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Office of Nuclear Reactor Regulation
Attn: J. F. Stolz, Chief
Operating Reactor Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
DH Plant Shielding Option (NUREG 0737 - II.B.2)

Following discussions with you and members of your staff on January 30 and 31, 1984 at TMI-1 concerning status of NUREG 0737 item implementation, GPUN again reviewed the plant shielding item as it relates to boron precipitation. This review (Attachment 1) disclosed that by locking open DHV 12B and installing a reach rod for DHV-64 (see Figure 1) sufficient flow is available for core cooling and boron precipitation prevention under worst case single failures (Attachment 2) without requiring manual action in an inaccessible high radiation area.

This particular proposed solution has the advantage that it improves the schedule for resolution of this item by limiting the required physical modifications to a manual reach rod on DHV-64 which is scheduled for completion six weeks after delivery (installation expected in September, 1984).

In order to bring this issue to an expeditious conclusion, we request your review of this proposed solution at your earliest convenience.

Sincerely,

H. D. Hukill
Vice President TMI-1

Attachments

cc: J. Van Vliet
R. Conte

References: 1. TMI-1 Restart Report Section 2.1.2.3
2. GPUN ltr dated September 20, 1982 (5211-82-221)
3. GPUN ltr dated October 21, 1983 (5211-83-280)
4. NRC ltr dated March 14, 1984

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ATTACHMENT 1

DISCUSSION

The Decay Heat Removal (DHR) system is designed to function in two modes: a normal Decay Heat Removal mode and as an Engineered Safeguard (E.S.) System.

DECAY HEAT REMOVAL (Normal Operation)

In the decay heat removal mode, the DHR system provides a means of removing decay heat from the core and residual heat from the Reactor Coolant System (RCS) during shutdown. The flow path for this mode is from the 'B' hot leg through the decay heat dropline to either DH pump A or B and its associated cooler and back to the reactor vessel through DH-V4A or B and the core flood nozzle. A flow path is also provided for auxiliary spray to the pressurizer from the outlet of the 'A' DH cooler.

LPI MODE (Engineered Safeguard)

In the E.S. mode, the DHR system provides low pressure injection of borated water to the reactor from the borated water storage tank (BWST). The flow path is from the BWST through the decay heat pump and cooler to the core flood nozzle.

When the BWST reaches the Lo-Lo level setpoint (3 feet), the system is switched to the recirculation mode. The DH pump suction is aligned to the reactor building sump and water is recirculated through the DH cooler and back to the vessel.

The DH System also functions as a source of water to the HPI System if needed to provide an alternate flow path for injection of cooling water to the vessel, i.e., when RCS pressure is above the TDH of the decay heat pump. In this mode, the DH pumps supply water from the RB sump to the suction of the make-up pumps which discharge to the RCS cold legs. This operation, known as "piggy back cooling" is used to insure a flow path until the LPI paths are established.

CONTROL OF BORON PRECIPITATION

The DHR system is used as a method of controlling boron concentration in the core following an accident. Boron precipitation on fuel elements was evaluated by B&W and is discussed in Topical Report BAW 10103A, Rev. 3. This report presented three modes of operation to control boron precipitation. Of these, the following two were found to be acceptable by the NRC and have been adopted at TMI-1 (Ref. OP 1104-4):

1). Gravity drain from the decay heat dropline to the RB sump through the LPI string not in operation and continue LPI with the operable string.

2). Forced circulation with hot leg injection via the auxiliary pressurizer spray line.

The first mode utilizes either DH string to provide a letdown path from the RCS hot leg back to the cold leg. In order to establish this flow path, the dropline must be opened to the RB sump by opening DH-V1, 2, 3 and one of the DH-V12 valves. DH-V1, 2, 3 are motor operated valves which are operated from the control room; the DH-V12A and B valves are local, manually operated valves. Post accident radiation levels have been calculated to be sufficiently high to preclude local operation of these valves.

The second boron control mode requires an operable 'A' DH pump or an open cross connect from the 'B' DH string in order to inject to the hot leg via the pressurizer. The path to the pressurizer is established by opening the DH-V64 and RC-V4 valves and closing the RC-V3 valve. Operation of the RC-V3 and RC-V4 valves is from the Control Room; however, the DH-V64 valve is operated by a local handwheel which could be made inaccessible due to post accident radiation levels.

MODIFICATIONS

In order to ensure that a post-LOCA boron control mode is available, the following changes will be made:

1). Lock Open DH-V12B

This change will allow for a letdown path to the RB sump without the need to locally operate DH-V12B in a high radiation area. Thus, Mode 1 of long term boron control will be made available by opening the DH-V1, 2, 3 valves from the control room. The ability of the DH system to perform its normal function would not be compromised. Either DH-V12A or B are open during normal decay heat removal operation. This change does not impact Mode 2 since hot leg injection through the auxiliary pressurizer sprays can be achieved with DH-V12B open. Separation of the two DH trains is maintained by the DH-V12A valve which would remain closed.

2). Installation of a Reach Rod on DH-V64

The ability to operate DH-V64 is necessary in order for Mode 2 boron precipitation control (hot leg injection through the auxiliary pressurizer spray) to be implemented. In the present configuration, should DH-V64 be inaccessible due to high radiation levels, the Mode 2 flow path could not be established since the valve is normally closed. The addition of a reach rod extension will allow for remote operation of the valve from a shielded location.

These modifications will not adversely impact the ability of the DHR system to perform either its normal or accident mitigation functions. The changes will allow for flexibility in the implementation of boron precipitation control modes in a post-accident situation by insuring that a flow path is available in the event of a single failure in either DHR train.

CORE COOLING

The Decay Heat Removal System is designed to maintain core cooling by injection of water to the vessel in the event of a loss of coolant accident. Low pressure injection is accomplished through two separate trains, each consisting of a pump and heat exchanger along with valves, instrumentation and controls necessary to operate each train.

Each train has a separate suction line from the BWST which is valved into service in the injection phase. When on recirculation, the suction of each pump is lined up to the reactor building sump through separate lines. In both modes, water is injected to the vessel via two separate core flood nozzles located on opposite sides of the vessel.

The two trains are cross connected, at a point downstream of the DH coolers, by a 6 inch line containing two normally closed gate valves (DH-V38 A&B) installed in series. This allows for operational flexibility in the event of a loss of one LPI path by enabling either pump to inject via both core flood nozzles. It also allows for a flow path from the 'B' DH loop to the auxiliary pressurizer spray line which is connected to the 'A' loop only.

In the event of a LOCA, the plant operators are instructed by procedure to ensure adequate LPI is established and that two injection paths exist prior to switching to recirculation. There are several possible flow paths which will satisfy this requirement including:

1) Two DH pumps in operation, each discharging through its associated LPI leg.

2) One DH pump in operation, discharging through both LPI paths. This requires that the cross-connect valves be opened so that either DH pump can inject to the vessel via both core flood nozzles.

3) One or both DH pumps in operation discharging through one LPI line and providing suction to the make-up pump.

If the operator detects a flow of less than 1,000 gpm in each LPI leg when greater flow is expected, the operator will attempt to establish either mode 1 or mode 2 flow path described directly above.

Prior to switching to recirculation, all flow downstream of the pumps, is clean water from the borated water storage tank. Thus the operators will be able to manually manipulate DH-V38 A and B to establish the required flow paths. These valves could be opened prior to switching to the recirculation mode. Once operation in the recirculation mode is begun, these valves may be inaccessible due to high radiation.

Should the DH-V38 valves be inoperable or inaccessible and if LPI cannot be established, either or both DH pumps can be lined up to serve as booster pumps for the make-up system. This 'piggy back' mode of operation would serve to recirculate water from the RB sump, through the DH coolers to the make-up pumps suction. The make-up pumps discharge to the vessel via the RCS cold

legs. This operating mode can be established from the Control Room; no local action is required. No system modifications are required since at least two cold leg/core flood nozzle injection flow paths can be established remotely from the control room with any initiating event and any subsequent single active failure. The flow rates in these modes provide adequate core cooling.

CONCLUSION

Adequate capability for core cooling under all postulated events exists with the current configuration. Procedural modification to open DH-V12B during operation and the addition of a reach rod on DH-V64 will provide boron precipitation control capability. These changes will resolve all remaining issues with required post accident access raised as part of the NUREG 0737 study.

Attachment 2

SINGLE FAILURE ANALYSIS

EVENT - FAILURE OF CORE FLOOD INLET NOZZLE

1) Malfunction: DH-P1A fails to start

a) Mode: Low pressure injection from BWST

Action: Verify DH-P1B operating

Open DH-V38 valves

Balance flow to insure ≥ 1000 gpm flow rate to each LPI leg

b) Mode: Recirculation from Reactor Building sump

Action: Open (verify open) DH-V38 valves

Start (verify operating) DH-P1B

If DH-V38 valves are closed and/or inaccessible, a second LPI flow path may not be available. Establish 'piggy-back' cooling mode by aligning the operable DH pump to the suction of the make-up pumps.

c) Mode: Boron Precipitation Control

Action: Establish Mode 2 boron control

Verify DH-P1B operating

Verify DH-V38 valves open

Open DH-V64, RC-V4

Close RC-V3

If Mode 2 boron control cannot be established, establish a Boron Precipitation control flow path by opening DH-V1, V2, V3, and V6B. This allignment establishes flow from the hot leg (DH drop line) and the reactor building sump for sufficient DHR pump suction. Makeup will be via the Core Flood inlet nozzle.

2) Malfunction: DH-P1B fails to start

a) Mode: Low pressure injection from BWST

Action: Verify DH-P1A operating

Open DH-V38 valves

Balance flow to insure ≥ 1000 gpm flowrate to each LPI leg

b) Mode: Recirculation from Reactor Building sump

Action: Open (verify open) DH-V38 Valves

Start (verify operating) DH-P1A

If DH-V38 valves are closed and/or inaccessible, a second LPI flow path may not be available. Establish 'piggy-back' cooling mode by aligning the operable DH pump to the suction of the make-up pumps.

c) Mode: Boron Precipitation Control

Action: Establish Mode 2 boron control

Verify DH-P1A operating

Open DH-V64, RC-V4

Close RC-V3

3) Malfunction: DH Dropline Unavailable
(DH-V1, 2 or 3 fails to open)

This malfunction does not impact either LPI from the EWST or recirculation from the RB sump since the dropline is not required for either of these modes. Actions required for Boron Precipitation Control are:

- Start (verify operating) DH-P1A
- Establish hot leg injection (Mode 2 Boron Control) by opening DH-V64 and RC-V4 to the pressurizer and closing RC-V3.

4) Malfunction: Failure of LPI Inlet Valve (DH-V4 A or B)

a) Mode: Low pressure injection from BWST

LPI may not be available if valve failure is in the line opposite a CF nozzle break

If so, borated water will be injected via the HPI system until:

(1) The affected inlet valve can be manually opened and LPI flow is established; or,

(2) The supply of cooling water from the BWST is exhausted, at which point recirc will be supplied by the DH pumps providing water to the MU pumps suction ('piggy-back' cooling).

b) Mode: Recirculation from RB Sump

Action: Establish 'piggy-back' cooling by aligning DH pump discharge to suction of the MU pumps

c) Mode: Boron Precipitation Control

Action: Verify (start) DH-P1A operating

Establish Mode 2 Boron Control

5) Malfunction: DH-V6 (A or B) Fails to Open

a) Mode: Low pressure injection from BWST

Action: None required since these valves are not open during initial injection phase

b) Mode: Recirculation From Reactor Building Sump

Action: If DH-V38 A&B are open:

Use operable DH-V6 valve to draw from sump through DH pump in the same loop

Inject to reactor via both LPI loops

If DH-V38 valves are closed and/or inaccessible, a second LPI flow path may not be available. Establish 'piggy-back' cooling mode by aligning the operable DH pump to the suction of the make-up pumps.

c) Mode: Boron Precipitation Control

Action: If DH-V38 A & B are open:

Establish Mode 2 Boron Control

Open DH-V64, RC-V4

Close RC-V3

Use pump in loop with operable DH-V6 to inject to auxiliary pressurizer spray line

If DH-V38 A&B are closed and:

i.) DH-V6B fails closed:

Establish Mode 2 Boron Control

Open DH-V64, RC-V4

Close RC-V3

ii.) DH-V6A fails closed:

Open DH-V1, V2, V3 and V6B to establish flow from the hotleg (DH dropline) and the Reactor Building Sump for sufficient DHR pump suction. Makeup will be via the Core Flood nozzle.

6) Malfunction: Failure of a Diesel Generator

a) Mode: Low pressure injection from BWST

Action: Open DH-V38 valves

Open affected DH-V4 valve manually or by cross tie to operating DG

Establish injection to reactor using operable DH pump through both LPI paths

If DH-V38 A&B or affected DH-V4 valve cannot be opened, establish 'piggy-back' cooling by aligning the operable pump to the suction of the MU pumps.

b) Mode: Recirculation from Reactor Building sump:

Action: If DH-V38 A&B and affected DH-V4 are open, use the operable DH loop to establish recirculation from Reactor Building sump to reactor via both LPI paths.

If DH-V38 A&B or affected DH-V4 are not open and/or inaccessible (e.g., if failure of DG occurs while on recirculation) establish a second flow path by aligning the operable DH pump to the suction of the MU pumps ('piggy-back' cooling).

c) Mode: Boron Precipitation Control

Action: If DH-V38 A&B are open:

Establish Mode 2 Boron Control

Open DH-V64, RC-V4

Close RC-V3

Use operable pump to inject to auxiliary pressurizer spray line.

If DH-V38 A&B are closed and:

1) Failure is 'A' DG:

Establish Mode 1 Boron Control

Open DH-V1, V2, V3

2) Failure is 'B' DG:

Establish Mode 2 Boron Control

Open DH-V64, RC-V4 (Vital Swing Bus 1C-ES)
Close RC-V3

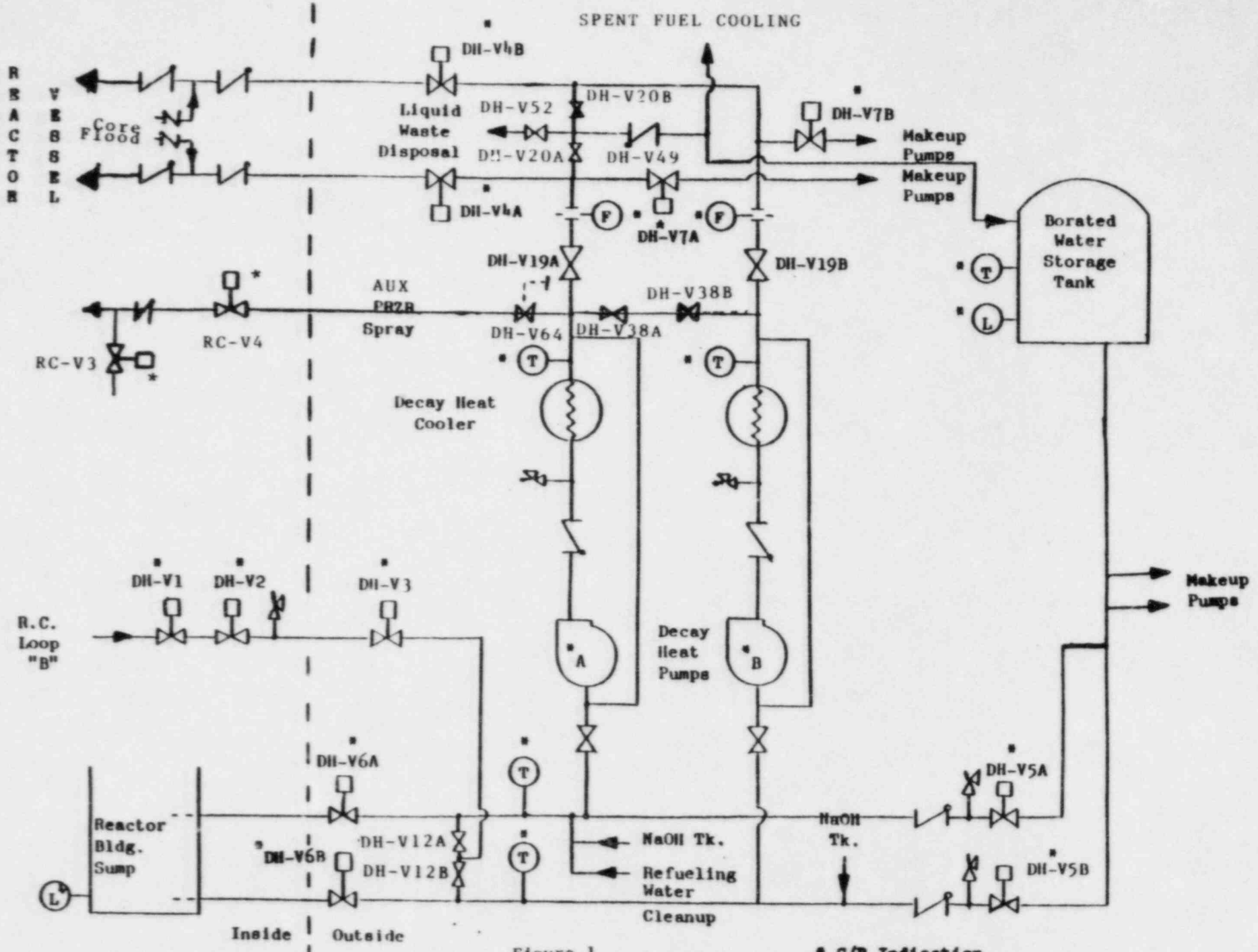

Figure 1

* C/R Indication

DECAY HEAT REMOVAL SYSTEM (SIMPLIFIED)