discharge hoses are connected to the inlets on the control manifold and the electrical cords are plugged into the previously installed dedicated electrical outlets. A 100 foot section of hose is connected to each manifold outlet and routed to the northwest portion of the reactor building and placed in the seismic gap leading to the basement.

3.2.2 Normal Operation

3.2.2.1 Reactor Building Sump Recirculation

The starters, located in the relay room, are energized to start the pumps. The flow rate is adjusted to approximately 200 gpm per pump at the control manifold. After three sump volumes have been recirculated, sump samples are obtained and analyzed for boron. When the sump boron concentration exceeds 4350 ppm, the pumps are stopped.

3.2.2.2 Reactor Vessel/Sump Recirculation

Once the sump boron concentration is verified to be greater than 4350 ppm by a boron mass balance calculation and a sample analysis, the two 100 foot hoses are removed from the seismic gap, routed to the reactor vessel, and placed into the IIF. One or two pumps are started and throttled as required to match the reactor vessel leak. Periodic adjustments to this makeup rate are accomplished by starting and stopping the pumps from the relay room starters or by entering the reactor building and adjusting the throttle positions.

3.2.3 Shutdown

Makeup to the reactor vessel continues until the leak is stopped or until a permanent recirculation system is installed.

4.0 CASUALTY EVENTS AND RECOVERY PROCEDURES

4.1 CASUALTY EVENTS

The possible system casualty events during reactor vessel sump recirculation include the following:

a) loss of power to RRS-P-1A or RRS-P-1B
b) failure of RRS-P-1A or RRS-P-1B
c) rupture of a hose
d) transfer of out-of-specification water to the reactor vessel.

4.2 DESIGN FEATURES TO MITIGATE EFFECTS OF CASUALTY EVENTS

4.2.1 Power is supplied to the starters from a Class 1E electrical system to meet the single failure criterion.

4.2.2 For leak rates of less than 200 gpm, only RRS-P-1A is required; RRS-P-1B provides the backup to meet the single failure criterion. For leak rates exceeding 200 gpm, both pumps are required; the spare pump provides the backup to meet the single failure criterion.

4.2.3 Spare hose is available to replace a ruptured or leaking hose.

4.2.4 Sampling capability exists in the system to prevent out-of-specification water from being discharged into the reactor vessel. In addition, the sump water will be mixed and borated as required prior to injection into the reactor vessel.

4.3 RECOVERY PROCEDURES

4.3.1 Recovery from a loss of power to the pumps involves using the BWST for makeup until power is restored.

4.3.2 Recovery from a failed pump involves starting and throttling the remaining train and using the BWST for additional makeup as required until the failed pump is replaced.

4.3.3 Recovery from a ruptured hose involves starting and throttling the remaining train and using the BWST for additional makeup as required until the failed hose is replaced.

4.3.4 Recovery from a casualty event in which out-of-specification water is discharged into the reactor vessel involves stopping the pumps, making up with the BWST, and adding boron to the sump.

5.0 MAINTENANCE

5.1 CORRECTIVE MAINTENANCE

5.1.1 Pump repairs shall be performed in accordance with reference 1.2.7.

5.1.2 Damaged hoses or couplings shall be replaced per the requirements of reference 1.2.1.

5.1.3 If repair welding is required to any pressure retaining component of the system, it shall be performed in accordance with the UWI used for initial construction. Upon completion, the specific component shall be leak tested per ANSI B31.1, 1983.

5.2 PREVENTIVE MAINTENANCE

5.2.1 Preventive maintenance on the pumps is performed per the requirements of reference 1.2.7.

5.2.2 Periodic calibration of the system flow and pressure indicators is performed in accordance with existing plant procedures.

5.2.3 All components are routinely inspected to spot potential problems.

5.3 SURVEILLANCE

Technical Specification Surveillances are performed as described in section 3.1 and in the time interval required by reference 1.2.5.

5.4 IN-SERVICE INSPECTION

If the RRS is placed in operation per section 3.2, all system components will be routinely inspected to spot potential problems.

6.0 TESTING

All system components, including the spare pump and hoses, are hydrostatically and functionally tested in accordance with ANSI B31.1, 1983, references 1.2.1 and 1.2.2, and plant procedures

7.0 HUMAN FACTORS

7.1 All system components are labeled to ensure proper identification.

7.2 Dollys are used to transport heavy equipment.

7.3 All components are appropriately tagged to ensure they are not inadvertently removed from the staging area.

APPENDIX A
TABLE 1
REACTOR BUILDING SUMP RECIRCULATION PUMPS (RRS-P-1A, RRS-P-1B, SPARE)

Pump Details (see Figure 1 for Pump Performance Curve)	
Identification	RRS-P-1A, RRS-P-1B, SPARE
Manufacturer	Weda
Model No.	L707G
Type	single stage vertical shaft centrifugal, submersible
Rated Speed, rpm	3500
Rated capacity, gpm	265
Rated total dynamic head, feet	100 (at rated capacity)
Shutoff head, feet	260
Shaft Seal	Ball bearing and double mechanical seals
Lubricant	Oil
Motor Details	
Manufacturer	Weda
Type	2-Pole, 3-Phase induction 440V/20A
Enclosure	Cast aluminum, AISI 17
HP	16.5

APPENDIX A
FIGURE 1
REACTOR BUILDING SUMP RECIRCULATION PUMPS (RRS-P-1A, RRS-P-1B, SPARE)