INTRODUCTION

It is desirable to reduce radiation exposure to workers in nuclear power plants to values that are as low as reasonably achievable. One method of reducing occupational exposure is to reduce the source of the exposure. Decontamination of the primary coolant system would reduce shutdown radiation levels and occupational radiation exposure in nuclear power plants.

One promising method is the use of dilute organic chemicals for rapid decontamination of the primary coolant systems as has been demonstrated in Canadian reactors.\(^1\) A similar approach could be used for operational decontamination of nuclear power plants in the United States. In 1977, the U.S. Department of Energy contracted with the Commonwealth Research Corporation (CRC)** to study the technical feasibility of this approach for boiling water reactors (BWRs). In turn, CRC subcontracted the experimental work to General Electric.

The objective of the Dilute Chemical Decontamination Program is to develop and evaluate a process which utilizes reagents in dilute concentrations for the decontamination of BWR primary systems and for the maintenance of dose rates on the out-of-core surfaces at acceptable levels.

---

\(^{*}\)Present address: The Atomic Industrial Forum
Washington, D.C. 20014

**CRC is a wholly-owned subsidiary of Commonwealth Edison Company.
PROCESS CONCEPT

The process concept on which the feasibility study was based consists of the injection of concentrated organic reagents into the primary coolant until the desired concentration (\(<0.01M\)) is reached. Decontaminations would be performed during a reactor shutdown with the fuel remaining in the core. The solvent would be recirculated throughout the primary system and would dissolve most of the out-of-core and fuel deposits. Some corrosion products may be released as particles. A side stream would be processed continuously through a filtration system to control the particles and through an ion-exchange system to regenerate the reagent by removing the dissolved corrosion products. The decontamination process would be terminated by a purification cycle during which the solvent would be circulated through mixed-bed ion-exchange resins until the coolant is returned to BWR specifications. It is envisioned that the entire process would be completed in less than 3 days.

SOLVENT DEVELOPMENT

In early screening tests 0.01M solutions of oxalic acid, nitrilotriacetic acid (NTA), and ethylenediaminetetraacetic acid (EDTA) were identified as being capable of dissolving 80% of the Co-60 in BWR out-of-core films in less than 72 hours. Exploratory tests were performed to evaluate the properties of these three reagents relative to:

1. dissolution of the out-of-core films and fuel deposits,
2. regeneration by ion-exchange,
3. purification by mixed-bed ion exchange,
4. radiolytic stability,
5. thermal stability,
6. precipitation and redeposition of dissolved crud, and
7. general corrosion of low alloy steels.

Based upon the results of these tests, oxalic acid was selected to be the principal component in the solvent formulation. A summary of the advantages and disadvantage of each reagent is given in Table 1. The exploratory tests demonstrated that at conditions considered acceptable for a dilute chemical decontamination, 0.01M solutions of oxalic acid are capable of dissolving 80% of the Co-60 in BWR out-of-core oxide films in less than 12 hours.

The major process disadvantage identified for oxalate base solvents was precipitation of ferrous oxalate. Several approaches to eliminate, minimize, or control the precipitation of ferrous oxalate were evaluated. These approaches included the addition of corrosion inhibitors to reduce the ferrous iron generation rate, oxygenation of the solvent to oxidize the ferrous iron to