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Your ref: Docket No. 52-006
Our ref: DCP/NRC1658

December 12, 2003

SUBJECT: Transmittal of Revised Responses to AP1000 DSER Open Items

This letter transmits Westinghouse revised responses to Open Items in the AP1000 Design Safety Evaluation Report (DSER). A list of the revised DSER Open Item responses transmitted with this letter is Attachment 1. The non-proprietary responses are transmitted as Attachment 2.

Please contact me at 412-374-4728 if you have any questions concerning this submittal.

Very truly yours,

R. P. Vijuk, Manager
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/Attachments

1. List of the AP1000 Design Certification Review, Draft Safety Evaluation Report Open Item Responses transmitted with letter DCP/NRC1658
2. Non-Proprietary AP1000 Design Certification Review, Draft Safety Evaluation Report Open Item Responses dated December 12, 2003

D063

December 12, 2003

Attachment 1

List of

Non-Proprietary Responses

Table 1 "List of Westinghouse's Responses to DSER Open Items Transmitted in DCP/NRC1658"	
5.2.3-2 Revision 2 19.1.10.3-1 Revision 3	

DCP/NRC1658
Docket No. 52-006

December 12, 2003

Attachment 2

AP1000 Design Certification Review
Draft Safety Evaluation Report Open Item Non-Proprietary Responses

AP1000 DESIGN CERTIFICATION REVIEW

Draft Safety Evaluation Report Open Item Response

DSER Open Item Number: 5.2.3-2 Revision 2

Original RAI Number(s): None

Summary of Issue:

Alloy 52/152 materials are known to be difficult to weld. Address what examinations have been given to the adequacy of quality assurance (QA) criteria for the Alloy 51/152 weldments that will be used to connect stainless steel piping to the ferritic pressure vessel. Address whether the QA criteria are commensurate with the risk associated with weldment failure.

Westinghouse Response:

The "difficulties of welding" ascribed to Alloys 52 and 152 refers to the fact that large section multipass welds made with these materials have been observed to contain hot cracks. Such hot cracks are controlled by the application of proper weld technique, but are difficult to totally eliminate. In addition, welding with the shielded metal arc process using the Alloy 152 coated electrode requires frequent back-chipping and grinding to eliminate "floaters", which are small (Al and Ti) oxide inclusions.

The Quality Assurance criteria for these weldments are essentially the same as those previously and currently applied to weldments of Alloys 82 and 182. The welds must pass the required ASME Boiler & Pressure Vessel (B&PV) Code Section III requirements - i.e., for dye penetrant inspections, no reportable indications (that is, no linear indications) are permitted on the final weld surface. If they are found to be present, they must be removed and the welds repaired as specified by the ASME B&PV Code. This results in no surface cracks in the weld. The presence of minor subsurface hot cracks is of no consequence for at least three reasons: (1) they are not in contact with the primary water; (2) the excellent corrosion resistance of Alloys 52 and 152 will preclude the occurrence of stress corrosion cracking at the water-weld metal interface (these materials have never been observed to experience environmental degradation in primary water): and (3) the very small subsurface hot cracks have not been found to serve as crack initiation or propagation sites. This Quality Assurance criteria is intended to minimize the risk of weldment failure.

NRC Follow-on Comments

Response does not directly answer requests.

Response indicates difficulties with SMA process using Alloy 152. Westinghouse should clarify limitations that will be place on use of Alloy 152, such as use only on joints where access is an issue.

Response appears to be written for butt weldments rather than for both butt welds and partial penetration welds (e.g., J-groove welds).

Response does not incorporate South Texas experience with lack of fusion in vessel bottom head penetration J-groove weld.

Westinghouse should address inspections that will be performed to identify potential lack of fusion in partial penetration welds, for example volumetric examination, final pass eddy current examinations, or additional weld pass surface examination and address acceptance criteria.

Westinghouse Response to Follow-on Comments

The previous response was not intended to distinguish between the general weldability of Alloy 52 and Alloy 152. Thus, the previous response was not limited to SMA welding with Alloy 152. Alloy 52 and Alloy 152 can be used interchangeably. Proper weld procedures, and the associated weld inspections, must be carefully observed for either Alloy.

The previous response referred to "large section multipass welds". This may have been inferred by the NRC to apply only to butt welds. This was not the intent, since these materials are widely used for such additional operations as buttering for weld joint preparation, multipass filler welds for partial penetration J-groove welds, and surface overlay repairs. To our knowledge, thousands of such welds have been made and have been in nuclear service for at least ten years, with no known problems.

The welding at South Texas involved the use of Alloy 182 (not Alloy 52 or Alloy 152) to accomplish a partial penetration J-groove weld to the stainless steel cladding and the Alloy 600 instrument tube. The "lack of fusion" is a problem with weld practice, not the basic weldability of the alloy. This is addressed by the welding practices as discussed in the following paragraphs.

The inspections and acceptance criteria for partial penetration J-groove welds and pressure boundary (butt) welds are governed by Sections 3 (manufacturing) and 11 (preservice and in-service) of the ASME B&PV Code. The requirements for partial penetration J-groove welds are dye penetrant (PT) inspections after the first pass and at regular successive weld depths. The Code specifies every half-inch, but Westinghouse procedures require successive PT inspections every one-fourth inch of weld metal. The Section 11 requirements for the J-groove welds are currently being modified to require UT examinations of the interface where the weld joins the penetration tube (or pipe). This is being done to ensure that lack of fusion in that area is detected.

The pressure boundary welds, such as the large butt welds used for reactor vessel or steam generator nozzle safe-end welds, are required by Section 11 to be radiographically inspected using carefully prescribed practices. The chief purpose of these inspections is to detect and support repair of lack of fusion or similar major volumetric defects. Minor embedded hot cracking may not be detected. Final surface PT inspections are relied upon to detect the intersection of weld flaws and defects with the final weld surface.

The acceptance criteria for each of these inspections are specified by the Code and also by Westinghouse procedures. Properly implemented, these procedures and the acceptance criteria are judged adequate to ensure successful and reliable field performance.

NRC follow-on comment:

The specifications identified in the response for Alloy 52/152 welds should be included in the DCD.

Westinghouse Response to NRC follow-on comment:

The issue encompasses the general weldability, and associated inspection issues, attendant to the use of the nickel-based Alloy 52 [ERNiCrFe-7] and Alloy 152 [ENiCrFe-7] weld metals planned for use in a number of primary pressure boundary locations in the AP1000 design.

These weld metals will be used for a number of ASME Class 1 reactor coolant pressure boundary locations, including:

- Reactor Vessel Components (Table 5.2-1 and Section 5.3)
- Steam Generator Components (Table 5.2-1 and Subsection 5.4.2)
- Pressurizer Components (Table 5.2-1 and Subsection 5.4.5)
- Core Makeup Tanks (Table 5.2-1 and Subsection 5.4.13)
- The Passive Residual Heat Removal Heat Exchanger (Table 5.2-1 and Subsection 5.4.14)

The inspections and acceptance criteria for partial penetration J-groove welds and pressure boundary (butt) welds are governed by Sections 3 (manufacturing) and 11 (preservice and in-service) of the ASME B&PV Code. The requirements for partial penetration J-groove welds are dye penetrant (PT) inspections after the first pass and at regular successive weld depths. The Code specifies every half-inch. However, Westinghouse procedures require successive PT inspections every one-fourth inch of weld metal.

The pressure boundary welds, such as the large butt welds used for reactor vessel or steam generator nozzle safe-end welds, are required by Section 11 to be radiographically inspected using carefully prescribed practices. The chief purpose of these inspections is to detect and support repair of lack of fusion or similar major volumetric defects. Minor embedded hot

cracking may not be detected. Final surface PT inspections are relied upon to detect the intersection of weld flaws and defects with the final weld surface.

The Section 11 requirements for the partial penetration J-groove welds are currently being modified to require UT examinations of the interface where the weld joins the penetration tube (or pipe). This is being done to ensure that lack of fusion in that area is detected. Westinghouse is currently performing in-service inspections of these regions with the latest UT equipment and industry-approved practices.

It is implicit that the diligence associated with the current state-of-the-art weld preparation and inspection practices and procedures will be fully utilized for the AP1000. The procedures will, of course, continue to be upgraded as further enhancements of this technology evolve. This will extend similarly to any additional locations where these weld metals may be deployed beyond those currently identified.

DCD subsection 5.2.3.1 will be revised as shown below.

Design Control Document (DCD) Revision:

5.2.3.1 Materials Specifications

Table 5.2-1 lists material specifications used for the principal pressure-retaining applications in Class 1 primary components and reactor coolant system piping. Material specifications with grades, classes or types are included for the reactor vessel components, steam generator components, reactor coolant pump, pressurizer, core makeup tank, and the passive residual heat removal heat exchanger. Table 5.2-1 lists the application of nickel-chromium-iron alloys in the reactor coolant pressure boundary. The use of nickel-chromium-iron alloy in the reactor coolant pressure boundary is limited to Alloy 690. Alloy 600 may be used in limited areas for welding or buttering. Where Alloy 600 is used, it is not in contact with the reactor coolant. Steam generator tubes use Alloy 690 in the thermally treated form. Nickel-chromium-iron alloys are used where corrosion resistance of the alloy is an important consideration and where the use of nickel-chromium-iron alloy is the choice because of the coefficient of thermal expansion. Subsection 5.4.3 defines reactor coolant piping. See subsection 4.5.2 for material specifications used for the core support structures and reactor internals. See appropriate sections for internals of other components. Engineered safeguards features materials are included in subsection 6.1.1. The nonsafety-related portion of the chemical and volume control system inside containment in contact with reactor coolant is constructed of or clad with corrosion resistant material such as Type 304 or Type 316 stainless steel or material with equivalent corrosion resistance. The materials are compatible with the reactor coolant. The nonsafety-related portion of the chemical and volume control system is not required to conform the process to requirements outlined below.

Table 5.2-1 material specifications are the materials used in the AP1000 reactor coolant pressure boundary. The materials used in the reactor coolant pressure boundary conform to the applicable ASME Code rules. Cast austenitic stainless steel does not exceed a ferrite content of 20 FN. Calculation of ferrite content is based on Hull's equivalent factors.

The welding materials used for joining the ferritic base materials of the reactor coolant pressure boundary conform to or are equivalent to ASME Material Specifications SFA 5.1, 5.2, 5.5, 5.17, 5.18, and 5.20. They are qualified to the requirements of the ASME Code, Section III.

The welding materials used for joining the austenitic stainless steel base materials of the reactor coolant pressure boundary conform to ASME Material Specifications SFA 5.4 and 5.9. They are qualified to the requirements of the ASME Code, Section III.

The welding materials used for joining nickel-chromium-iron alloy in similar base material combination and in dissimilar ferritic or austenitic base material combination conform to ASME Material Specifications SFA 5.11 and 5.14. They are qualified to the requirements of the ASME Code, Section III. Alloy 600 may be used in limited areas but is not in contact with reactor coolant.

The fabrication and installation specifications for partial penetration welds with Alloy 52/152 within the ASME Class 1 reactor coolant pressure boundary require successive dye penetrant examinations after the first pass and after every one-fourth inch of weld metal. The specifications for J-groove welds that join ASME Class 1 reactor coolant pressure boundary Alloy 690 penetrations require ultrasonic examination of the interface where the weld joins the penetration tube. The specifications for butt welds used for nozzle safe-end welds require these welds to be radiographically inspected. These weld specifications are applicable to the ASME Class 1 reactor coolant pressure boundary portions of the reactor vessel (Section 5.3), the reactor coolant pumps (subsection 5.4.1), the steam generators (subsection 5.4.2), the reactor coolant system piping (subsection 5.4.3), the pressurizer (subsection 5.4.5), the core makeup tanks (subsection 5.4.13), and the passive residual heat removal heat exchanger (subsection 5.4.14).

PRA Revision:

None

AP1000 DESIGN CERTIFICATION REVIEW

Draft Safety Evaluation Report Open Item Response

DSER Open Item Number: 19.1.10.3-1 (Response Revision 3)

Original RAI Number(s): None

Summary of Issue:

Representative Sequences for Assigning Source Terms

The accident sequences used to represent the various release categories are identified and briefly described in PRA Chapter 45. Additional sequence information is provided in PRA Chapter 34. The basis for selecting the representative sequence for each release category is not provided. Such information is necessary in order to confirm that the sequence selected to represent each release category is reasonably representative of the collection of sequences assigned that category, in terms of the magnitude, timing, energy, and elevation of release. Based on the limited information that was provided, the staff noted a number of inconsistencies. Specifically, for release category CFE releases from the ADS Stage 4 valves enter directly into containment rather than into the IRWST, and given the location of the valves relative to the containment shell, would not result in containment failure from diffusion flames as assumed in the PRA. For release category CFL containment failure is assumed at 3 hours, which is inconsistent with the time frame for late containment failure. Also, important details impacting the release characteristics need to be documented, such as whether an additional decontamination factor is credited in determining the source term for SGTR events (as it was in AP600), and the containment isolation failure location and size assumed for containment isolation sequences. This is Open Item 19.1.10.3-I.

Westinghouse Response (Revision 3):

The Revision 1 response to this DSER Open Item included major revisions to Chapters 34 and 45 of the AP1000 PRA. In discussions with the staff, they indicated editorial mistakes with the revised PRA Chapter 45. Revision 2 of this response indicated the corrections to Chapter 45 that were incorporated in the AP1000 PRA Revision 5. Revision 3 of this response provides an additional Chapter 45 correction that will be included in the next revision of the AP1000 PRA.

Design Control Document (DCD) Revision:

None

PRA Revision:

45.2.4 Release Category CFE
Release category CFE represents fission product releases to the environment from containment failure induced by severe accident phenomena that may occur during the core melting and

relocation phase of the accident sequence. Fission products are released from the reactor coolant system to the containment. Before significant deposition of the aerosol fission products, the containment fails due to a high-energy event (i.e., hydrogen combustion or steam explosion). Release category CFE contributes to the LERF of the AP1000.

The fission product release fractions from an accident class 3D sequence with early containment failure induced by diffusion flames were used to represent release category CFE.

The source term releases for Release Category CFE are presented in Figures 45-37 through 45-48.