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### Processes and Practices Related to Occupational Dose

ID: 64

#### IMPROVED FILTERS FOR PRIMARY COOLANT

**Keywords:** FILTERS; FILTRATION; ACTIVITY; PRIMARY COOLANT; RADIATION DOSE; FINE FILTERS; ULTRA-FINE FILTERS; HOLLOW FIBER FILTERS; ABSOLUTE RATED FILTERS

#### Description:

Studies indicate that a large percentage of radioactivity in PWR coolant can be attributed to particles less than 1  $\mu\text{m}$  in size. New chemistry guidelines will reduce but not eliminate the process of metal transport. The best defense against radiation field increase is to stop the flow of particles to the reactor. This is best done with absolute rated filters which are fine enough to trap sub-micron particles.

PWR chemical and volumetric systems (CVCS) are fitted with filters either upstream or downstream of the let-down ion exchange beds. These filters have frequently been specified to be 5  $\mu\text{m}$  or 25  $\mu\text{m}$  nominally rated filters, which typically have absolute filtration ratings in the range 20 to 50  $\mu\text{m}$ . These filters are too coarse to remove particle borne activity effectively, either for control of out-of-core radiation or for protection of ion exchange beds. Filters of 1  $\mu\text{m}$  absolute rating or finer are needed to remove these particles.

Changes in coolant chemistry and the introduction of sophisticated new filter media now permit economical use of fine absolute rated filters to remove and control particle-borne activity in reactor coolants.

The use of absolute rated filters on coolant let-down helps to control out-of-core radiation by removing irradiated particles from the system, preventing crud from passing to the reactor (so becoming irradiated) and by minimizing ion exchange resin fouling so that capture of soluble nickel and cobalt during cool-down oxygenation is effective on a single pass. Since a substantial part of the released irradiated cobalt inventory is removed by ion exchange, prevention of resin fouling is a major benefit and constitutes the reason for installing fine filters upstream of the ion exchange beds.

Other benefits of fine filters are that reactor coolant pump seals are left clean and there is substantial reduction in seal water leak-off from the reactor coolant pumps.

Absolute rated glass fibre filters with positive zeta potential are now in service in the USA, Canada, France, Germany, Sweden, Spain, and Belgium. They will be used at Sizewell B in the U.K. Even finer absolute rated nylon filters are in service in France, Germany, and Holland for reactor coolant filtration, pump seal protection, and fuel pool and effluent filtration.

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### References and Selected Abstracts:

1. Scowen, P., "How Finter Filters Can Keep Exposures Down," Nuclear Engineering International, Vol. 34, Number 423, p. 44, October 1989.
2. Usui, N., Tsuruoka, K., Ohsumi, S., Uchida, S., Nagasa, M., Mochizuki, H., and Hirahara, Y., "Procedures for Reducing Shut-Down Dose Rate at No. 1 and No. 4 Units of Fukushima Daiichi Nuclear Power Station and Current Experience with Dose Rate and Occupational Exposure at the Plants," Japan Atomic Industrial Forum, Inc. Tokyo. Proceedings of a Symposium-21. JAIF Annual Conference on Water Chemistry in Nuclear Power Plants, Tokyo, Japan, April 13, 1988, pp. v.1.

Abstract: The No. 1 and No. 4 Units of Fukushima-Daiichi Nuclear Power Station (1F-1 460 MWe BWR-3; and 1F-4 784 MWe BWR-4) started commercial operation in 1970 and 1978, respectively, and are now operating in the 12th and 9th fuel cycles, respectively. A radiation reduction program for 1F-1 and 1F-4 has been implemented since 1979. This report describes the effectiveness of radiation level improvement that has been executing for 1F-1 and 1F-4.

The following improvements have been made to reduce the radiation level:

1. Increase in frequency of condensate demineralizer backwash
2. Low linear velocity of condensate demineralizer (only in 1F-1)
3. Replacement of condensate demineralizer (only for anion resin in 1F-1 cation resin used continuously)
4. Installation of hollow fiber filter (50% of condensate flow rate in 1F-1, 33% of condensate flow rate in 1F-4)
5. Improvement of lay-up during plant shutdown
6. Replaced low cobalt materials.

As a result, iron concentration in feedwater, radioactive crud concentration in reactor water and hot spots of radiation level have been reduced. But the level of 1F-1 and 1F-4 are still higher than that of new plants. It is necessary to investigate the effective radiation level improvement further.

3. Weber, L.D., Weissmann, B.J., Scowen, P.A., and Poschmann, T.W., "Reducing Out-of-Core Radiation in PWRs by Applying Ultrafine Filters," NUREG/CP-0110, p. 283 in Proceedings of the International Workshop on New Developments in Occupational Dose Control and ALARA Implementation at Nuclear Power Plants and Similar Facilities," held at Brookhaven National Laboratory, Upton, Long Island, New York, September 18-21, 1989. (Available from National Technical Information Service, Springfield, VA 22161.)

ABSTRACT: Particulate contribution to out-of-core radiation field is significant. Filters supplied against old nominal specifications are too coarse to effectively remove particle-borne activity in PWR systems. A substantial fraction of crud and radioactivity in these systems exists as submicron particles.

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Absolute rated filters of glass fiber and of nylon media construction are proven performers in NSSS radiation reduction and RC pump seal protection programs.

Positive zeta potential has been found to enhance contaminant removal by both glass and nylon filter media.

A reproducible functional method of assessing filter performance and reliability has been presented. Beta ratio curves provide a valuable method for comparing performance of different filters.

System cleanup and consequently longer filter life are typically achieved by employing absolute rated fine or ultrafine filters in CVCS letdown and primary coolant pump seal application.

Improved filtration upstream of ion exchange beds is expected to extend bed life.

Available instrumentation external to the filter housing enables continuous remote monitoring of filter cartridge radiation field to ensure compliance with off-site disposal limits.

Application of absolute rated filters is expected to provide a rational basis for grade selection under varying system conditions, e.g., steady state, start-up, crud burst cleaning, etc.

Filter developers/manufacturers must remain responsive to the needs of ALARA and radwaste managers in this rapidly changing regulatory environment.