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Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Subject: Response to Request for Additional Information Regarding Relief Request I3R-11 Associated with the Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds

References:

1) Letter from D. M Gullott (Exelon Generation Company, LLC) to NRC, "Relief Request I3R-11 Associated with Alternative Requirements for Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds," dated September 19, 2013

2) Email from Joel Wiebe (NRC) to J. A. Bauer (Exelon Generation Company, LLC), "Preliminary RAIs for Relief Request I3R11, 'Alternate Repair of CRDM Canopy Seal Weld,'" dated November 6, 2013

In Reference 1, in accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), Exelon Generation Company, LLC (EGC), requested NRC approval of a proposed alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2001 Edition through the 2003 Addenda for Braidwood Station, Units 1 and 2.

As noted in Reference 1, while performing a boroscopic inspection of the reactor head assembly during the Braidwood Station, Unit 1 2013 fall refueling outage (i.e., A1R17), white residue was observed on the control rod drive mechanism (CRDM) canopy seal welds for reactor head penetrations 41, 49, 61, 65 and 73 which indicates the potential of past reactor coolant system (RCS) pressure boundary leakage at one or more of these locations. The CRDM assemblies were designed and fabricated to the ASME B&PV Code, Section III, "Nuclear Power Plant Components," 1974 Edition through Summer 1974 Addenda. It should be noted that after additional inspection activities, the residue on the subject penetrations was determined to be legacy staining and not active RCS leakage. Subsequently, this relief request was not needed during A1R17; however, EGC would like to pursue NRC approval of this relief request for future potential use.

Reference 1 stated that the proposed alternative would permit the use of an alternative method of repair and nondestructive examination for the CRDM canopy seal welds that provides an acceptable level of quality and safety, consistent with 10 CFR 50.55a(a)(3)(i). Upon further review, as documented in the response to Question 6 in Attachment 1, excavation of flaws in canopy seal welds does present a number of hardships, which include radiation exposure, creating an open root weld which would require an argon purge, and, depending on the location, lack of access to support flaw removal. Therefore, the proposed alternative discussed in Relief Request I3R-11 is more appropriately justified in accordance with 10 CFR 50.55a(a)(3)(ii); i.e., "Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety." The alternative method also significantly reduces the projected occupational radiation dose when compared to the Code required repair method.

During initial review of the subject relief request, the NRC concluded that additional information would be needed to complete their review. The NRC transmitted the Request for Additional Information (RAI) to EGC in Reference 2. On November 19, 2013, NRC and EGC personnel held a clarification teleconference to discuss the content of the NRC's RAI. During the call, it was agreed that EGC would provide a response to the RAI on or before January 24, 2014. Attachment 1 to this letter provides the requested information.

There are no regulatory commitments contained within this letter.

Should you have any questions concerning this letter, please contact J. A. Bauer at (630) 657-2804.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

Attachment 1: Response to Request for Additional Information Regarding Relief Request I3R-11 Associated with the Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds

cc: NRC Regional Administrator – Region III
NRC Senior Resident Inspector – Braidwood Station
Illinois Emergency Management Agency – Division of Nuclear Safety

ATTACHMENT 1

Response to Request for Additional Information Regarding Relief Request I3R-11 Associated with the Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds

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During initial review of the subject relief request, the NRC concluded that additional information would be needed to complete their review. The NRC transmitted the Request for Additional Information (RAI) to EGC in Reference 2. The NRC requested information and associated responses to each question are presented below.

The NRC staff notes that there is more than one seal weld that is degraded and will be repaired; however, the questions below use a single weld as representative of all degraded seal welds.

1. Provide drawings and sketches to show/identify the following items:

(1) Configuration of the canopy seal (how the canopy seal is assembled) and its location with respect to the control rod drive mechanism (CRDM) housing. Identify the diameter of the canopy seal.

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Response to Request for Additional Information Regarding Relief Request I3R-11 Associated with the Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds

Response

At this time, this request for relief is associated with a contingency repair. There currently are no known degraded canopy seal welds at Braidwood Station.

Components associated with the canopy seal welds were assembled using threaded connections, were torqued and seal welded using consumable inserts. The general configuration of the canopy seal welds along with their general location on the control rod drive mechanism assembly are provided in Figures 1 and 2. The approximate diameter of the canopy seal welds ranges from 3.75" (for the upper canopy seal weld) to 6.45" (for the lower canopy seal weld).

(2) The parts of the CRDM that provide the pressure boundary and structural support in the proximity of the canopy seal, as the relief request stated that the weld does not provide structural or pressure boundary support.

Response

The threaded joints between the cap and rod travel housing, rod travel housing and latch housing, and latch housing and head adapter provide the primary pressure boundary and structural support for the control rod drive mechanisms.

(3) The locations of the flaw(s) in the seal weld(s).

Response

At this time this request for relief is associated with a contingency repair. There are currently no known degraded canopy seal welds at Braidwood Station. Based on a review of documented industry experience associated with canopy seal leaks dating back to August 1987, canopy seal leakage has been characterized as pinhole leaks (i.e., rounded indications) with no significant flaws extending to the outside surface. Currently, canopy seal leaks have been limited to middle canopy seal welds and lower canopy seal welds.

(4) The minimum dimensions of the weld overlay including weld throat and toe, and how the weld beads will be deposited.

Response

A formal engineering design for a canopy seal weld overlay for Braidwood Station has not been completed and approved at this time. A preliminary design previously initiated for a contingency repair plan contained provisions for a minimum overall overlay thickness of 0.16" to cover a nominal base metal thickness ranging from 0.075" to 0.150". A final design for any seal weld will be based on the applicable portions of ASME Code Case N-504-4, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," as noted in Reference 1. The purpose of

the canopy seal weld overlay is for secondary pressure retention only and does not provide any structural support (i.e., the existing threads will continue to provide structural integrity as they are unaffected by the overlay repair). The weld beads will be deposited using the Gas Tungsten Arc Welding (GTAW) process.

2. ***The relief request stated that the proposed repair uses a remotely controlled Gas Tungsten Arc Welding (GTAW) process with Alloy 52/52M weld metal. The industry experience has shown that it is difficult to make a sound weld using Alloy 52/52M weld material. For example, hot cracking and ductility dip cracking have been experienced when welding with Alloy 52/52M.***

(1) Discuss the steps to minimize fabrication defects in the weld overlay/buildup.

Response

At this time, a specific welding vendor has not been selected to perform the canopy seal weld overlay discussed in this submittal. Welding vendor selection would be based on vendor availability at the time of need, experience welding Alloy 52/52M and proven performance of the vendor. Based on the accessibility of the canopy seal weld, weld overlay repairs would be performed using an appropriate Welding Procedure Specification (WPS) along with welders or welding operators qualified in accordance with ASME Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators," requirements. Since the existing base materials are relatively thin, special consideration to travel speed and heat input would be critical parameters to be addressed during the weld qualification process.

Based on a review of documented industry experience, most of the difficulties attributed to Alloy 52/52M overlay repairs have been associated with overlays onto existing dissimilar metal welds on nozzle-to-safe end configurations or embedded flaw repairs on pressurized water reactor upper head penetrations (i.e., overhead welding). All base materials associated with the canopy seal welds are stainless steel. Overhead welding is not a concern as the lower and upper canopy seal welds are oriented horizontally (see 2G position as depicted in Figure QW-461.4(b), "Groove Welds in Pipe – Test Position," of ASME Code, Section IX). The middle canopy seal welds are also oriented horizontally (see 1G position as depicted in Figure QW-461.3(a) of ASME Code, Section IX. Based on a review of documented industry experience associated with canopy seal leaks dating back to August 1987, the issues of hot cracking and ductility dip cracking observed on other Alloy 52/52M overlay applications noted above has not been observed on canopy seal welds.

(2) Discuss whether a plant-specific mock up is used to demonstrate that the welding process will produce a sound weld because the welding will be controlled remotely. If not, provide justification.

Response

At this time, a specific welding vendor has not been selected to perform the canopy seal weld overlay discussed in this submittal. As these types of repairs are typically encountered on an emergent basis, welding vendor selection would be based on vendor availability, experience with welding Alloy 52/25M and past performance. Exelon procedure CC-AA-501-1028, "Exelon Nuclear Welding Program High Risk/High Value (HR/HV) Welds," will be used to evaluate specific weld repairs and determine whether mock-ups are necessary to ensure a sound weld overlay is successfully applied.

(3) Identify the specific ASME Code sections and subarticles to which the welding procedures and personnel are qualified for the proposed repair.

Response

Welding procedure specifications along with associated welding personnel (i.e., welders and welding operators) qualifications would be performed in accordance with ASME Code, Section IX requirements. All associated canopy seal repair welding activities would be approved in accordance with a repair plan consistent with ASME Code, Section XI, IWA-4150, "Repair/Replacement Program and Plan."

3. The relief request stated that the weld buildup is considered a repair in accordance with IWA-4110 of the ASME Code, Section XI. The relief request further stated that applicability of the original code of construction or design specification is mandated because the weld is performed on an appurtenance to a pressure-retaining component. The relief request noted that the canopy seal weld is an ASME Class 1 component. The relief request explained that after the weld repair, a VT-1 visual examination will be performed. The NRC staff noted that in general, the nondestructive examination for the Class 1 weld is not [a] visual examination, but a volumetric examination and/or surface examination as required in Table IWB-2500-1 of the ASME Code, Section XI and the ASME Code, Section III. The NRC staff recognizes that the subject canopy seal welds are not a pressure-retaining, or structural-supporting component.

(1) Discuss the NDE requirement in accordance with the ASME Code, Section XI for which relief is requested because the submittal did not provide the examination category and Item number for the subject canopy seal welds with respect to Table IWB-2500-1.

Response

There is no applicable ASME Code, Section XI, Category or Item Number associated with this configuration as canopy seal welds are not subject to Table IWB-2500-1, "Examination Categories," surface or volumetric examinations. The only applicable ASME Code, Section XI NDE requirements associated with the canopy seal welds are those associated with defect removal (i.e., IWA-4422.2.2, "Defect Removal Followed by Welding or Brazing"). A final surface examination is required in accordance with the Code of Construction (i.e., ASME Code, Section III) and the original Design Specification.

(2) Identify the ASME Code sections and subarticles that permit a visual examination as part of the post-welding inspection for the repaired weld.

Response

ASME Code, Section XI IWA-4520, "Examination," paragraph *(c)* states: "Alternative examination methods, a combination of methods, or newly developed techniques may be substituted for the methods specified in the Construction Code or in this Division, provided the Inspector is satisfied that the results are demonstrated to be equivalent or superior to those of the specified method." Depending on the location of a particular canopy seal weld, the accessibility necessary to perform the required liquid penetrant examination may not be possible; therefore, Braidwood Station is requesting substituting a VT-1 examination as part of the subject relief request; i.e. Relief Request I3R-11.

(3) Discuss exactly how the VT-1 visual examination will be conducted.

Response

Conduct of the VT-1 examination would be dependent on accessibility of the inspection. If the canopy seal repair was associated with a control rod drive mechanism on the outer periphery of the core, it may be possible to perform the inspection through direct visual observation and a mirror. If inspection access is limited, VT-1 examinations would be conducted using remote visual equipment such as a video probe or camera equipment that accompanies the welding equipment. Remote visual equipment resolution will be demonstrated prior to and upon completion of the examination(s) in accordance with ASME Code, Section XI IWA-2216, "Remote Visual Examination," and ASME Code, Section V, "Nondestructive Examination," Article 9, "Visual Examination," requirements.

(4) The licensee stated that the VT-1 visual examination will be demonstrated to resolve a 0.001-inch thick wire against the surface of the weld. The NRC notes that the ASME Code, Section XI, IWA-2210, IWA-2211, and Table IWA-2210-1 (the 2001 edition) provide requirements for the VT-1 examination. The NRC staff further notes that Table IWA-2210-1 provides requirements for qualifying VT-1 examination based on character resolution which the NRC staff prefers in

lieu of the licensee proposed wire resolution. Discuss whether the proposed VT-1 examination satisfies Table IWA-2210-1.

Response

Braidwood Station will utilize the requirements of ASME Code, Section XI, Table IWA-2210-1, "Visual Examinations," for procedure demonstrations required to support the VT-1 examinations proposed in the relief request.

4. ***The relief request stated that a VT-2 visual examination will be performed during the system leakage test.***

(1) Discuss whether the system leakage test and the VT-2 examination will be performed every refueling outage. If not, discuss the frequency of the test.

Response

The canopy seal welds are contained within the Class 1 system leakage test boundary and are examined by the VT-2 visual examination method each refueling outage as required by ASME Code, Section XI, Table IWB-2500-1, Category B-P, "All Pressure Retaining Components," Item Number B15.10, "Pressure Retaining Components." In addition to the Class 1 system leakage test performed at the conclusion of each refueling outage, leakage checks at the beginning of each refueling outage and during forced outages are conducted in accordance with Braidwood Station's commitment to Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants."

(2) Discuss exactly how a VT-2 examination will be conducted on the canopy seals and whether a VT-2 examination is adequate because the canopy seal weld is located in an area of high radiation and high elevation.

Response

The control rod drive mechanism housings are not insulated and are oriented vertically. Accessibility to conduct VT-2 examination of the lower canopy seal welds is relatively unobstructed once the shroud access doors are opened. Staining, due to RCS leakage, would be evident at low points in this area. The intermediate and upper canopy seals cannot be observed directly and are examined to the extent practical in accordance with ASME Code, Section XI, IWA-5241, "Insulated and Noninsulated Components," paragraph *(d)*. Radiation dose rate in this area does not prevent performance of the VT-2 examinations.

(3) Discuss the existing examination requirement for the canopy seals and reference the relevant subarticles in the ASME Code, Section XI.

Response

As previously stated, canopy seal welds are contained within the Class 1 system leakage test boundary and examined by the VT-2 method each refueling outage as required by ASME Code, Section XI, Table IWB-2500-1, Category B-P, Item Number B15.10. There are no ASME Code, Section XI examinations specific to canopy seal welds, and replacement seal welds are specifically exempted from post welding pressure testing per ASME Code, Section XI, IWA-4540, "Pressure Testing of Classes 1, 2, and 3 Items," paragraph *(b)(8)*. Applicable examinations are limited to the VT-2 method conducted during the system leakage test.

5. ***(1) Discuss the potential for failure of the canopy seal after the repair, including the likelihood of the through wall flaw in the existing canopy seal weld growing into the weld overlay and eventually growing through wall in the weld overlay. Provide technical basis including appropriate literature references in the discussion.***

Response

Based on a review of documented industry experience associated with canopy seal leaks dating back to August 1987, there have been no failures of canopy seal weld overlay repairs where Alloy 52/52M has been applied. The existing threads associated with the base metal components will continue to provide structural integrity as they are unaffected by the overlay repair. Alloy 52/52M is recognized as being corrosion resistant and will provide an acceptable repair of the existing canopy seal weld if through-wall leakage is discovered. The ability of Alloy 52/52M weld material to resist cracking is documented in EPRI Report 1021014, "Materials reliability Program: Technical Basis for Preemptive Weld Overlays for Alloy 82/182 Butt Welds in Pressurized Water Reactors (PWRs) (MRP-149)," Revision 1-A.

(2) Provide the basis why the degraded canopy seal over time will not result in a catastrophic failure of the CRDM.

Response

Based on a review of documented industry experience associated with canopy seal leaks dating back to August 1987, there were no instances of catastrophic failures associated with canopy seal leakage in any domestic or foreign plants or any instances of applied weld overlays failing after being placed in service. Industry experience has attributed degradation of the existing seal welds to transgranular stress corrosion cracking (TGSCC). The weld overlays proposed through this relief request will be made with Alloy 52/52M which is resistant to stress corrosion cracking. The canopy seal weld

and associated overlay weld is separate from the structural pressure retaining threaded segments of the CRDM. The threaded segments are not designed to be leak tight and, therefore, canopy seal welds are utilized as part of the plant design. The proposed overlay simply replaces a leaking section of the canopy seal weld and, because it does not affect the threaded CRDM joint, does not change the probability of a CRDM failure.

(3) Discuss the impact on other components from leakage of the canopy seal, assuming leakage was to start during reactor startup, and the means for detecting a leak of the canopy seal.

Response

At this time, this request for relief is associated with a contingency repair. There are currently no known degraded canopy seal welds at Braidwood Station. Based on a review of documented industry experience associated with canopy seal leaks dating back to August 1987, there were no instances of significant degradation associated with any target surfaces as a result of identified canopy seal leakage.

Should a minor canopy seal weld leak develop during reactor startup, there are no components in the near vicinity of the CRDMs that would be adversely impacted by a canopy seal weld leak. There are also established RCS leak detection methods available to detect RCS leakage from any location. If a leak developed, the leak could be detected by the containment area or process radiation monitoring system; or by the containment sump monitor. In addition, a RCS leakrate surveillance is conducted every shift that would identify leakage.

6. ***The licensee submitted the relief request pursuant to 10 CFR 50.55a(a)(3)(i). The NRC staff finds that 10 CFR 50.55a(a)(3)(i) is not applicable to the subject repair because the proposed repair does not reach the quality level of an ASME Code repair. For example, the proposed repair permits the flaw(s) to remain in service whereas an ASME Code repair would require the flaws to be removed. The NRC staff finds that the proposed repair may satisfy 10 CFR 50.55a(a)(3)(ii).***

Response

In general, ASME Code repairs remove identified flaws, however weld overlays over existing flaws are recognized as an approved ASME Code repair through a number of ASME Code, Section XI Code Cases (e.g., N-504-4, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1") which have been accepted by the NRC throughout the years dating back to NUREG-0313, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," Revision 1, dated January 1980, which addressed intergranular stress corrosion cracking repairs by weld overlay. However, as discussed in Braidwood Relief Request I3R-11, excavation of flaws in canopy seal welds does present a number of hardships, which include radiation exposure, creating an open root weld which would require an argon purge, and, depending on the location, lack of

access to support flaw removal. Therefore, EGC concurs that Relief Request I3R-11 is justified in accordance with 10 CFR 50.55a(a)(3)(ii); i.e., "Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

REFERENCES

1. Letter from D. M Gullott (Exelon Generation Company, LLC) to NRC, "Relief Request I3R-11 Associated with Alternative Requirements for Repair/Replacement of Control Rod Drive Mechanism (CRDM) Canopy Seal Welds," dated September 19, 2013

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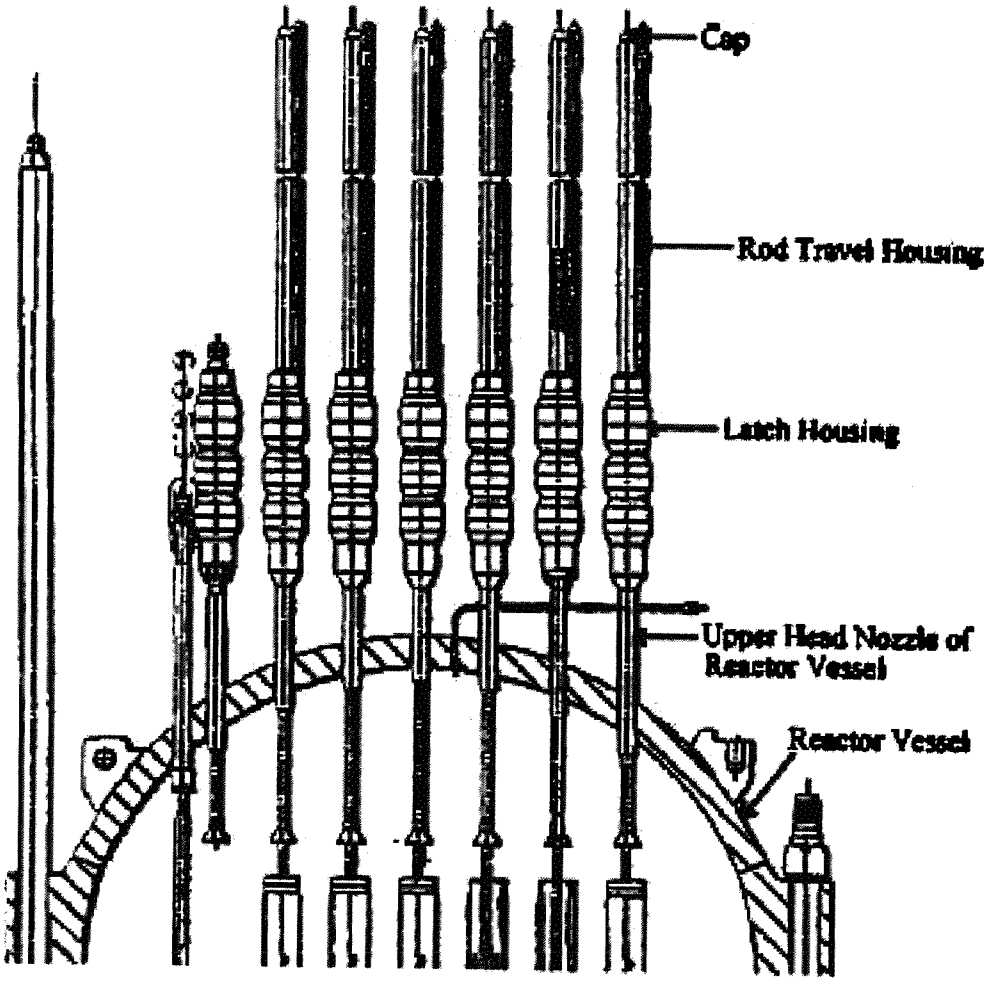

Fig. 1 Structure of CRDM Housing

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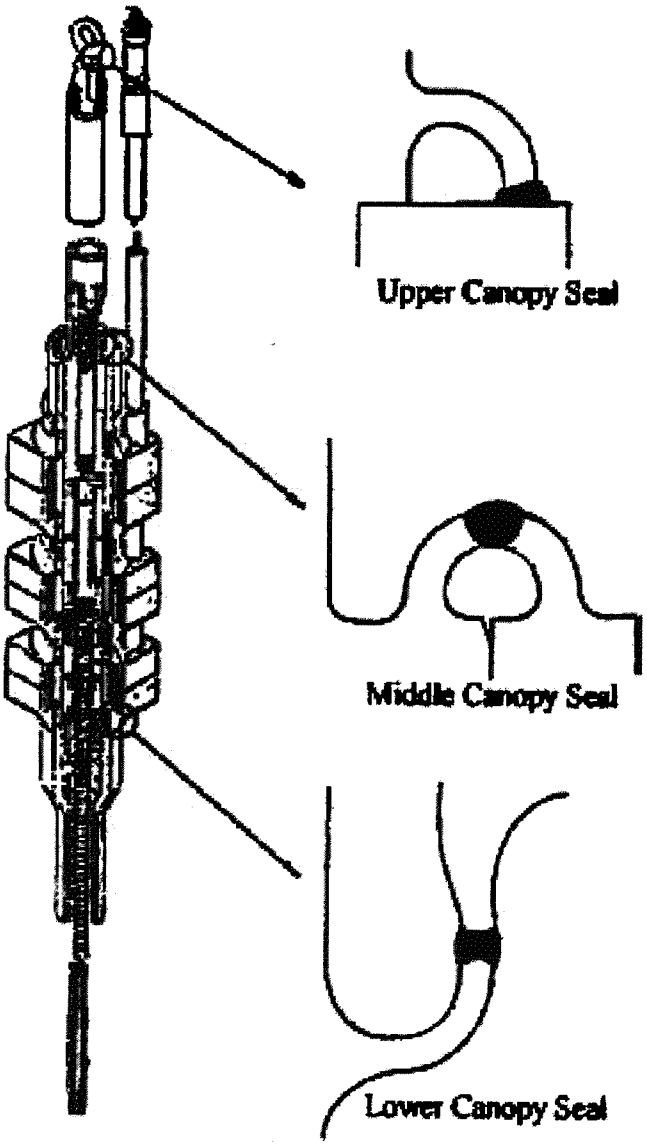

Fig. 2 Sectional View of Canopy Seals