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May 21, 1982

Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch #5
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden 2
SEP Topic: VI-1, Organic Materials and Post Accident Chemistry

NRC Docket 50-237

Reference: (1) T.J. Rausch letter to D.G. Eisenhut dated August 14, 1981

Mr. Crutchfield:

Reference (1) committed Commonwealth Edison to devote additional resources to completion of SEP. CECo committed to develop several topic Safety Assessment Reports (SAR) which would be submitted for Staff review. In accordance with this committment, CECo hereby provides as Attachment 1, the SAR for SEP Topic VI-1, Organic Materials and Post Accident Chemistry.

Please address any questions you may have concerning this matter to this office.

One (1) signed original and thirty-nine (39) copies of this transmittal have been provided for your use.

Very truly yours,

T J Rausch
T.J. Rausch
Nuclear Licensing Adminstrator
Boiling Water Reactors

SPP:mnh/1829D*
Attachment
cc: RIII Resident Inspector, Dresden
Gregg Cwalina, SEP Integrated Assessment Mgr.

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Docket No. 50-237

# Attachment 1

# Safety Assessment Report

# SEP Topic VI-1, Organic Materials and Post Accident Chemistry

May 1982

# SEP SAFETY ASSESSMENT REPORT

## Topic VI-1, Organic Materials and Post Accident Chemistry

## 1.0 INTRODUCTION

The purpose of this assessment is twofold:

1. To ensure that organic coatings used inside the Dresden Unit 2 containment are suitable for use under design basis accident conditions, consistent with the intent of Section 6.1.2 of the Standard Review Plan.

2. To ensure that post-accident containment chemistry at Dresden Unit 2, does not result in unacceptable rates of steel corrosion, or increase the volatility of dissolved iodines, consistent with the intent of Sections 6.1.1, and 6.1.3 of the Standard Review Plan.

## 2.0 CRITERIA

### 2.1 Criteria for Organic Materials Used Inside the containment

Section 6.1.2 of the Standard Review Plan requires that all significant coating systems used inside containment be suitable for use in the environmental conditions seen after an accident. The stability of the coatings and their decomposition products must be examined to determine the potential for interactions with engineered safety features. Specific areas of concern are:

1. The possibility of coatings peeling and clogging sump screens.

2. The generation of volatiles from the decomposition of coatings which could interfere with the proper functioning of charcoal absorbers used to remove radio-iodine from the containment atmosphere.

3. The generation of hydrogen and other flammable volatiles from the decomposition of coatings. These gases could adversely impact the operation of systems used for containment hydrogen control on some plants.

According to the Standard Review Plan, a coating system is considered acceptable if:

1." It meets Regulatory Guide 1.54 or equivalent; or, the area covered with the system is a negligible fraction of the containment interior surfaces.

2. No adverse interactions with engineered safety features are likely as a result of materials released by radiation decomposition or chemical reaction of the coating system in the containment post-accident environment."

## 2.2 Criteria for Post-Accident Chemistry Control

Standard Review Plan Section 6.1.1, "Engineered Safety Features Metallic Materials", requires that the composition of core spray coolants be compatible with materials in the containment building, including the reactor vessel, reactor internals, primary piping, and structural and insulating materials. The intent of this requirement is to ensure that integrity of the reactor coolant pressure boundary is maintained, and to prevent evolution of excessive amounts of hydrogen in the containment, should an accident occur. The acceptance criteria with regard to coolant chemistry in Section 6.1.1 of the Standard Review Plan read:

> The composition of containment spray and core cooling water should be controlled to ensure a minimum pH of 7.0, as given in the Branch Technical Position MTEB 6-1, Reference 11, attached. Experience has shown that maintaining the pH of borated solutions at this level will inhibit initiation of stress-corrosion cracking of austenitic stainless steel components for periods of more than seven months.
>
> Hydrogen release within the containment because of corrosion of materials by the sprays in the event of a loss-of-coolant accident should be controlled as described in Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment following a Loss-of-Coolant Accident". As the pH increases over 7.5, the rate of corrosion of aluminum increases. The amount of aluminum within the containment should therefore be controlled, and the amount of hydrogen that could be genertated within the containment should be calculated as recommended in Regulatory Guide 1.7.

Standard Review Plan Section 6.1.3, "Post-Accident Chemistry", requires that the pH of spray and emergency coolant solutions be cotrolled. The purpose of controlling the pH is to reduce the probability of chloride stress corrosion cracking leading to equipment failure or loss of containment integrity, and to ensure low volatility of dissolved radio-iodines. The acceptance criteria stated in Section 6.1.3 of the Standard Review Plan are stated as follows:

> The procedures and methods which the applicant proposes to use to raise or maintain the pH of the solutions expected to be recirculated within containment after a DBA should be straightforward and reliable. The chemistry of the post-accident environment in the containment should not result in significant deterioration of engineered safety features.

## 3.0 DISCUSSION

### 3.1 Organic Materials

Identified coatings cover approximately 180,500 sq. ft. of the interior of the Dresden Unit 2 containment. Approximately 58,950 sq. ft. of this is in the drywell, and 121,550 sq. ft. is in the torus. By comparison, the surface areas of unidentified paints are considered to be insignificant. As a result of I.E. Bulletin 79-14 work, a 1/2% additional amount of coating was applied in the containment.

The drywell shell, Bio-shield wall, and Vessel Supports were originally coated with Dupont #67-4-746 Dulux Zinc Chromate Primer. This layer was covered with Carboline Rustbond Primer 6C Modified Vinyl. The finish is Carboline Polyclad #933-1 Vinyl Copolymer. These two vinyls were described to us as being a polyvinyl chloride. Reference A notes the failure of this type of material at an exposure of $8.7 \times 10^8$ rads. The total integrated dose for coatings within a typical BWR containment ranges from $5 \times 10^6$ to $3 \times 10^9$ rads, with most surfaces seeing less than $10^7$ rads (Reference B). The normal integrated 40 year dose for Dresden is between $1.5 \times 10^6$ to $1.9 \times 10^6$ rads (Reference H) and add this to a 1 year post accident dose of $1.1 \times 10^8$ rads (Reference I) the total dose inside drywell would be $1.11 \times 10^8$ rads. It is, therefore, evident that this coating system will not fail due to radiation effects following an accident.

This statement is also true for other components of the drywell, coated with different materials. The concrete surfaces are coated with Carboline 195 Surfacer, a modified epoxy-polymide, and Carboline Phenoline 368 WG Finish, a modified phenolic. The maximum gamma radiation resistance of an epoxy is approximately 4 to $9 \times 10^8$ rads, while that of phenolic coatings is $4.4 \times 10^9$ Rads. The structural steel framing and lateral bracing is covered with the above named Dupont primer, with an intermediate coating of alkyd enamel and a finish of Detroit Graphite Red Lead 501 Alkyd Enamel. The grating areas are covered with the Dupont Zinc Chromate and finished with the Alkyd Enamel. The maximum gamma radiation resistance for an Alkyd Enamel is $5.7 \times 10^9$ rads. As compared to the values listed in Reference B, it may be deduced that this system will not fail following an accident.

The suppression pool is divided into two coating systems with the immersion phase of shell covered with Carboline Carbo Zinc 11, a self curing inorganic primer that protects steel galvanically, eliminating sub-film corrosion and recommended for interior and exteriors of storage tanks containing fuels and organic solvents. The vapor phase of shell and remaining areas (Headers and Supports, Downcomers, Baffles, Vent Lines, Spherical Junctions and Galleries) are coated with Phenoline 368 WG Primer, a modified phenolic that provides good corrosion protection for steel and good resistance to water and moisture penetration, and Phenolic 368 WG Finish, a modified phenolic that has good abrasion and excellent thermal shock and radiation resistance and is used for lined steel and concrete tanks subject to severe exposures.

As stated in the drywell portion of this discussion, based on values from Reference B, the systems are suitable for their environments.

The manufacture's data (Reference C) for the products incorporated indicate the materials range from good to excellent in chemical resistance, where only the Rustbond 6C did not rate as high against solvents. Thus, the coating system utilized is compatible with Dresden Unit 2 normal and post-accident chemistry.

The design temperature for the Dresden Unit 2 containment is 281°F for a design basis accident (DBA) and 135°F during normal power operation (Reference D). The manufacturer's data lists the vinyls' main temperature resistance at approximately 150°F and the phenolics at 200°F - 250°F. This low temperature resistance in the vinyl materials is causing some peeling in the upper level of the drywell. Yet, we do not believe this action to be a problem. The material has never dropped off, and the peelings are smaller than one square inch. Also, pull tests conducted 2 years ago show pulls were greater than 200 lbs, as stated in the ANSI N5.12 report. This problem is being rectified by scraping, blasting, and touching up the peeling areas with Carboline Carbo Zinc 11, during each outage. This product rates very good to excellent in chemical resistance and its temperature resistance is 750-800°F. Peeling is not expected with this material since only extreme temperature encountered would cause the material to fall in a fine powder form, rather then large segments. The CZ-11 is also used to touch-up the torus and according to Carboline product data meets stringent performance requirements of the American National Standards Institute, ANSI N101.2-1972 and ANSI N5.12-1974 (Reference C). Therefore, no clogging of the sump screens is anticipated.

The painting systems, both in the drywell and in the torus, is periodically inspected. Evaluation of coating integity is conducted in accordance with the requirements of ANSI N101.2-1972, Section 4.5. According to Reference E, forty years exposure to the normal containment environment is considerably more severe on a coating then any postualted loss of coolant accident. It is believed that the chemical, temperature, and radiation resistance of the current coating systems, together with periodic inspection and maintenance, make the possiblity of torus strainer clogging due to coating failure after an accident, remote.

The generation of hydrogen from zinc rich coating under design basis accident conditions has been well documented (Reference F). Dresden Unit 2 relies on containment inerting for post-accident hydrogen control. The controlling factor with regard to flammability limits in a nitrogen inerted containment is oxygen concentration rather than hydrogen concentration. In addition utilizing the ACAD/CAM system it is possible to control the concentration of hydrogen in the containment. At 3.5% $H_2$, air from the reactor building is introduced and controlled to dilute the hydrogen concentration. This method is also employed for the possible evolution of hydrogen gas from the vinyl coating. Thus, the generation of hydrogen or flammable organic gases from protective coatings will not adversely affect post-accident containment hydrogen control at Dresden Unit 2.

Charcoal filters are utilized in the standby gas treatment to limit the release of gaseous fission products to the environment after an accident. Containment air from the ACAD/CAM system, routed at 25 CFM to the Standby Gas Treatment, is also incorporated for this purpose. This system treats the air leaking from the drywell to the reactor building, before discharging to atmosphere. At a drywell pressure of 62 psig, maximum leakage to the reactor building is 1/2% of the drywell free volume per day. This quantity decreases as drywell pressure decays following an accident. Thus the loading of volatiles produced by paint decomposition on the charcoal filters, is only a small proportion of the already small quantity of volatiles present in the drywell. On this basis, no adverse impact upon the standby gas treatment function is expected due to gas evolution from protective coatings within the containment.

## 3.2 Post-Accident Chemistry

The acceptance criterion of Standard Review Plan Section 6.1.1, concerned with limiting the corrosion of stainless steel after an accident, appears to be directed at pressurized water reators which utilize boric acid solutions for reactor coolant and reactivity control. Dresden Unit 2 is a boiling water reactor and therefore uses high purity demineralized water without additives for this purpose.

The pressure suppression pool also contains demineralized water. All carbon steel surfaces in the torus are painted to prevent corrosion. Even without protective coatings, the expected corrosion rate for carbon steel, used structurally in air-staurated demineralized water, is less than 10 mils per year. Such a corrosion rate following an accident is of negligible significance. (Reference G).

In the unlikely event that the Standby Liquid Control system is actuated after a loss-of-coolant accident, sodium pentaborate solution will be introduced into the reactor vessel. If the vessel is refilled to the elevation of the break, the sodium pentaborate solution in the vessel will spill into the torus.

When sodium pentaborate dissolves in water, it produces a mildly basic solution. The pH of the solution varies with concentration. For the range of concentrations we are interested in, the pH will be someplace between 7.4 and 7.8 (Reference G). At the maximum expected sodium pentaborate concentration during recirculation, carbon steel will corrode at a rate of about 11 mills per year, and stainless steel at a rate of less than 0.1 mills per year. Again, these rates are insignificant following an accident. Thus, no additional provisions are required to control corrosion of steel following an accident.

As stated in Section 3.1 of this evaluaton, Dresden Unit 2 relies primarily on inerting of the containment atmosphere for post-accident hydrogen control. Control of post-accident chemistry to minimize the evolution of hydrogen from aluminum corrosion is therefore not a consideration in the Dresden Unit 2 design.

F) Post-Accident Hydrogen Generation from Protective Coatings in Power Reactors, H.E. Zittle, Nuclear Technology, Vol. 17, February 1972.

G) U.S. Borax Industrial Products Catalog, p.65, n.d., figure titled, "pH Values in the System $Na_2O-B_2O_3-H_2O$ at 25°C"

H) "Environmental Qualfication of Electrical Equipment Dresden Nuclear Power Station Unit 2", Bechtel Power Corporation, November 1, 1980, Vol. 3 of 3.

I) Response to I.E. Bulletin 79-01B Post LOCA/HELB Radiation Exposure Levels Received by ESF System Components for Dresden Nuclear Power Station Units 2 and 3, Bechtel Power Corporation, July 18, 1980

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Section 3.1 of this evaluation also discussed the fact that at Dresden Unit 2, post-accident iodine control is accomplished through containment integrity, and operation of the standby gas treatment system. Containment sprays are not used to remove radio-iodines from the containment atmosphere. Therefore, post-accident chemistry control to ensure the retention of iodines in sump water is not required.

## 4.0 CONCLUSIONS

### 4.1 Organic Materials

The composition of the protective coatings used inside the Dresden Unit 2 containment, is believed to be suitable for use in the worst case environment seen after an accident. This together with regular inservice inspections and proper maintenance, ensures that clogging of containment sump screens by coating failure will not occur. Proper functioning of systems used to control containment hydrogen and iodine after an accident, is not compromised by the evolution of gases from decomposition of protective coatings. The paint system used in the Dresden Unit 2 containment complies with the intent of NRC Standard Review Plan, Section 6.1.2.

### 4.2 Post-Accident Chemistry

The post-accident coolant chemistry seen in the Dresden Unit 2 containment does not contribute to the corrosion of carbon and stainless steels. Neither does it compromise the functioning of systems used to control containment hydrogen and iodine after an accident. Additional provisions for the control of post-accident chemistry are not required. The presently expected post-accident coolant chemistry is consistent with the intent of NRC Standard Review Plan, Sections 6.1.1 and 6.1.3.

## 5.0 REFERENCES

A) Bolt and Carroll, Radiation Effects on Organic Materials, Academic Press, New York 1963.

B) ANSI N101.2-1972, Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities.

C) Carboline Product Data Sheet.

D) Dresden 2 FSAR.

E) Investigation of Corrosion Rates in SA-516 grade 70 Carbon Plate Material in Aqueous Environments, Nutech COM-01-641, March 1980, 64.313.0015.