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Processes and Practices Related to Occupational Dose

ID: 29

MINIMIZE AND CONTROL CRUD BURST DURING SHUTDOWN

Keywords: CRUD BURST; SHUTDOWN; CRD; HYDROGEN; OXYGEN CONCENTRATION; CONDENSATE DEMINERALIZER; HOLLOW FIBERFILTER; OPERATIONAL CONTROL; CHEMISTRY CONTROL

Description:

For suppressing accumulation of radioactivity, the dissolved hydrogen concentration in primary coolants is rapidly lowered to a concentration equilibrium with radiolysis of water at the initial stage of PWR-type plant shutdown. A hydrogen-containing gas mixture is injected into the primary coolant to a hydrogen partial pressure as maintaining the dissolved hydrogen on equilibrium concentration thereby promoting the dissolution of cruds in the primary coolants. Since the dissolution of metal Ni in nitric acid solution is promoted as the hydrogen partial pressure is lowered in the cover gases, dissolution of the cruds can be promoted by maintaining the water quality conditions of the primary coolants to an active region causing dissolution of metal Ni. That is, by positively lowering the dissolved oxygen concentration from the intitial stage of plant shutdown, it is possible to remove more radioactive material than usual on the letdown demineralizers by suppressing the accumulation of radioactive in the system, reduction in the radiation dose rate is achieved which decreases the exposure received by workers during the shutdown period.

References and Selected Abstracts:

1. Saegus, M., Suwa, H., Yokoyama, J, Oshima, S. and Kasahara, K., "Method of Dissolving Crud upon Shutdown of PWR Type Reactor," Mitsubishi Atomic Power Industries, Inc., Tokyo, Japan, October 26, 1989, 6 p. (in Japanese).

2. N. Usui, R. Tsuruoka, K. Ohsumi, S. Uchida, M. Nagase, H. Mochizuki and Y. Hirahara, "Procedures for Reducing Shutdown 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 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 F1-4 784 MWe BWR-4) started commercial operation in 1970 and 1978, respectively, and are now operating 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 effectivenss of radiation level improvement that has been executed for 1F-1 and 1F-4.

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The following improvements have been made to reduce the radiation level: (1) increase the frequency of condensate demineralizer backwash, (2) low liner 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 fiberfilter (50% of condensate flow rate in 1F-1, 33% of condensate flow rate in 1F-4), (5) improvement of lay-up during plant shutdown, and (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. Lassau, R.T., Cherepakhov, G., Smee, J.L., Berger, J., "Reduction of Radiation Fields in the Cooling Water Circuits of PWRs: A One-Step or a Multistep Process," Topical Meeting on Engineering for Nuclear Plant Operation and Maintenance, Myrtle Beach, SC, April 17, 1988.

ABSTRACT: A basic problem for nuclear power plants is the formation or radioactive corrosion products in crud particles and oxide films found mainly in the primary side of the reactor cooling water circuits. The activated corrosion products produce radiation fields, which are the major source of exposure for personnel during maintenance and operation of the system. As a health safeguard, and for the considerable economic benefit to a plant that can be realized by the reduction of radiation fields, the nuclear industry implements physical and chemical decontamination methods to dissolve oxide films and assist in the removal of crud during plant shutdowns. These procedures impact on the scheduling of activities that must be accomplished before the reactor can be returned to full operation and are carefully planned to minimize the time for decontamination while maximizing the radioactive field reductions. Of considerable importance to the industry are procedures that might be implemented during normal reactor operation and as a reactor approaches shutdown would assist in the removal of radioactive material while controlling the recontamination during reactor operation. A study program was undertaken to compare radioactive field reductions and corrosion rates obtained from a dilute multistep chemical decontamination with data obtained from a single-step parametric cycling experiment on PWR materials.

4. Shaw, Robert A., "The Role of Coolant Chemistry in PWR Radiation-Field Buildup," EPRI-NP-4247, October 1985.

ABSTRACT: Summarizing information presented in earlier reports and presenting exposure rate, crud transport, and coolant chemistry data collected later in the study, this report describes radiation-field trends associated with various components of PWR primary coolant circuits. Some of the key findings follow. (1) In a reactor that has produced power for two years, the major source of radiation fields is cobalt-60. (2) Coolant pH is the key operational factor affecting radiation-field buildup. During PWR shutdowns, the preferred method of controlling the release of radioactive cobalt is the forced oxygenation of the reactor coolant by hydrogen peroxide after cooldown and before drain-down. (3) On the basis of research findings presented and evaluated in this report, there is enough evidence to warrant a plant testing program to verify that increasing the primary coolant pH to about 7.5 will result in a significant decrease in crud transport and plant exposure rates.

5. Uchida, S., Asakura, Y., Kitamura, M., Ohsumi, K., Yonezawa, K., and Matsushima, Y., "Effects of Crud Diameter on Shutdown Dose Rate of Recirculation Pipes in Boiling Water Reactors," J. Nucl. Sci. Techol. (Tokyo, Japan), May 1983, pp. 414-421.

ABSTRACT: The effects of crud diameter on radioactive corrosion product buildup in the primary cooling pipes of boiling water reactors were evaluated and the following conclusions were obtained: (1) The crud diameter affected the radioactivity buildup through two processes, i.e., deposition of crud

on the fuel surfaces and adsorption of ionic cobalt on the fuel deposited crud. (2) As the result of numerical calculations by a radioactive corrosion product transport model, it was demonstrated that the shutdown dose rate was reduced by the suppression of crud concentration in the primary coolant when the crud diameter remained constant, and it was reduced by the increase of the average crud diameter when the crud concentration remained constant.

6. Mike, M., Saito, T., Uchida, S., Izumiya, M., and Izumiya, M., "Optimum Design for the Primary Cooling System in BWRs to Control Shutdown Radiation Dose Rate," Hitachi Hyoron, August 1982, pp. 563-566 (in Japanese).

ABSTRACT: The reduction of radiation dose rate at the time of shutdown is an important task for smoothly performing the regular inspection and maintenance works in nuclear power plants as the number of those plants in operation has increased. Hitachi, Ltd. has investigated the industrially applicable measures to reduce dose rate to suppress the exposure dose per year in 1100 MWe class BWR nuclear power plants below 200 man-rem. The exposure dose in normal checking works during a regular inspection is regarded to be macroscopically dependent on the dose rate of piping in recirculation system. Thus, it was found that the above target can be achieved by suppressing the dose rate on piping surface to 30 mR/h. For further reduction of iron crud and /sup 60/Co ions contributing to the increase of dose rate, in addition to the oxygen injection into the feed water system and the duplicated condensate purification system, the use of corrosion-resistant steel and low cobalt material has been attempted.