AMENDMENT 2 TO RESAR-SP/90 PDA MODULE 5, "REACTOR SYSTEM"

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INSTRUCTION SHEET

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4.5 REACTOR MATERIALS

4.5.1 Drive System Structural Materials

4.5.1.1 Control Rod and Gray Rod Drive System Structural Materials

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4.5.1.1.1 Control Rod Drive Mechanism (CRDM) and Gray Rod Drive Mechanism (GRDM) Materials Specifications

All parts exposed to reactor coolant are made of metals which resist the corrosive action of the water. Three types of metals are used exclusively: stainless steels, nickel-chromium-iron, and cobalt-based alloys. In the case of stainless steels, only austenitic and martensitic stainless steels are used. For pressure boundary parts, martensitic stainless steels are not used in the heat-treated conditions which cause susceptibility to stress-corrosion cracking or accelerated corrosion in Westinghouse pressurized water reactor chemistry. Pressure boundary parts and components are made of type 304 stainless steel, or Inconel 600.

Internal latch assembly, drive rod assembly and hub extension assembly parts are fabricated of heat-treated martensitic stainless steel. Heat treatment is such that susceptibility to stress-corrosion cracking is not initiated.

a. CRDM/GRDM Pressure Vessel Assembly

   All pressure retaining materials comply with Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code and are fabricated from austenitic (type 304) stainless steel or Inconel 600.

b. CRDM/GRDM Coil Stack Assembly

   The coil housings require a magnetic material. Both low carbon cast steel and ductile iron have been successfully tested for this

application. The choice, made on the basis of cost, indicates that ductile iron will be specified on the CRDMs and GRDMs. The finished housings are zinc flame sprayed to provide corrosion resistance.

Coils are wound on bobbins of glass reinforced silicon thermoset molding material, with double glass insulated copper wire. Coils are then vacuum impregnated with silicon resin. A wrapping of mica sheet is secured to the coil outside diameter. The result is a well insulated coil capable of sustained operation at 200°C.

c. CRDM/GRDM Latch Assembly

Magnetic pole pieces are fabricated from type 410 stainless steel. All nonmagnetic parts, except pins and springs, are fabricated from type 304 stainless steel. Haynes-25 is used to fabricate latch/link pins. Springs are made from a nickel-chromium-iron alloy (Inconel X-750). Latch arm tips are clad with Stellite-6 to provide improved wearability. Hard chrome plate and Stellite-6 are used selectively for bearing and wear surfaces.

d. CRDM/GRDM Drive Rod Assembly

The drive rod assembly utilizes a type 410 stainless steel drive rod. The coupling is machined from type 403 stainless steel. Other parts are type 304 stainless steel with the exception of the springs, which are nickel-chromium-iron alloy and the locking button, which is Haynes-25.

e. CRDM/GRDM Hub Extension Assembly

The hub extension assembly utilizes a type 410 stainless steel hub extension rod. The coupling hub and semi-permanent coupling are machined from type 403 stainless steel. The locking sleeve is machined from Inconel 600 material.

4.5.1.1.2 Fabrication and Processing of Austenitic Stainless Steel Components 2

The discussions provided in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System", concerning the processes, inspections, and tests on austenitic stainless steel components to ensure freedom from increased susceptibility to intergranular corrosion caused by sensitization; and the control of welding of austenitic stainless steels (especially control of delta ferrite), are applicable to the austenitic stainless steel pressure-housing components of the CRDM/GRDM.

4.5.1.1.3 Contamination Protection and Cleaning of Austenitic Stainless Steel 2

The CRDM/GRDM are cleaned prior to delivery in accordance with Westinghouse process specifications. Process specifications in packaging and shipment are discussed in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System". Westinghouse personnel conduct surveillance of these operations to ensure that manufacturers and installers adhere to appropriate requirements as discussed in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System".

4.5.1.1.4 Other Materials 2

Haynes-25 is used in small quantities to fabricate latch/link pins and locking buttons. The material is ordered in the solution-treated, cold-worked condition. Stress-corrosion cracking has not been observed in this application over the last 20 years in the environment similar to the WAPWR.

The CRDM/GRDM springs are made from a nickel-chromium-iron alloy (Inconel X-750) ordered to MIL-S-23192 Class A, No. 1 temper cold-drawn wire or Class D, spring temper cold drawn wire. Operating experience of similar designs has shown that springs made of this material are not subject to stress-corrosion cracking.

4.5.1.2 Displacer Rod Drive System Structural Materials

4.5.1.2.1 Materials Specifications

All DRDM parts exposed to the reactor coolant are made of metals which resists the corrosive action of the reactor coolant water chemistry. The following metals are used exclusively - 300 and 400 series austenitic and martensitic stainless steels, nickel-chromium-iron, and cobalt based alloys.

A. Pressure Boundary

Pressure retaining parts forming the primary pressure boundary are fabricated solely from nickel-chromium-iron alloy and the austenitic types 304 and 316 stainless steels where additional processes for property enhancement are permissible but not mandatory. All pressure boundary materials comply with the ASME Boiler and Pressure Vessel Code Section III.

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B. Internals Cylinder Assembly

The internals cylinder assembly is comprised of 304 or 316 materials for the cylinder, upper and lower support pieces, latch pins, and lock pins. Alternate nickel based gall resistant alloys [ ] may be utilized for latch and support hardware. Springs are made from nickel-chromium-iron alloy (Inconel X750). Hard chrome plate is used selectively for bearing and wear surfaces.

(a,b,c)

C. Drive Rod Assembly

The drive rod assembly is made up of two drive rods. One is type 410 stainless steel, the second is type 304 SST. The joining coupling is machined from type 403 stainless steel. The remaining drive rod assembly parts are made from 304 stainless, nickel-chromium-iron alloys for springs, screws, and pins, cobalt based alloys for seals and high wear locking devices, the selective use of hard chrome on threads and wear surfaces, and the nickel based anti-gall alloy [ ] for the piston.

(a,b,c)

D. RPI Support Assembly

The RPI Support Assembly is external to the primary coolant however due to the functional requirements imposed by the detection system the support assembly parts are fabricated solely of austenitic stainless steels. The top plate which serves as a seismic support is fabricated from material complying with the ASME Boiler and Pressure Vessel Code Section III, Sub-Section NF.

4.5.1.2.2 Fabrication and Processing of Austenitic Stainless Steel Components

The discussions provided in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System", concerning the processes, inspections, and tests on austenitic stainless steel components to ensure freedom from increased susceptibility to intergranular corrosion caused by sensitization, and the discussions provided in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System", concerning the control of welding of austenitic stainless steels especially control of delta ferrite, are applicable to the austenitic stainless steel pressure-housing components of the DRDM. 2

4.5.1.2.3 Contamination Protection and Cleaning of Austenitic Stainless Steel

The DRDMs are cleaned prior to delivery in accordance with the guidance of American National Standards Institute (ANSI) discussed in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System". Westinghouse personnel conduct surveillance of these operations to ensure that manufacturers and installers adhere to appropriate requirements as discussed in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System".

4.5.2 Reactor Internals Materials

4.5.2.1 Materials Specifications

All the major materials for the reactor internals are type 304 stainless steel. Parts not fabricated from type 304 stainless steel include bolts and

dowel pins, which are fabricated from type 316 stainless steel, and radial support key bolts, which are fabricated of Inconel-750. Radial support clevis inserts are Inconel-600 with Stellite-6 hardfacing, and the holddown spring is type 304 stainless steel. There are no other materials used in the reactor internals or core support structures which are not otherwise included in the ASME Code, Section III, Appendix I.

4.5.2.2 Controls on Welding

The discussions provided in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System" are applicable to the welding of reactor internals and core support components.

4.5.2.3 Nondestructive Examination of Tubular Products and Fittings

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The nondestructive examination of wrought seamless tubular products and fittings is in accordance with Section III of the ASME Code.

4.5.2.4 Fabrication and Processing of Austenitic Stainless Steel Components

Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System" discusses the level of conformance of reactor internals and core support structures with Regulatory Guides 1.31, 1.34, 1.44 and 1.71.

4.5.2.5 Contamination Protection and Cleaning of Austenitic Stainless Steel

The discussions provided in Subsection 5.2.3 of RESAR-SP/90 PDA Module 4, "Reactor Coolant System" are applicable to the reactor internals and core support structures and verify conformance with ANSI 45 specifications and Regulatory Guide 1.37.