September 9, 1982

Docket No. 50-29
LSO5-82- 09-032

Mr. James A. Kay
Senior Engineer - Licensing
Yankee Atomic Electric Company
1671 Worcester Road
Framingham, Massachusetts 01701

Dear Mr. Kay:

SUBJECT: SEP TOPIC VI-1, ORGANIC MATERIALS AND POST-ACCIDENT CHEMISTRY
YANKEE NUCLEAR POWER STATION

Enclosed is our draft evaluation of SEP Topic VI-1, Organic Materials and Post-Accident Chemistry for the Yankee Nuclear Power Station. This review was based on the licensee's safety assessment report dated June 14, 1982. The staff has concluded that Yankee does not meet the current licensing criteria for this topic. Specific items are identified in our evaluation.

This evaluation will be a basic input to the Integrated Safety Assessment for your facility unless you identify changes needed to reflect the as-built conditions at your facility. This assessment may be revised in the future if your facility design is changed or if NRC criteria relating to this subject are modified before the Integrated Assessment is completed.

Sincerely,

Original signed by:

Ralph Caruso, Project Manager
Operating Reactors Branch No. 5
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

SEO4 Add: Gary Staley

DSU USE EX (11)

9/9/82

OFFICE	SEPB	SEPB	SEPB	SEPB	ORB#5	ORB#5	AD:SA:DL
SURNAME	GCwalina:bl	MBoyle	CGrimes	WRussell	RCaruso	DCrutchfield	TIppolito
DATE	9/2/82	9/2/82	9/2/82	9/3/82	9/7/82	9/7/82	9/ /82

Yankee
Docket No. 50-29
Revised 3/30/82

Mr. James A. Kay

cc
Mr. James E. Tribble, President
Yankee Atomic Electric Company
25 Research Drive
Westborough, Massachusetts 01581

Chairman
Board of Selectmen
Town of Rowe
Rowe, Massachusetts 01367

Energy Facilities Siting Council
14th Floor
One Ashburton Place
Boston, Massachusetts 02108

U. S. Environmental Protection Agency
Region I Office
ATTN: Regional Radiation Representative
JFK Federal Building
Boston, Massachusetts 02203

Resident Inspector
Yankee Rowe Nuclear Power Station
c/o U.S. NRC
Post Office Box 28
Monroe Bridge, Massachusetts 01350

Ronald C. Haynes, Regional Administrator
Nuclear Regulatory Commission, Region I
631 Park Avenue
King of Prussia, Pennsylvania 19406

SYSTEMATIC EVALUATION PROGRAM

TOPIC VI-1

YANKEE NUCLEAR POWER STATION

TOPIC: VI-1, Organic Materials and Post-Accident Chemistry

I. INTRODUCTION

The design basis for selection of paints and other organic materials is not documented for most operating reactors. Topic VI-1 is intended to review the plant design to assure that organic materials, such as organic paints and coatings, used inside containment do not behave adversely during accidents when they may be exposed to high radiation fields. In particular the possibility of coatings clogging sump screens should be minimized.

Low pH solutions that may be recirculated within the containment after a Design Basis Accident (DBA) may accelerate chloride stress corrosion cracking and increase the volatility of dissolved iodines. The objective of Topic VI-1 is to assure that appropriate methods are available to raise or maintain the pH of solutions expected to be recirculated within the containment after a DBA.

Organic Materials: An assessment of the suitability of organic materials in the containment includes the review of paints and other organic materials used inside the containment including the possible interactions of the decomposition products of organic materials with Engineered Safety Features (ESF), such as filters.

Post Accident Chemistry: An assessment of post accident chemistry includes a determination of proper water chemistry in the containment spray during the injection phase following a DBA and that appropriate methods are available to raise or maintain the pH of mixed solution in the containment sump.

II. REVIEW CRITERIA

Organic Materials: The plant design was reviewed with regard to General Design Criterion 1, "Quality Standards and Records" of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants" which requires that structures and systems important to safety be designed and tested to quality standards commensurate with the importance of the safety function to be performed. Also, contained in the review was Appendix B to 10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." This guide describes an acceptable method of complying with the Commissions quality assurance requirements with regard to protective coatings.

Post Accident Chemistry: The design was reviewed with regard to General Design Criterion 14, "Reactor Coolant Pressure Boundary" of Appendix A to 10 CFR Part 50. This requires that the reactor coolant pressure boundary be designed and erected so as to have an extremely low probability of abnormal leakage and gross rupture. Also, regarded in the review was General Design Criterion 41, "Containment Atmosphere Cleanup," of Appendix A to 10 CFR Part 50. This requires that systems to control substances released in reactor containment be provided to reduce the concentration and quality of fission products released to the environment following a postulated accident.

III. RELATED SAFETY TOPICS

The effectiveness of the iodine removal system is evaluated as part of Topic XV-19, for a spectrum of loss-of-coolant accidents.

Topic VI-7.E reviews the ECCS in the recirculation mode to confirm the effectiveness of the ECCS.

IV. REVIEW GUIDELINES

Organic Materials: Current guidance for the review of organic materials in containment is provided in Sections 6.1.1, "Engineered Safety Features Materials" and 6.1.2, "Organic Materials" of the Standard Review Plan and in Regulatory Guide 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants." Regulatory Guide 1.54 endorses the requirements and guidelines described in detail in ANSI N101.4-1972, "Quality Assurance for Protective Coatings (Paints) for the Nuclear Industry" and ANSI N5.12-1974, "Protective Coatings (Paints) for the Nuclear Industry."

Post-Accident Chemistry: Guidance for the review of post-accident chemistry is provided in Sections 6.1.1 and 6.5.2 of the Standard Review Plan. Section 6.1.1 is related to assuring that appropriate methods are available to raise or maintain the pH of the mixture of the containment spray, ECCS water, and chemical additives for reactivity control and iodine fission product removal in the containment sump during the recirculation phase and to preclude long term corrosion problems after the accident. Section 6.5.2 is related to providing proper water chemistry in the containment spray and sump during injection phase following a Design Basis Accident.

V. EVALUATION

Organic Materials: By letter dated June 14, 1982, the licensee provided references to the types and amounts and the environmental testing of organic coating materials used in the plant. Protective coating systems comprise the bulk of the organic materials (outside of electrical cable insulation) in the containment. Accident effects on cable insulation are reviewed under NUREG-0458 (Reference 1).

Most of the containment interior surfaces are coated with polyvinyl chloride paint using acceptable industrial procedures. Paints based on polyvinyl chloride resins are less resistant than epoxy or phenolic paints to the effects of radiation. However, tests (Ref. 2, 3, 4) have shown that coatings of the vinyl type on concrete and steel substrates have remained in serviceable condition after radiation doses in excess of 10^8 rad which is a conservative DBA dose estimate.

The vinyl polymers have good resistance to chemical attack by mildly basic aqueous solutions, but only limited resistance to heat (Ref. 5). After a severe accident, containment temperatures would exceed 150°F for only a few days. Therefore, gross failure and delamination of vinyl paints is not expected. This is confirmed by the qualification tests on vinyl coated steel specimens irradiated at temperatures up to 176°F (Ref. 3, 4).

The principal safety concern with polyvinyl chloride in the Yankee Nuclear Power Station is decomposition under radiation to yield hydrochloric acid. Because of its high G value (Ref. 4) to produce HCl, as much as one third of the chloride content of polyvinyl chloride could be converted to HCl under severe accident conditions. Engineered safety features constructed of stainless steel would be corroded by sump solutions containing acid chlorides.

The licensee does not describe any measures to neutralize the HCl produced by the radiolysis of polyvinyl chloride after a severe DBA. In the absence of such measures, the use of polyvinyl chloride to coat most of the containment interior surfaces is not acceptable.

Certain small surface areas of plant equipment were coated with industrial coatings whose radiation resistance has not been tested. However, because only small areas of these coatings are exposed in the containment, we conclude that their failure under accident conditions would not present a significant safety hazard.

The irradiation of polyvinyl chloride produces very small amounts of gases beside hydrogen chloride. The quantity of organic gases in containment after a DBA would not interfere with the adsorption of organic iodides by the purge charcoal filters.

The amount of hydrogen from this source is small compared to that which could be produced in a DBA from the zirconium-water reaction, from the radiolysis of water, or from the reaction of the zinc in inorganic zinc coatings with high temperature borate solutions (Ref. 6). Hydrogen generation from the latter sources is reviewed under SEP Topic VI-5, "Combustible Gas Control."

The licensee stated that an inspection of the paint in November 1978, revealed only slight rusting in a few areas. The procedures and frequency of future inspections were not specified. Inspection at least once per three-years according to the procedures specified in ANSI 101.2-1973 would be acceptable.

Post-Accident Chemistry: The plant does not have a containment spray system for post-accident mitigation of the radiological consequences of an accident. In the event of a loss-of-coolant accident, water from the safety injection tank and accumulator will be used for emergency core cooling. The water contains a minimum of 2200 ppm boron as boric acid and will be recirculated during the course of an accident. The pH value of the water is below 7.0 and there is no provision to raise the pH to above 7.0 during the course of an accident.

During operation of emergency core cooling, excess borated water will be collected in the containment sump and the sump water will be exposed to the containment air. There is no provision to control the chloride concentrations in the sump water. During recirculation, the sump water will be saturated with oxygen and, at a pH value below 7.0, this can increase the potential for chloride-induced stress corrosion cracking of austenitic stainless steel components in the emergency core cooling system.

Because there is no post-accident containment spray system, leachable chlorides from non-metallic thermal insulation materials on austenitic stainless steel components inside containment should pose no significant safety concern.

Offsite doses associated with post-accident iodine releases are evaluated under Topic XV-19 as part of the Systematic Evaluation Program.

Hydrogen generation from chemical reactions between metals inside containment and the recirculating core-cooling water will be evaluated, independent of the Systematic Evaluation Program, under the TMI Task Action Plan (Task II.B.7 in NUREG-0660) and Unresolved Safety Issue A-48 in NUREG-0705.

VI. CONCLUSIONS

Organic Materials: The staff has concluded that current licensing criteria are not met. Specifically, there is an absence of measures to control the acidity of sump solution in the post-DBA environment. In addition, the licensee has not committed to an acceptable inspection program for organic coatings inside containment.

Post-Accident Chemistry: On the basis of the above evaluation, we conclude that the post-accident water chemistry does not meet the acceptance criterion of II.B.1.a in Standard Review Plan Section 6.1.1 (NREG-0800), July 1981.

VII. REFERENCES

1. NUREG-0458 "Short Term Safety Assessment on the Environmental Qualifications of Safety-Related Electrical Equipment of SEP Operating Reactors," May, 1978.

2. ORNL-3589, Gamma Radiation Damage and Decontamination Evaluation of Protective Coatings and Other Material for Hot Laboratory and Fuel Processing Facilities, G. A. West and C. D. Watson, February, 1965.

3. ORNL-3916, Unit Operations Section Quarterly Progress Report, July - September 1965, M. E. Whatley et al., March 1966 pp 66-75.

4. Radiation Effects on Organic Materials, edited by R. O. Bolt and J. G. Carroll, Academic Press, New York and London, 1963.

5. Chemical Engineers Handbook, J. H. Perry, Editor, 5th Edition, pp. 23 - 54 to 23 - 57.

6. H. E. Zittel, "Post-Accident Hydrogen Generation from Protective Coatings in Power Reactors," Nuclear Technology 17, 143-6 (1973).