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TMI-2  
**DIVISION**  
**SYSTEM DESCRIPTION**  
**FOR**

Defueling Water Cleanup

Reactor Vessel Cleanup System

(ECA 3525-84-0041)

(ECA 3525-85-0304)

COG ENG E. Z. Boldt DATE 8/27/84

RTR RL Mays DATE 8/27/84

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**Nuclear**

NO

15737-2-M72-DWC01

**Title** Division System Description for Defueling Water Cleanup  
Reactor Vessel Cleanup System**PAGE** **OF**  
2 25**Rev.****SUMMARY OF CHANGE**

- 1 Incorporated changes to add third 4 x 4 Ion Exchanger to allow two ion exchangers to be dedicated to this system and separate system from FTC/SFP System; revised references; revised setpoints (Section 2.2); revised initial fill and draining to reflect addition of ion exchanger level switch disable, added valve numbers.
- 2 Change Dwg. No., item 22.b p.7; added note page 7; deleted sentence p.8; added "V084 (FV-10)", p.8; deleted parentheses around "p-6 or 8", p.9; added "by EPICOR-11 from a RCBT as required," p.9; changed EPICOR to "Nuclear Packaging 50 ft<sup>3</sup> ENVIRALLOY Demineralizer/HIC," p.10 changed later to "4850," p.16; added note p.16.
- 3 Added relief valves R-4, R-5, R-6 & R-7 to protect filter canisters. Added specific location of sample points. Added detailed description of sample box 1 and 2 and their exhaust system. Changed boronometer from AE-12 to AE-17. Added references 18r,s,t,u, 22a,d,e, 23 and 24. Added valve numbers to Section 3.2. Added startup details on the RV return line valves and the sample box 2 filtration module. Added precaution for sample box 2 face velocity. Revised section 5.0 to delete forthcoming information.
- 4 Added ref. 22f, inlet hose to P-2A/B changed to hard piping. CLD system tie-in incorporated, noted that CLD-P-1 may be used to aid backflushing. Added flow indicators on sample box return lines. Revised post filter F-6 load point. Revised set point for filter canister loading & post filter loading. Added LAL-2A.
- 5 Revised description of LIS-2A/B in Section 2.2. Added "The ion exchanger post" in front of "filter" in last paragraph of Section 2.1.
- 6 Changed set point for filter canister post filter. Noted addition of bypass spool piece and additional modes of operation. Changed maximum NTU value for processing to 5. Added reference 25.

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## 1.0 DESIGN DESCRIPTION

### 1.1 Summary

The reactor vessel cleanup system is a temporary liquid processing system which is designed to process water contained in the reactor vessel. The system's major functions are:

- a) to filter the water contained in the reactor vessel to remove suspended solids above a nominal .5 micron rating. This is done to maintain the clarity of the water. | 6
- b) to remove soluble fission products from the reactor vessel by demineralization of the water. This is done to keep the equivalent Cs-137 concentration less than .02  $\mu\text{Ci/ml}$ , excluding antimony, and thus reduce the dose rate contribution of the water. Sb-125 concentration can be controlled by batch processing of reactor vessel water at the RCBTs. | 6

### 1.2 References

1. Planning Study, Defueling Water Cleanup System Doc. No. TPO/TMI-046
2. Technical Plan, Defueling Water Cleanup System Doc. No. TPO/TMI-047
3. Division I, System Design Description, Defueling Water Cleanup System Doc. No. 2-R72-DWC01
4. Bechtel Drawing 2-M74-DWC01, Defueling Water Cleanup (DWC) Reactor Vessel Cleanup System
5. Bechtel Drawing 2-M74-DWC02, Defueling Water Cleanup (DWC) Fuel Transfer Canal/Spent Fuel Pool Cleanup System
6. Bechtel Drawing 2-M74-DWC03, Defueling Water Cleanup (DWC) Auxiliary Systems
7. Bechtel Drawing 2-POA-6401, General Arrangement Fuel Handling Building Plan El. 347'-6"
8. Bechtel Drawing 2-POA-1303, General Arrangement Plenum Removal Reactor Building
9. DCN No. 2026-30-2, Flow Diagram Spent Fuel Cooling and Decay Heat Removal
10. Burns & Roe Drawing No. 2026, Flow Diagram Spent Fuel Cooling and Decay Heat Removal

11. GPU Drawing No. 2R-95(1-21-001 P&ID Composite Submerged Demineralizer System
12. TMI-2 Recovery Division System Design Description for Submerged Demineralizer System, Doc. No. SD 3527-005
13. Division System Design Description for Spent Fuel Pool/Fuel Transfer Canal Cleanup System, Doc. No. 15737-2-M72-DWC02
14. Instrument Index, Doc. No. 15737-2-J16-001
15. Design Engineering Valve List, Doc. No. 15737-2-P16-001
16. Standard for Piping Line Specifications for GPU Nuclear Corp. TMI-Unit 2 Standard 15737-2-P-001
17. Mechanical Equipment List, Doc. No. 15737-2-M16-001
18. Bechtel Piping Isometrics
  - a. 2-P60-DWC01-DWCS - Pumps P-2A&B, P-3A&B, P-4A&B, and Miscellaneous Details
  - b. 2-P60-DWC02-DWCS - Reactor Vessel Filter Trains A & B - Inlet Manifold Piping
  - c. 2-P60-DWC03-DWCS - Reactor Vessel Filter Trains A & B - Outlet Manifold Piping
  - d. 2-P60-DWC04-DWCS - Transfer Canal/Fuel Pool Filter Trains A & B - Inlet Manifold Piping
  - e. 2-P60-DWC05-DWCS - Reactor Vessel Filter Train Sample Lines
  - f. 2-P60-DWC06-DWCS - Discharge Piping from Sample Boxes No. 1 & No. 2 to Penetration R-537
  - g. 2-P60-DWC07-DWCS - Samples Lines Upstream & Downstream of Ion Exchangers
  - h. 2-P60-DWC08-DWCS - Forwarding Pumps P-6 and P-7, Suction & Discharge Piping
  - i. 2-P60-DWC09-DWCS - Forwarding Pumps P-6 and P-7 Discharge Piping
  - j. 2-P60-DWC10-DWCS - Supply Piping to Ion Exchangers K-1 & K-2, Supply & Discharge Piping for Post Filter F-8



- k. 2-P60-DWC11-DWCS - Supply Piping to Ion Exchangers K-1, K-2 and K-3
  - l. 2-P60-DWC12-DWCS - Borated Water Flush Piping from SPC-T-4
  - m. 2-P60-DWC13-DWCS - Transfer Canal/Fuel Pool Filter Trains "A" & "B" Outlet Manifold Piping
  - n. 2-F60-DWC14-DWCS - Transfer Canal/Fuel Pool Filter Trains "A" & "B" Outlet Manifold Discharge Piping, Supply & Discharge to Booster Pump P-5
  - o. 2-P60-DWC15-DWCS - Nitrogen Supply Piping to SPC-T-4 and Drying Station
  - p. 2-P60-DWC16-DWCS - Discharge Piping from DWC Booster Pump P-5
  - q. 2-P60-DWC17-DWC Miscellaneous Piping Details
  - r. 2-P60-DWC18-DWCS - Miscellaneous Piping Details
  - s. 2-P60-DWC19-DWCS - Sample Panel No. 1, FHB
  - t. 2-P60-DWC20-DWCS - Sample Box No. 2, FHB
  - u. 2-P60-DWC21-DWCS - Sample Panel No. 2 Drain & Return to Spent Fuel Pool A
- 19. ECA No. 3525-84-0041, Definition of the Defueling Water Cleanup System.
  - 20. ECA No. 3245-84-0034, Defueling Water Cleanup System Penetration Modifications.
  - 21. ECA No. 3527-84-0042, SDS Tie-in to DWCS.
  - 22. Bechtel Area Piping Drawings
    - a. 2-P70-DWC02 - Instrument Air Manifolds & Hose Routings for DWCS - Reactor & FHB
    - b. 2-P70-DWC03 DWCS Hose Network Reactor Bldg. Plan El. 347'-6"
    - c. 2-P70-DWC04 DWCS Hose Network Fuel Handling Bldg. Plan El. 347'-6"
    - d. 2-P70-DWC05 - DWC System Hose Network Sections and Details
    - e. 2-P70-DWC06 - DWCS - Process Hose Schedule - Reactor & FHB
    - f. 2-P70-CLD01 - Canister Loading & Decontamination System, Fuel Handling Building

23. TER-15737-2-G03-106, TMI-2 Division Technical Evaluation Report for Defueling Water Cleanup System.
24. TER-15737-2-G03-114, TMI-2 Division Technical Evaluation Report for Defueling Canisters.
25. ECA No. 3525-85-0304, DWCS RV Filtration Manifold Modification.

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### 1.3 Detailed System Description

#### 1.3.1 Description

The reactor vessel cleanup system is a liquid processing system which will process water from the reactor vessel. The system is shown schematically on Dwg. 2-M74-DWC01, and its associated Dwgs. 2-M74-DWC02 and 2-M74-DWC03. (Note, some valves identified herein have been given an instrument designator as well as a valve number. When this occurs, the instrument designator is shown in parentheses after the valve number.)

The system has two submersible type pumps (deep well pumps), P-2A and 2B, which are housed in wells and located in the fuel storage pit in the shallow end of the fuel transfer canal in the Reactor Building. Each pump has a 220 gpm capacity and will process 200 gpm from the reactor vessel and recirculate 20 gpm. The suction from the reactor vessel is through the Westinghouse work platform via pipes which connect the nozzles provided on the work platform to the wells.

The system has four particulate filters, F-1, 2, 3 and 4, each capable of filtering a flow of 100 gpm. The filters are composed of sintered metal filter media which is contained in modified fuel canisters. These filters are capable of removing debris, mainly fuel fines ( $UO_2$ ) and core debris ( $ZrO_2$ ), down to a 0.5 micron rating. Since the canisters contain fuel fines, they are designed to prevent a criticality condition from existing when they have been loaded. Also, the filters are submersed in the transfer canal to provide the appropriate radiation shielding.

The two pumps and four filters are arranged so that one pump discharges to two filters. Therefore, the filtration portion of the system is divided into two trains, each train contains one pump which feeds two filter canisters. This allows the system to filter 200 or 400 gpm from the Reactor Vessel. The two pump arrangement allows for greater flexibility in system operations and provides redundancy to allow system operation during maintenance.

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A filter is used until the differential pressure reaches a predetermined setpoint. At this point the system is shutdown and then, after a waiting period (approximately 5 min.), it is restarted. The differential pressure is noted and if it returns to a low value the system will be run again to the pressure setpoint. This process is repeated until the differential pressure at restart reaches a value near the shutdown setpoint. When this occurs within one hour, the train is shutdown and the filters are replaced.

Loaded canisters are expected to generate small quantities of oxygen and hydrogen gas due to radiolysis of water. Pressure relief valves R-4, R-5, R-6, and R-7 are provided on the filter canister outlet lines upstream of their isolation valves. Their purpose is to prevent overpressuring the filter canisters when isolated due to the small quantities of  $H_2$  and  $O_2$  produced (approximately  $0.029 \text{ ft}^3/\text{day}$ .)

Once the water has been filtered, all, or a portion of, the flow can be returned to the Reactor Vessel. The amount of water returned is controlled by remotely adjusted valves V015A & B (HV30A&B). Each of these lines will connect, via flexible hoses, to the separate inlet nozzles on the work platform. A sparger has been placed on each return line to maintain a positive pressure in the attached hoses.

That portion of the flow not returned to the vessel can be further processed to remove soluble fission products. The flow from the pumps, which passes through a single line to the ion exchangers, is automatically controlled by remotely adjusted flow control valve V084 (FV-10). There is a post filter, F-5, located in that line to ensure that, in case of a failure of a filter canister, no fuel fines can reach the ion exchangers. The loading on the post filter is expected to be minimal and, as such, they will be standard disposable cartridge type filters.

Bypass lines are installed on both filter trains. The bypass line will allow the filter canisters in a train to be bypassed, and allow direct routing of water to the post filter and ion exchangers.

Two ion exchangers, K-1 and K-3, are dedicated for use in this system. Each of these ion exchangers can handle the normal 30 gpm flow. The ion exchange media is a bed of zeolite resin which will remove the Cs-137. The two ion exchangers provide flexibility in operation so that one can be taken out of service without interrupting normal flow. The ion exchange media is contained in a  $4 \times 4$  liner which is similar to those in use for the EPICOR II system.



The level in each ion exchanger is maintained by regulating the flow out of the ion exchanger to match the inflow. The outflow is regulated by a throttling control valve V029 or V266 (LV 45 or 72), which is located downstream of an air driven reciprocating diaphragm pump P-6 or 8. This valve automatically throttles in response to changing level in the ion exchanger. The maximum system flow rate is 30 gpm per 4 x 4 liner. The pumps head-flow characteristics can be changed by adjusting the air pressure to the pumps. Post filter F-6 is located downstream of these pumps to prevent the migration of any resin fines. The water is returned from here to the reactor vessel via flexible hoses.

Sample points are provided upstream and downstream of each filter train. These samples are routed to sample box 1, a glove box located in the FHB. The glove box has a self contained blower and HEPA filter which discharge to the FHB ventilation system. Sample points are also provided upstream and downstream of ion exchangers K-1 and K-3. These samples are routed to sample box 2, a laboratory hood located in the FHB. The hood is connected to combination blower/prefilter, HEPA filter package S-2 and discharges to the FHB atmosphere. The S-2 inlet dampers should be adjusted to maintain a 100 to 140 feet/minute face velocity at the sample box 2 hood.

This system provides the operator with the capability to periodically monitor the effectiveness of the system. Also, the turbidity of the effluent from the filters is constantly monitored by nephelometers and displayed at the local control panel. The radiation levels of the ion exchange influent and the boron concentration and pH of the ion exchange effluent are also constantly monitored and displayed at the local control panel.

Several inlets have been provided on the DWC system through which borated water can be gravity fed from the standby reactor pressure control system storage tank to backflush the system. The CLD booster pump (CLD-P-1) may also be used as an aid in backflushing the system. The system will be backflushed when radiation levels in the piping are determined to be excessive and prior to maintenance.

A path to allow flow to the reactor coolant bleed tanks is provided to allow for system inventory reduction. Also, batch processing to remove Sb-125 will be performed by EPICOR-II from a RCBT as required. This flow path uses a portion of the submerged demineralizer system. This path is located downstream of the DWC ion exchangers, and, as such, this flow does not pass through the SDS ion exchange vessels.

### 1.3.2 System Components

#### P-2 A/B Reactor Vessel Cleanup Pumps

Type: Vertical Submersible Deep Well Pump  
 Model: Goulds VIS 9AHC/2  
 Material: Stainless Steel Bowl and shaft with a  
           bronze impeller  
 Motor: Franklin Electric 25 hp, 460 Volt, 3 phase  
 Rating: 264 FT TDH at 220 gpm  
 Minimum Flow: 20 gpm

#### F-1/2/3/4 Reactor Vessel Filters

Type: Pleated Sintered metal media  
 Model: Pall Trinity special product contained in a  
       critically safe canister  
 Rating: 0.5 micron Nominal Removal Rating  
 Flow: 100 gpm

#### F-5/6 Filter Canister Post Filter and DWC Post Filter

Type: Disposable Cartridge  
 Model: Filterite No. 921273 Type  
       18X503C-304-2-FADB-C150  
 Rating: 0.45 micron nominal removal rating  
 Flow: 20 to 60 gpm

#### K-1/3 Ion Exchangers

Type: Zeolite resin contained in a 4'x4' H1C  
 Model: Nuclear Packaging 50 ft<sup>3</sup> Enviralloy  
       Demineralizer/H1C  
 Flow: 30 gpm

#### P-6/8 Forwarding Pumps

Type: Air driven double diaphragm pump  
 Model: B.A. Bromley Heavy Metal Pump Model No. H25  
 Material: Stainless Steel with Viton diaphragms  
 Rating: 60 feet TDH at 60 gpm

#### PSV R-4, R-5, R-6, & R-7 Relief Valves

Model: Anderson Greenwood No. 83M546-4L  
 Orifice Area: 0.049 in<sup>2</sup>  
 Set Pressure: 130 psig

Sample Box 1

Type: Glove Box  
 Mfr: Labconco  
 Model: No. 50002, Radioisotope Glove Box  
 Material: Fiberglass-reinforced polyester  
 Built-in Blower: 115 volt, 1/15 HP, variable speed  
 Filters: Inlet Prefilter, outlet HEPA filter  
 Dimensions: 50" x 30" x 37"

Sample Box 2

Type: Laboratory Hood  
 Mfr: Labconco  
 Model: No. 47810, Radioisotope-47 Laboratory Hood  
 Material: 316 stainless steel  
 Dimensions: 47" x 29" x 59"  
 Recommended Face Velocity: 100-140 ft/min.

S-2 Sample Box 2 Filtration Module

Mfr: General Dynamics Reactor Plant Services  
 Model: PFB(H)-1000  
 Filters: Prefilter and HEPA filter  
 Blower: 230 VAC, 5 HP, 20 AMP, 3450 rpm  
 Rated Capacity: 1000 CFM

For instrumentation, valves, piping, and equipment details, see references 14, 15, 16 and 17 respectively.

1.4 System Performance Characteristics

The system is designed to function in any of the modes of operation shown in table 1 below.

Table 1

## Reactor Vessel Cleanup System Operational Configurations

FILTER FLOW (GPM) (Return to Reactor Vessel)	ION EXCHANGER FLOW (GPM) (Return to Reactor Vessel)
400 [200]	0
400 [200]	30
400 [200]	60
[0]	30
[0]	60

(Numbers in brackets indicate flow if only one train is in operation.)

The operational mode is determined by the particulate and radioactive concentrations in the reactor vessel. If the visibility in the reactor vessel is sufficient to allow defueling operations to continue, and the NTU level is below 5 (see Section 2.3), a train with a bypass line may be run at a reduced flow to allow processing of the water through the ion exchangers (30 gpm each) without using the filter canisters. The choice of one or both ion exchangers is based on the equivalent C-137 concentration in the reactor vessel.

If the visibility deteriorates, such that defueling operations cannot continue, or if the NTU level exceeds 5, processing through the ion exchangers should be discontinued, and filtration through the filter canisters should be initiated and continued until defueling operations can resume and the NTU level is below 5. Filtration would be done by either adjusting the valve line-up in the bypassed train or by starting the other train, or by performing both of the above.

As the filters load up, the pressure differential across the filter train increases. As the differential pressure increases, the flow rate is maintained constant by manually adjusting remote valves V015A and V015B (HV-30A and 30B).

### 1.5 System Arrangement

Well pumps P-2A and 2B are located in the fuel storage pit of the Unit 2 Reactor Bldg. These pumps are housed in wells which are located in this pit. The wells are connected by pipe to the Westinghouse work platform. The pump discharge is routed to the filter canisters via a skid mounted manifold which is located above the water level of the canal. The filter isolation valves are also located on the skid. The filter canisters are in racks which are submersed in the fuel transfer canal. The manifold is connected to the inlet and outlet of the filters via coded, armoured hose. The inlet and outlet connections are coded to prevent mis-connection of the hoses. The outlets from the filters return to the manifold from where the water is routed back to the vessel or to the ion exchange system for further processing.

The ion exchangers are located behind appropriate shielding in the Fuel Handling Building. The water that has been demineralized is pumped back to its source by air driven pumps which are located near the ion exchangers.

Sample box 1 is at the southeast end of the spent fuel pool A.  
 Sample box 2 is on the DWCS platform near the DW ion exchangers.

The system uses the following existing penetrations which have been modified for their temporary function.

<u>Penetration No.</u>	<u>System</u>	<u>Modified Function</u>
R-542	Decay Heat	Backflush
R-546	Radwaste Disposal Gas	Flow to Ion Exchangers
R-553	Radwaste Disposal Reactor Coolant Liquid	Return from Ion Exchangers
R-537	R.B. Emergency Spray and Core Flooding	Sampling Return
R-545B&C	Spares	Sampling
R-554D	Instrument Air to LOCA Dampers	Instrument Air Supply to DW

For further location and arrangement information, see references 7, 8 and 18.

## 1.6 Instrumentation and Control

### 1.6.1 Controls

The majority of system control is handled remotely from a control panel which is located in the Fuel Handling Building. This is due to the fact that much of the system is located in the Reactor Building which has limited access. The reactor vessel cleanup pumps do have local hand switches to shut the pumps down.

Filtered water flow back to the reactor vessel is monitored by the operator and adjusted by remotely controlled valves V015A and V015B (HV30A6B). The flow to the ion exchangers is controlled automatically by flow control valve V084 (FV-10), which seeks to maintain flow to the ion exchangers at the selected setpoint.

Return flow to the reactor vessel from the ion exchangers is controlled automatically by control valves V029 and V266 (LV 45 and 72). Each valve responds to a changing level in its associated ion exchanger, which is sensed by a "bubbler" type of level measuring device. This level is maintained between a high and low setpoint in the ion exchanger. The forwarding pumps' head-flow characteristics can be changed as needed by manually adjusting the air pressure to the pumps. This control scheme maintains the inflow equal to the outflow in the ion exchanger.

For further information on the instrumentation, refer to the Instrument Index (Ref. 14).

#### 1.6.2 Power

The pump motors are supplied with 480V power through a motor control center which is energized by an existing unit substation located in the Auxiliary Building. 120 VAC power will be supplied from the control panel or local sources.

#### 1.6.3 Monitoring

Monitoring equipment is provided to evaluate the performance of the system and to aid in proper operation of the system.

The discharge pressure of the submersible well pumps is monitored (PI-4A & 4B) to determine if the pump is operating correctly and also to provide another indication that the pump is operating.

In order to determine the degree of filter loading, the primary filter canisters and the secondary post filters are equipped with remote indication of differential pressure across the filters (DPI-5A, 5B & 33). The differential pressure across the canisters will be used to determine when the filters are loaded to capacity.

Flow in the filter train and the ion exchanger loop is monitored (FI-7A, 7B and 10) to ensure that inflow to the reactor vessel equals the outflow. This is important to insure that the level in the reactor vessel remains constant. Also, the flow to each ion exchanger is integrated by a local device (FQI76 & 77) to determine the loading on each ion exchanger.



The process fluid conditions are monitored to determine the effectiveness of the system. The turbidity level in the fluid is monitored (AI 43A & 43B) prior to its return to the source. Also, the capability to obtain grab samples of process fluid has been provided for at several locations in the system. The radiation levels in the process fluid are continuously monitored upstream of the ion exchangers (RE-9). A high radiation alarm (RAH-9) is also provided. This will alert the operator to the need of processing at a higher rate. The pH and boron concentration are monitored downstream of the ion exchangers (AE 11 & 17). This assures the operator that the proper boron concentration is maintained in the return flow.

The high and low level trip conditions in the ion exchangers alarm to the local control panel located in the Fuel Handling Building. This is done to ensure that the operator is aware of this condition so that the proper evaluation of the system condition that caused the level mismatch can be made. The operator will isolate the ion exchanger portion of the system during this event.

In line flow indicators are provided in the return line from the Sample Boxes to the Reactor Vessel. Their purpose is to confirm that flow exists through the sample box piping, and therefore, provide a means of assuring that a representative sample has been taken by showing that there has been flow long enough to flush out the stagnant water.

#### 1.6.4 Trips and Interlocks

The reactor vessel cleanup well pumps, P-2A/B, are provided with low level setpoint trips, and alarm LAL-2A, to ensure that the pumps do not operate under potential cavitation conditions. Also, a low level in an ion exchanger will trip its forwarding pump and terminate flow from that ion exchanger. Additionally, a high level in the ion exchanger would terminate flow to that ion exchanger by closing its inlet valve, and also would stop its forwarding pump. These trips are taken from a conductivity level probe in the ion exchangers. A low level in the IIF will trip pumps P-2A and P-2B.

Locally mounted toggle switches are provided near the ion exchanger to disable the level switches to allow for filling and draining of the ion exchangers. An alarm at the local control panel alerts the operator when the level switches are disabled.

The reactor vessel cleanup well pumps, P-2A/B are equipped with interlocks to prevent them from being started during a low level condition. Additionally, either a high or a low level in the ion exchangers prevents the valve upstream of the ion exchangers from being opened and prevents the restart of the air driven forwarding pumps. This will ensure that the exchangers are not overfilled and also that any flow mismatch condition is properly evaluated by the operator prior to restart of the system.

For trip setpoints, see section 2.2.

### 1.7 System Interfaces

Those systems interfacing with the DWC are as follows:

- a) Standby Reactor Pressure Control System (existing)  
 Use: Provide a source of borated water for backflushing  
 Tie-in: A single connection from SPC-T-4 downstream of SPC-VI to several points in system
- b) Submerged Demineralizer System (existing)  
 Use: Provide a path to the reactor coolant bleed tanks  
 Tie-in: Downstream of CN-V-IX-32 near 1 1/2" jumper from downstream of ion exchanger post filters.
- c) Instrument Air System (existing)  
 Use: Provide source of instrument air to equipment in the Reactor Building.  
 Tie-in: From existing Instrument Air supply to LOCA dampers.
- d) Instrument Air System (existing)  
 Use: Provide source of instrument air to equipment located in the Fuel Handling Building.  
 Tie-in: From existing Instrument Air supply to Spent Fuel Pool gate seals
- e) Service Air System (existing)  
 Use: Provide a source of service air to the Forwarding Pumps P-6 and P-8.  
 Tie-in: Service Station 87 plus another station if needed
- f) FHB Ventilation System (existing)  
 Use: Receive sample box 1 ventilation  
 Tie-in: 4 inch diameter hose station at southeast end of FHB
- g) Canister Loading & Decontamination System (new)  
 Use: Provide borated water for surface decontamination of canisters  
 Tie-in: At Valves DWC-V321, V322, & V323

## 1.8 QUALITY ASSURANCE

The defueling water cleanup system is classified according to the safety functions of its parts. There are three classifications in this system:

- a. Portions of the system associated with ion exchange processing are considered to be a radioactive waste processing system; therefore, these portions of the system shall be subject to the quality assurance guidelines contained in NRC Regulatory Guide 1.143.
- b. The filter canisters are classified as nuclear safety related and are designed to prevent a condition that could result in a return to nuclear criticality of the fuel retained in the filters.
- c. The remaining portions of the system are subject to the BNAPC non-safety-related quality assurance program.

The TMI-2 Recovery QA Plan will be applicable for work performed on site.

## 2.0 SYSTEM LIMITATIONS, SETPOINTS AND PRECAUTIONS

### 2.1 Limitations

The system is flow limited to 200 gpm through each filter train, 400 gpm total, and 30 gpm through each ion exchanger, 60 gpm through the ion exchanger loop.

The main filter canisters are limited to 55 psid as read on DP1-5A/B. This allows a 45 psi differential across the filter media, with 10 psi of drop due to friction losses in the piping and hoses at design flow.

At this point, an alarm on the local control panel will inform the operator to stop and restart the system or change out the filter.

The filter canister post filter (F-5) is limited to 18 psid. The ion exchanger post filter (F-6) is limited to 45 psid.

The ion exchanger post filter is considered full and ready for change out when either the maximum pressure differential is reached or when the performance (flow) drops 20% below design flow.

### 2.2 Setpoints

DPSH 5 A/B trips the alarm at 55 psid across the filter canisters.

ASL 17 trips the alarm at a low Boron concentration of 4850 ppm.

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DPSH 33 trips the alarm at 18 psid across the filter canister post filter. | 6

RC-LIS 103 trips alarms and pumps at high IIF level of 327'-9" and a low IIF level of 327'-3".

RIS-9 trips the alarm at a high radiation reading of 0.9 mR/hr.

LSL 37/71 and LSH 37/71 trip the ion exchange loops at  $\pm 3"$  from the normal operating level. (Note: Low level is 10" from top of IX, High level is 4" from top of IX.)

LIS 2A/B trips alarm LAL-2A when a decreasing level of 320'-6 1/2" is reached in the well, and trips pumps 2A/B when a decreasing level of 317'-6 1/2" is reached in the well. (The pumps are tripped when the water is approximately 1'-0" above the pump suction).

For additional setpoint information, refer to Ref. 14.

### 2.3 Precautions

Due to the number of quick disconnect couplings, extra care should be taken to ensure that the couplings are properly connected and that they are connected in the proper locations. This precaution will help prevent a loss of reactor vessel inventory.

The portion of the startup procedures concerning the well pumps should be strictly adhered to to prevent the rapid filling of an empty manifold. This situation could cause a harmful pressure wave to develop which has the potential to damage the filter media. Also, during initial startup, a siphon must be established in the suction of the well pumps. This will be done by filling and venting the piping and by slowly starting the system.

The filter canisters operate by a surface filtration method, and their efficiency increases as a cake is built up on the surface of the media. Therefore, the build up of this cake is an important part of the filtration process. To prevent the migration of fines to the post filter, the ion exchange portion of the system should not be started until a cake has begun to be formed on the media. This can be verified by observing the turbidity of the filter effluent. When the filter train is started up, there will be an initial turbidity spike caused by smaller particles passing through the media. As the cake is built, these particles are stopped and the turbidity decreases. Once the turbidity reaches a level of 5 NTU or less, the ion exchange portion of the system can be started. To prevent the breakdown of the cake, the system should not be started or stopped unnecessarily. | 6

Due to the radioactivity in the water, the system should be carefully drained and flushed prior to any maintenance work.

Double isolation has been provided for in the system design to separate borated and nonborated water supplies.

Periodically the face velocity across the sample box 2 hood should be checked to verify it is within the range of 100 to 140 feet/minute. If the face velocity is too low the S-2 inlet dampers should be readjusted accordingly.

### 3.0 OPERATIONS

#### 3.1 Initial Fill

The system is filled initially by borated water from the standby reactor coolant pressure system through the backflushing system provided (see section 3.7). The filters are filled to the inlet and outlet manifolds and the ion exchangers are filled until they reach their normal operating level. The suction piping from the 11F to well pumps 2A/B should be filled as much as possible.

To initially fill the DWC ion exchangers K-1 and K-3 the level switches must be blocked out. This is accomplished by placing the block-out toggle switch, for the ion exchanger to be filled, in the proper position. This will allow isolation valve V025 or V260 to be opened. Once the ion exchanger is filled to the operating level, the level switches are returned to operation by returning the block out toggle switch to its original position. As a reminder to the operator, an alarm is activated at the control panel when the level switches are blocked out.

#### 3.2 Startup

Prior to startup, valve alignment must be checked to verify that the process water for each filter train and the ion exchanger loop is taken from and returned to the reactor vessel. The well pumps P-2A/B are isolated by the remote manual isolation valves V004A/B

(HV27A/B). The ion exchanger loop is isolated by the remote isolation valves V025 & V260, and the control valves V029 & V266 (LV45 & LV72) in the ion exchanger loop. The return lines to the source are isolated by the remote control valves V015A/B (HV 30 A/B). For initial startup, valves V016 A/B should be closed. The well pumps are started and placed on minimum recirculation flow. The pump isolation valve V004A or B (HV27A or B) for one filter train is slowly opened to allow any trapped air to escape through the automatic vent valves. Once the isolation valve is fully opened, the return valve V015 A/B (HV30A/B) is opened approximately 85%. During initial startup, the globe valve V016 A/B is opened

slowly until 200 gpm through the train is obtained. Following initial startup, valves V016A/B will remain in these positions, and startup will be initiated by slowly opening valve V004A/B (HV27A/B) with valve V015A/B (HV 30A/B) approximately 85% open. Flow is then adjusted to 200 gpm by adjusting valve V015A/B (HV 30A/B). The other train then is brought to the desired flow by following the same procedure.

The ion exchange system is brought into service only when the turbidity, as monitored by the in line nephelometer, AE-43 A/B, reaches an acceptably low level (i.e. 5 NTU). The ion exchanger should always be brought to normal operating level prior to operation of this portion of the system.

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If the ion exchanger is at low level, it should be filled with borated water from the back flush system (see Section 3.7). At this time, the inlet isolation valve V025 or V260 is opened. The air pressure to the ion exchanger forwarding pump is manually adjusted to the pressure required to maintain the flow rate chosen. The air supply solenoid valve V154 or V262 is then opened which will start the pump and lower the level in the ion exchanger to the point where the level control valve will close. This level is above the isolation low level. Flow is slowly started to the ion exchanger by opening the flow control valve until the desired ion exchanger flow rate is obtained. The proper flow of water will be returned to the source automatically as the level control for the ion exchanger adjusts the downstream control valve to regulate the outflow.

The sample box 2 filtration module inlet dampers should be adjusted to create a 140 feet per minute face velocity across sample box 2.

### 3.3 Normal Operation

Normal operation of the system is in one of the modes shown in Table 1 of Section 1.4. The mode of operation chosen is based on the particulate and radioactivity concentrations in the Reactor Vessel.

### 3.4 Shutdown

The steps to bring the system to a shutdown condition are basically the reverse of the startup procedure. The ion exchanger flow would be brought to zero slowly by remote operation of the upstream flow control valve. As the level in the ion exchanger drops, flow from the forwarding pumps is terminated by the closure of the control valve downstream of the pump. Either (depending on system operation) of the isolation valves from the filtration trains to the ion exchanger is then closed, and the solenoid valve for the air supply to the forwarding pump is closed. The filtration trains are shut down one at a time by closing the flow return control valve and then shutting down the pumps and closing the pump isolation valves.



### 3.5 Draining

There is a low point drain which can drain both filtration train manifolds and part of the ion exchange loops to the fuel transfer canal. A manual blockout switch is provided which will deactivate the ion exchanger level switches. This allows the ion exchangers to be pumped out to the reactor coolant bleed tanks via the connection provided.

### 3.6 Refilling

The fully drained system can be refilled in the same manner that the system was initially filled. A partially drained system can be refilled by using either the back flush system (see section 3.7) or the well pumps (see section 3.2).

### 3.7 Infrequent Operations

Flushing of the system may be performed when the internal contamination level gets high or prior to internal maintenance work. The system is shutdown (see Section 3.4) prior to flushing.

One flushing option allows a gravity flush from SPC-T-4. Borated water is stored in the charging water storage tank, SPC-T-4, located at the 347 ft. elevation in the Fuel Handling Building. This tank is connected to the DWCS. If desired, the CLD booster pump (CLD-P-1) may be used to assist in backflushing. Either filter train may be flushed without stopping flow through the other.

Flushing may be accomplished by opening one of the inlet valves from the flushing system (depending on which portion of the system is to be flushed) and then opening the drain valve to the fuel transfer canal. After sufficient time has been allowed to flush the system, the drain valve is closed and then the inlet valve is closed. The system is then restarted following the procedures in Section 3.2.

System inventory can be decreased as needed by diverting the return flow from the ion exchangers through the lines provided to the Reactor Coolant Bleed Tanks. Also, the water can be routed to the RCBT as required for processing to remove Sb-125.

### 3.8 Transient Operations

The only effects of anticipated transients (e.g., loss of pumps, valve misoperation, or loss of controls) are a mismatch of flows from and to the reactor vessel. More water can be removed from the source than is replaced by a failure to control level in the ion exchangers. In the case where level control in the ion exchangers is lost, the source outflow will exceed the inflow by a maximum of 60 gpm. This situation can be detected by flow instrumentation in the return line and by a decreasing level in the reactor vessel. This is an unlikely event since the level controls receive their signals from two separate, diverse types of level instrumentation.

#### 4.0 CASUALTY EVENTS AND RECOVERY PROCEDURES

##### 4.1 Loss of Power

A loss of power to the entire system would simply shut the system down. A loss of power to the well pumps with an additional failure which results in simultaneous loss of level control in the ion exchangers would result in a flow mismatch. In this case, the system would be automatically shut down until power is restored.

Loss of power to individual components would place the component in its safe mode. An air operated valve, for example, would fail to a position that ensures no damage to other components.

Loss of power to the control panel would cause the loss of all information and fail all control and solenoid operated valves. The system would be shutdown until power is restored.

##### 4.2 Loss of Instrumentation/Instrument Air

Loss of instrumentation would hamper operations but no adverse conditions would result and the system could be safely shut down until the problem is resolved.

Loss of a single instrument channel will result in the loss of indication for that channel and, for those channels that have control features, a flow mismatch. This flow mismatch will result in an automatic shutdown of the affected portion of the system.

Loss of the internals indexing fixture (IIF) level indication system (bubbler) will result in an erroneous level indication which will be noted when compared with a redundant level indication system. Since this system has no control features, no adverse system conditions will result.

Loss of instrument air will take the individual components to their fail safe position. Flow mismatches induced by loss of air will result in automatic trips. Loss of air to the IIF level monitoring system will initiate a low air supply pressure alarm.

On the loss of instrument air, level control in the ion exchangers would be lost; however, the ion exchanger inlet isolation valve (V025 & V260) would fail to the closed position. Also, the level control valves, V029 and V266 (LV45 & LV72), will fail to the closed position to prevent siphoning of the ion exchanger.

##### 4.3 Filter Media Rupture

A failure of the filter media in the canister could potentially release fuel fines to the ion exchange portion of the system. A post filter is located downstream of both filter trains in the line to the ion exchangers. This filter will trap any fuel fines which would be transported past the filter canisters in the event of filter failure. The post filter is designed to be critically safe

and is sized so that a small accumulation of debris will increase the differential pressure to the alarm setpoint. Also, the nephelometers in the return line would alert the operator to a possible media rupture since the turbidity would increase rapidly.

The recovery procedure is to isolate the filter trains and find the ruptured filter by observing the differential pressure versus flow for each individual canister. Lower differential pressure for a given flow will indicate that this filter is ruptured. That canister or canisters and the post filter cartridge would be replaced and the system restarted.

The system may be operated in a mode that bypasses the filter canisters. During this mode of operation, the filter canister post filter will be providing the required system filtration. In order to preclude the rupture of the post filter's filter media during operation, the maximum differential pressure that will be permitted across the post filter will be 18 psid. The post filters are designed for a maximum differential pressure of 45 psid.

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#### 4.4 Line and Hose Break

The consequences of any line and hose break is a loss of reactor vessel inventory. The system has been designed to mitigate the consequences of such an incident to the extent possible.

To help prevent a hose rupture, all process hoses are armoured. In case of a hose rupture or line rupture, downstream of the reactor vessel pumps, P-2A & 2B, the system is equipped to trip these pumps on the IIF low level and alarm to the control panel. This event could deliver approximately 500 to 1000 gallons of reactor vessel water to the area of the break. The potential areas affected would be the Reactor Building and the Fuel Handling Building, each of which has sumps or drains to the Aux. Bldg. sumps to contain the spill.

If a suction pipe to the well pumps or a return hose to the reactor vessel should rupture, a siphoning of reactor vessel water would take place. The two 4 inch suction connections provided in the Westinghouse work platform are provided with two 3/4 inch holes drilled 18 inches below the water level which will act as a siphon breaker. The three 2 inch return lines are equipped with spargers, which are simply holes drilled into the pipes. The first holes are drilled 18 inches below the water level which will act as a siphon breaker. The sample return line is terminated 18 inches below the water level. Therefore, a maximum of approximately 3000 gallons of reactor vessel water would spill into the fuel transfer canal following a hose rupture. Approximately half of this water would be contained in the New Fuel Pit.

The recovery from these events would be accomplished by isolating the ruptured section and replacing the ruptured hose/pipe.

## 5.0 SYSTEM MAINTENANCE

The maintenance procedures are the recommended practices and intervals as described by the equipment vendors.

## 6.0 TESTING

### 6.1 Hydrostatic Testing

Piping and hose will be hydrostatically pressure tested. Testing of hose will be done after couplings have been attached. Pipe will be tested outside the buildings.

### 6.2 Leak Testing

All accessible connections will be initial service leak tested after the piping is assembled.

### 6.3 Instrument Testing

All instruments will be calibrated by vendors. Complete electric/pneumatic loop verification will be done during start-up.

## 7.0 HUMAN FACTORS

Filter canister hoses are coded for quick identification of inlet versus outlet.

Extensive use of hoses is made, especially in the Reactor Building, allowing quick installation and use of existing radiation shielding. Hoses which are expected to be frequently disconnected are equipped with quick disconnect couplings for ease of removal and replacement.

The following human factors guidelines have been incorporated into the design of the DWCS control panel:

- o The panel includes all controls and displays required for normal operation.
- o Displays provide immediate feedback that the system has responded appropriately to an operator's action.
- o Controls and displays are laid-out for a left to right flow path.
- o Mimic lines are used to clarify flow paths.
- o Control devices are mounted 3 to 6 feet above the floor.
- o Each control device has a name plate.

- o Light bulbs are replaceable from the front of the panel.
- o Recorders are grouped on the right side of the panel away from the flow path.
- o Adjustments to recorders and controllers can be performed from the front of the panel.