Local PDC
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

August 3, 1979

MEMORANDUM FOR: John Barton, Waste Management Activities, GPU

FROM: John T. Collins, Deputy Director, TMI-2 Support

SUBJECT: TMI CLEANUP SYSTEM DESCRIPTION FOR CONTAINMENT WATER

I have reviewed an informal copy of the subject document and my comments are noted below. In general the system description lacks specificity in that it does not contain any discussion with respect to the system being designed to meet appropriate federal regulations and applicable regulatory criteria and guidance. We will require that this information be included before we can give final approval.

John T. Collins
John T. Collins, Deputy Director
TMI-2 Support

Attachment:
TMI Cleanup System Description
(Marked-Up Copy)

cc: R. Vollmer
B. Rusche
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The document lacks specificity and does not contain any discussion as to what Regulations, design criteria and Regulatory Guides are applicable to this system

TMI CLEANUP SYSTEM DESCRIPTION

1.0 INTRODUCTION

This report describes the conceptual design of a system for treatment of the contaminated water in the containment sump of Three Mile Island (TMI) - Unit 2. This design is based on ion exchange purification. Specific process and equipment selections reflect Chem Nuclear Systems, Inc. (CNSI) Technology and recommendations of the TMI Technical Advisory Group.

2.0 DESIGN OBJECTIVES AND CRITERIA

The design objectives were to provide:

a) A totally integrated system that was as independent as possible from existing waste and off-gas systems at TMI.

b) A system that would remove the fission product and chemical contaminants in the water to a level that would meet existing regulatory release requirements.

This has not been decided how the water will be disposed of. The processing of the waste should not preclude any disposal method.

c) A system that could be operated with a minimum of exposure to personnel and a negligible risk to the general public. Cite Reg. Guide 8.8 ALARA

d) A system that would accomplish these objectives in a timely and cost effective manner.

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In order to accomplish these objectives, the following design concepts were used:

a) The ion exchange columns are to be located underwater in the spent fuel pool which will provide for containment and personnel shielding.

b) To the extent possible, all-welded stainless steel construction is specified to minimize the potential for leakage.

c) Lead or equivalent shielding is provided for pipes, valves and vessels (except those located underwater) which could or will carry contaminated water.

d) Contaminated water from the containment sump is to be filtered, collected in one of two batch tanks, sampled and then pumped continuously to the ion exchange system.

e) Two parallel filters and ion exchange systems are to be used to provide capacity and to assure continuous operation.

f) Continuous effluent monitoring and routine sampling systems are to be provided to assure adequate control of the operation.

g) The valving systems are to be designed to minimize the impact of operator error.

h) The system is to be designed for a minimum of two years service.

3.0 SYSTEM AND PROCESS DESCRIPTION

The conceptual system design consists of the following elements:

a) A Feed Filtering System.

b) Two Feed Tanks with independent mixing, sampling level measuring and feed pumping capability.

c) Two parallel primary ion exchange trains, each train comprised of three 7 cubic feet beds of zeolite exchange media.

d) Two parallel ion exchange beds containing organic cation resin for removal of strontium[1].

e) A continuous effluent monitoring system and sampler for control of bed loading.

f) A secondary containment system for the filters, primary and cation beds and radiation shielding for piping, valves, samplers and monitors.

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[1] About 90-95% of the strontium and essentially all of the cesium will be loaded on the zeolite.

g) A carbon-cation "filter" bed for removal of trace fission products.

h) A mixed-resin ion exchange polishing bed for removal of trace fission products that are not trapped on the primary or cation beds.

i) A 195 cubic foot ion exchange bed for removal of boron.

j) Two monitoring tanks for collecting and sampling the treated water prior to discharge from the system and storage.

k) An off-gas system for treating and filtering gases and air from the system.

l) Associated piping, valving and structural supports required for placement of the system components.

m) Auxiliary systems including underwater ion exchange column storage, a column dewatering system, a system for solidifying the resin beds with concrete and analytical equipment.

Feed Filter System - This system consists of two parallel underwater filter units. Each unit is a cluster of 5 micron cartridge filters protected by perforated metal screens and contained in a 24"Ø X 54" column. Inlet, outlet and vent connections are made with Hansen quick-release valved couplings which are remotely operated from the top of the pool. A gamma monitor, located in a dry well adjacent to the filters, and inlet and outlet pressure gauges are provided to monitor and control solids loading. Load limits will be based on available system pressure and/or the surface dose limit for the filter cask. The flow capacity of each filter is about 15 gpm. Feed will be pumped from the reactor containment sump, through the filters and into the feed tanks on a batch basis.

Feed Tank System - This system consists of two of the 15,000 gallon tanks located in the emergency tank farm. Each tank will have an airlift system for circulating the feed solution and for raising it to a small pump head tank (approximately 8"Ø X 3'). A sampler will be provided on each tank to permit characterization of the feed prior to sending it to the ion exchange system. Level measurement instruments are also provided. Feed will be pumped to the ion exchange columns using one of two seal-less magnetically coupled pumps rated at approximately 15 gpm each. The samplers, headpots and pumps will be located in a shielded enclosure.

Primary Ion Exchange Columns - This system consists of six underwater columns (24"Ø X 54"), each containing 7 cubic feet of Linde AW-500 zeolite resin. Inlet, outlet and vent connections are made with remotely operated Hansen couplings (similar to the filter connections). The beds are arranged in two parallel trains of three each with piping and valves provided to operate either train individually or both trains simultaneously. Loading will be controlled by feed batch size, loading time, effluent samples analysis and continuous monitoring (described later). Flow meters are provided for the total feed stream and the individual feed streams to the two parallel trains. The maximum loading per column will be 65,000 curies (cask limit). These columns are expected to remove > 99% of the cesium and 90-95% of the strontium from the water. When the desired bed loading is achieved on the first bed of the train, the feed flow to the train will be stopped. The treated water will then be displaced with fresh water (through the downstream beds) and the first bed will be disconnected and moved to the storage rack using the pool area crane. The second bed will be disconnected, moved to the first position and

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reconnected. Likewise the third bed will be moved to the second position and, finally a fresh bed will be placed in the third position. (Note: This approach is considered to be superior to a valving manifold which would permit rerouting of the streams because it minimizes the potential for a serious operator valving error. A valve switching approach was considered, however, a valving error could result in totally bypassing the primary beds. The current design prevents this from occurring.)

Cation Columns - Two additional underwater columns (of the same size and type as the primary columns) are located immediately downstream. These columns are loaded with organic cation resin (probably DOW HCRS) for removal of residual strontium. Column loading will be limited to 75 curies of strontium based on primary column effluent monitoring and analysis. The columns are arranged to be operated singly or simultaneously in parallel. The curie limit is based on restricting the integrated radiation dose to the resin to less than 10^8 RAD.

Sampling and Monitoring System - As previously described, the feed will be collected in batches, sampled and analyzed, and fed continuously to the ion exchange system. Sampling lines are provided on the effluent streams of each of the primary beds and cation beds. A continuous sample flow from each operating bed effluent will be passed through a beta scintillation monitor calibrated for strontium detection. A gamma monitor is located on the primary effluent line and a local area radiation monitor is located near the valve box (described later). Each of the monitors will have an alarm system and a high radiation trip point which will close an automatic valve of the main feed line, thereby stopping the operation automatically in case of a leak or a serious breakthrough. Shielded samplers are also provided to permit sampling at any time. Continuous sample effluent is routed to the off-gas separator tank (described later).

Containment and Shielding - The filters, primary beds, cation beds and their associated remote connectors and flexible lines are contained in submerged boxes designed to confine any contaminated leakage. Each box is connected to a pump manifold and a continuous flow of about 10 gpm is maintained through each box. The containment pump effluent is discharged to an additional mixed bed resin column and is released back into the pool. A large shielded box is provided for the various valves and piping which are required for feeding, flushing and venting the columns. This box will be located on the edge of the pool with shielded lines entering and exiting the box from the bottom. Valves will be operated manually using extension handles penetrating the top of the box. Color coding and numbering of valves will be used to simplify operation. The valves will also be serviced from the top of the box. A separate shielded box will be provided for the column samplers. All lines which are normally "hot" or could potentially be "hot" are to be shielded. Shielding will be designed to limit the operator dose to 1 mrem/hr at contact. Wherever possible, pipe runs will be located underwater to minimize the need for lead shielding.

"Filter" Bed - This is a 10 cubic foot ion exchange bed containing carbon and cation resin. This bed is intended to remove trace fission products from the water. Load control will be based on the cation effluent monitor and the column radiation level.

Mixed-Resin Polishing System - This system consists of a 195 cubic foot bed of mixed anion and cation resins enclosed in a special shielded cask. This unit, which is also intended to remove trace fission products from the cation effluent, will be located above the water. Load control will be based on the cation effluent analysis and the radiation level at the surface of the container.

Boron Removal Bed - A 195 cubic foot resin bed, enclosed in a shielded cask, is provided for boron removal. Effluent sample analysis and surface radiation level monitoring will be used to control loading.

Monitoring Tank System - Two monitoring tanks, of about 20,000 gallon capacity, will be provided for collecting and sampling the treated water prior to disposal. The tanks will be provided with mixing, level measuring and sampling systems, in addition to transfer pumps. Piping will also be provided for recycle of the treated water in the event that it does not meet disposal specifications.

Off-Gas System - The feed tanks, valve boxes, monitoring tanks and column vents are connected to this system. The system consists of a separator tank (which also serves as a sampler effluent collector and valve box drain tank), an electric off-gas heater, a roughing filter, a charcoal bed for iodine retention, two absolute (HEPA) filters and a centrifugal blower. The discharge of this blower will be monitored and routed to the reactor vent system. A pressure control system is provided for the blower to regulate vent system pressure. The separator tank which will be located in the surge pit and covered with a concrete shield is equipped with an automatic level controlled pump routed back to one of the feed tanks.

Piping and Equipment Arrangement - The feed pumps, feed samplers and head pots will be located in shielded enclosures directly over the tank farm area. As previously described, the filters, primary beds and cation beds are to be located underwater in special containment boxes. These boxes and columns are to be supported along one side of the pool on a structural steel rack which hangs from the edge of the pool. This rack will also support the system and will include an operating platform from which the remote connectors will be handled.

Auxiliary Systems - A storage rack, sized to handle the projected number of filters and ion exchange beds required to treat the containment sump water will be provided. A special rack will be provided for displacing the water from the columns and filters and drying them prior to loading them into the transfer cask. This will be located in the cask loading pool. A system will also be provided for solidifying the filters and ion exchange columns with concrete. One additional system that will be provided is an analytical system for analysis of feed and effluent samples. Counting systems for gamma and beta and the necessary equipment for boron and sodium analysis will be provided as a minimum.