WOLF CREEK
NUCLEAR OPERATING CORPORATION

Mark S. Larson
Controller Treasurer

MAY 24 2002

CT 02-0029

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Subject: Docket No. 50-482: 30-Day Response for NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity"

Gentlemen:

Attachment I contains the Wolf Creek Nuclear Operating Corporation (WCNOC) response to the 30-day requirement of U.S. Nuclear Regulatory Commission (NRC) Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity" dated March 18, 2002. Item 2 of the bulletin requires, within 30 days after plant restart following the next inspection of the reactor pressure vessel head to identify any degradation, information on the inspection scope and results, the corrective actions taken and the root cause of degradation identified.

Attachment II contains information provided in response to a request from the NRC during a teleconference with WCNOC personnel on April 23, 2002 regarding Wolf Creek Generating Station design and administrative processes associated with reactor vessel head penetration nozzle flange canopy seal welds.

No commitments are identified in this submittal. If you should have any questions regarding this submittal, please contact me at (620) 364-8831 ext. 4004, or Mr. Tony Harris at (620) 364-4038.

Very truly yours,

Mark S. Larson

MSL/rlr

Attachments: I - 30-Day Response to NRC Bulletin 2002-01
II - Design and Administrative Processes Associated with Reactor Vessel Head Penetration Nozzle Flange Canopy Seal Welds

cc: J. N. Donohew (NRC), w/a
D. N. Graves (NRC), w/a
E. W. Merschoff (NRC), w/a
Document Control Desk, w/a
Senior Resident Inspector (NRC), w/a

A095

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Mark S. Larson, of lawful age, being first duly sworn upon oath says that he is Controller Treasurer of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Mark S. Larson
Mark S. Larson
Controller Treasurer

SUBSCRIBED and sworn to before me this 24th day of May, 2002.

Cindy Novinger
Notary Public

NOTARY PUBLIC
STATE OF KANSAS
CINDY NOVINGER
My Appt. Exp. 7/8/02

Expiration Date July 8, 2002

**30-Day Response to NRC Bulletin 2002-01
Reactor Pressure Vessel Head Degradation and
Reactor Coolant Pressure Boundary Integrity**

Below is the Wolf Creek Nuclear Operating Corporation (WCNOC) response to the 30-day requirement of Nuclear Regulatory Commission (NRC) Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002. The bulletin's "Required Information" is shown in bold.

Required Information

2. **Within 30 days after plant restart following the next inspection of the reactor pressure vessel head to identify any degradation, all PWR addressees are required to submit to the NRC the following information:**

   A. **the inspection scope (if different than that provided in response to Item 1.D.) and results, including the location, size, and nature of any degradation detected,**

   B. **the corrective actions taken and the root cause of the degradation.**

Response to Item 2.A.

Refueling outage 12 ended at Wolf Creek Generating Station on April 27, 2002. During refueling outage 12, WCNOC performed an effective visual examination of the reactor vessel (RV) head and penetrations, as defined in NRC Bulletin 2001-01. 100% of the carbon steel surface area of the RV head was visually examined. Additionally, 100% of the interface areas between the RV head penetrations and the carbon steel on top of the head were visually examined. No indications of primary coolant leakage through the penetrations, and no indications of head degradation were identified.

An inspection plan was developed and approved by the WCNOC Support Engineering Exam and Test Group (which maintains responsibility for the Boric Acid Corrosion Inspection [BACINS] Program) and the WCNOC non-destructive examination (NDE) Level III examiner prior to the exam. The examination was performed using a site work document that includes requirements for personnel certification, demonstration requirements for the remote visual examination equipment capabilities, examination and acceptance criteria, and recording of inspection results.

Wolf Creek personnel performing the effective visual examination were certified in accordance with the applicable site certification procedure which meets or exceeds the requirements of ASME Section XI, 1989 edition. Examination personnel were certified to a minimum of Level II in the VT-2 method. Examination personnel were also required to read EPRI document 1006899, "Update: Visual Examination for Leakage of PWR Reactor Head Penetrations on Top Head," revised January 2002. This document includes the latest visual records for leaking head penetrations through Fall 2001. Also, the WCNOC Level III VT-2 examiner verbally briefed the examiners prior to the visual examinations and discussed the industry events associated with leaking head penetrations and the characteristics of leaking penetrations.

Though the contractor personnel providing and operating the remote inspection equipment were not certified NDE personnel (and therefore were not responsible for accepting the results of the visual examination), the contractor crew had performed several RV head inspections since Fall 2001.

The remote visual examination equipment was demonstrated to be capable of resolving typed lower case letters with a maximum letter height of 0.158 inch. Characters were verified to be clearly legible on the video monitor, both live and from videotape, with the camera placed within 12 inches of the test card. Additionally, the camera focal distances were measured and verified to be less than 12 inches. To demonstrate the color images provided by the cameras were acceptable, color sample cards ranging from snow white to light reddish brown were examined remotely, displayed on the video monitor, and then compared to the original sample cards.

Examiners were required to record all indications of leakage or potential leakage through the RV head penetrations. Also, examiners were required to record all indications of material degradation of the carbon steel RV head surfaces.

There were no material deficiencies identified on the RV head or penetration pressure boundaries. There were also no indications of leakage or potential leakage through the RV head penetrations. However, examiners did identify evidence of leakage (light film of dry boric acid splatter and some dried liquid trails) that originated from the reactor vessel head vent valves located on top of the control rod drive mechanism (CRDM) seismic support platform. The dry boric acid film was semi-transparent in nature and did not inhibit the examination of the RV head surface for indications of material degradation. In addition, small "clumps" of dried boric acid crystals were observed on the head. These "clumps" were not adhered to the head and appeared to have originated from the leaking head vent valves and then fell onto the head from the top of the insulation. The leaking head vent valves were repaired prior to restart from refueling outage 12.

Also, a number of RV head insulation panels were removed to facilitate other outage work near the RV head. Wolf Creek took advantage of this opportunity to perform additional cleaning and to remove foreign material on the RV head in accessible areas.

Response to Item 2.B.

There was no degradation identified on the RV head. No corrective actions were needed to address degradation of the head.

Design and Administrative Processes Associated with Reactor Vessel Head Penetration Nozzle Flange Canopy Seal Welds

Below is information requested by the NRC during a teleconference with WCNOC personnel on April 23, 2002 relative to canopy seal welds on the reactor vessel penetration (RVP) nozzle flanges including programmatic controls for identifying leaks and performing associated corrective actions.

There is also a ¾-inch penetration in the reactor vessel (RV) head for the head vent system. This penetration and associated piping has been inspected, but the information below is not applicable to the head vent system.

Response to Requested Information:

Configuration:

The reactor vessel head penetration assemblies at Wolf Creek Generating Station (WCGS) consist of two-piece construction -- an inconel tube section welded to a stainless steel (Type 304) flange, referred to as the head adapter flange. The inconel tube section is inserted into the penetration opening of the reactor vessel head and held in place by a partial penetration weld. Every head adapter flange attached to the inconel tube is designed and fabricated the same. Each is fabricated with a canopy lip and a threaded end for installation of attachments. There are a number of different attachments that can be installed on the head adapter flange. These attachments include control rod drive mechanisms (CRDMs), head adapter plugs, and core exit thermocouple (CET) attachments. Figure 1 shows the upper end of a typical WCGS reactor vessel head penetration.

During fabrication, the top attachment (the CRDM, head adapter plug, or CET attachment) is threaded into the head adapter flange. A gas tungsten arc weld process is used to form a seal weld. This seal weld is referred to as the lower canopy seal weld at WCGS. Figure 1 shows the configuration details for a typical lower canopy seal weld.

Design Considerations:

The WCGS reactor vessel head and penetration assemblies are classified as ASME Boiler and Pressure Vessel (B&PV) Code, Section III, Class 1 items. They were designed and fabricated to the 1971 Edition through Winter 1972 Addenda of Section III of the ASME B&PV Code (Reference 1). Section III, paragraph NB-3671.3 states that threaded joints in which the threads provide the only seal shall not be used. Thus, a seal weld (lower canopy seal weld) between the flange and attachment was incorporated into the original design of these items.

The reactor vessel head adapter canopy seals are classified as ASME Section III Class 1 items. Each seal is comprised of lip sections on two Class 1 pressure boundary parts and the seal weld which connects the two parts. However, the canopy seal is not a structural part of the pressure boundary and is not required to meet the structural requirements of ASME B&PV Code, Section III, NB-3000 (see Winter 1971 Addenda, paragraph NB-3227.7). The threads are the load carrying part of the joint design. The canopy seals are only required to satisfy specific requirements for seal welds in ASME Section III.

The canopy seal welds are thin welds of about 0.070" thickness that serve to seal the threaded pressure boundary connection. The canopy seal weld configuration forms a "dead end" in which impurities in water that works its way past the threads can accumulate (Figure 1). It is suspected that the water used during cold hydrostatic testing and hot functional testing remains in the canopy seal area for the life of the joint (unless a leak develops). Additionally, each time the head is removed from the vessel and reinstalled, and the vessel is repressurized, the trapped water in the seal area is oxygenated. This environment establishes conditions that appear to increase the probability of stress corrosion cracking. Annealed stainless steels are known to be susceptible to transgranular stress corrosion cracking (TGSCC) in this type of high temperature, stagnant chloride/oxygen environment.

Historical Industry Leakage Evaluations:

Westinghouse performed destructive examination and hardware failure analysis on a number of lower canopy seal welds removed from nuclear power plants in the late nineteen eighties (Reference 2). In addition, Westinghouse assisted WCNOC personnel in performing a hardware failure analysis report for leaking canopy seal welds (References 3 and 4). These investigations concluded that the failure mechanism was TGSCC. The cracking was identified both in the seal welds and in the base metal of the seal weld joints. All cracking was initiated from the interior of the joint. No sensitization of the material was identified in the components examined. Very low levels of chloride contamination were noted in water samples obtained from removed weld joint areas, as well as residues on the threaded surfaces that were analyzed. Westinghouse determined that the residual stresses associated with the seal welding process, combined with the very low levels of chloride in the oxygenated stagnant region, were sufficient to promote TGSCC on the joint.

The Westinghouse hardware failure analysis also included examination of some threaded joints that were removed along with the lower canopy seal welds. There was no evidence of corrosion or cracking on any of the threaded joints that were examined.

Leakage Considerations:

The industry indications of leaks in the seal welds to date have been characterized as pinholes or small cracks. There have been no industry reports of degradation of canopy seal welds resulting in significant leakage flow rates. Considering the head adapter flange design described above, leakage through a crack in the non-pressure boundary seal weld would be expected to be limited by the load carrying component, the flange connection threads.

Based upon the WCGS and industry experience, along with the fact that the canopy seal weld is not the load carrying part of the joint design, a gross failure on a lower canopy seal weld is unlikely to occur. If a gross failure of a seal weld does occur, leakage would be recognized using indications typical of a small leak inside containment and would be subject to the unidentified leakage Technical Specification limitations.

Additionally, the WCGS and industry experience with respect to leakage resulting in dry boric acid deposits indicates that the minor amounts of leakage identified to date on the WCGS lower canopy seal welds do not pose a concern with respect to structural integrity of the carbon steel portions of the reactor vessel head.

WCGS Leakage Inspections and Actions:

Administrative controls for the WCNOC boric acid corrosion inspection (BACINS) program are described in WCNOC's 60-day response to NRC Bulletin 2002-01 (Reference 5). There is a CRDM cooling shroud located on top of the RV head that has four viewing ports fitted with a transparent window. This allows viewing the CRDM canopy seal welds, as well as several other components above the RV head insulation (see Figure 2). Indications of leakage and boric acid buildup are recorded by the examiners. The two major inspections of the area above the RV head, the BACINS program visual inspection and the ASME Section XI reactor coolant system leakage test, are both completed while the head is on the reactor vessel and each typically takes 30 to 60 minutes, depending on the particular examiner.

Normally, a supplemental visual examination (a "closer look") is performed on an identified area of interest (e.g., a lower canopy seal weld) using remote visual equipment, primarily a video probe on an extension mechanism. Supplemental examinations are normally performed with the RV head removed from the reactor vessel and on the RV head stand. WCGS experience has been that leakage from lower canopy seal welds is minimal when it occurs, as illustrated by Figure 3. The volume of dry boric acid deposited has typically been less than one cubic inch, which is indicative of a leak that occurs over a relatively short period of time and then stops.

When a suspected leaking lower canopy seal weld is identified following the supplemental visual examination, WCGS installs a Canopy Seal Clamp Assembly (CSCA) (References 6 and 7). Figure 4 is a sketch of the CSCA design utilized at WCGS. The CSCAs are designed and fabricated as Class 1 components to the 1986 Edition of the ASME B&PV Code, Section III (Reference 8). Construction Code date reconciliation has been performed to document the acceptability of using a later edition of the Construction Code for the CSCAs (Reference 9)

In the CSCA design, a large ring of Grafoil™ (graphite) sealant that is compressed against the canopy seal weld region provides the barrier against fluid leakage. The Grafoil™ is held in place by the seal carrier halves, top and bottom housings, and attachment cap screws.

The CSCA is designed to be installed remotely from above the CRDM housings. The installation is typically performed with the reactor vessel head removed from the reactor vessel and on the head stand. This approach is cost effective and minimizes the radiation dose during the repair process.

Another possible outcome of an inspection that initially identifies an area of interest could be a determination that the observed boric acid originates from another source, such as leakage from another component. This appears to be the case for dry boric acid buildup observed on the weld area of the canopy seal weld on #5 penetration, which was identified during the BACINS visual examination early in refueling outage 12. The source of the boric acid was from an adjacent canopy seal weld, which was repaired. Following cleaning of #5 canopy seal weld while the RV head was on the head stand, an enhanced visual examination of the canopy seal weld area was performed. This visual examination did not identify any relevant indications, and this penetration was not repaired.

WCNOC's 15-day response to NRC Bulletin 2002-01 (Reference 10) included a discussion on penetration assembly columns with suspected leaking lower canopy seal welds. The following table lists the columns (by associated RV head penetration numbers) on which a CSCA has been installed.

Year	Outage	Clamped Penetrations IDs
1992	Mid-cycle	#24, #25
1993	RF-6	#29
1999	RF-10	#13, #27, #28
2002	RF-12	#10, #22

WCGS has not experienced lower canopy seal weld leakage of sufficient quantity for the boric acid to travel down the penetration, through the insulation, and to the carbon steel surfaces of the reactor vessel head. A 100% bare metal visual examination of the reactor vessel head carbon steel surfaces in refueling outage 12 confirmed that there is no degradation of the reactor vessel carbon steel head. The limited amount of boric acid residue identified on the RV head during this examination did not affect the vessel head in any manner.

References:

1. ASME Boiler and Pressure Vessel Code, Section III, 1971 Edition through Winter 1972 Addenda
2. Westinghouse Owners Group WCAP 12088, Metallurgical Failure Analysis of Leaking Canopy Seals, January 1989. [WOG Proprietary.]
3. Westinghouse Electric Report MED-PCE-11788, Summary Report Prepared to Assist WCNOC in Addressing the Wolf Creek Reactor Pressure Vessel Head Adapter Canopy Leakage Issue, February 1992. [Westinghouse Proprietary.]
4. Wolf Creek Hardware Failure Analysis Request (HFAR) MA 92-008, March 1992
5. Letter ET 02-0021, dated May 16, 2002, from Gary B. Fader, WCNOC to USNRC.
6. Wolf Creek Document #M-709-00090, Technical Manual for Installation, Removal, and Spare Parts for CSCAs
7. WC Design Change Package 05017, Canopy Seal Clamp Assemblies
8. ASME Boiler and Pressure Vessel Code, Section III, 1986 Edition, no Addenda
9. Wolf Creek Document M-709-00089-W01, ABB/CE Design Report MISC-ME-DR-023 for Canopy Seal Clamp Assemblies
10. Letter ET 02-0018, dated April 3, 2002, from Richard A. Muench, WCNOC to USNRC.

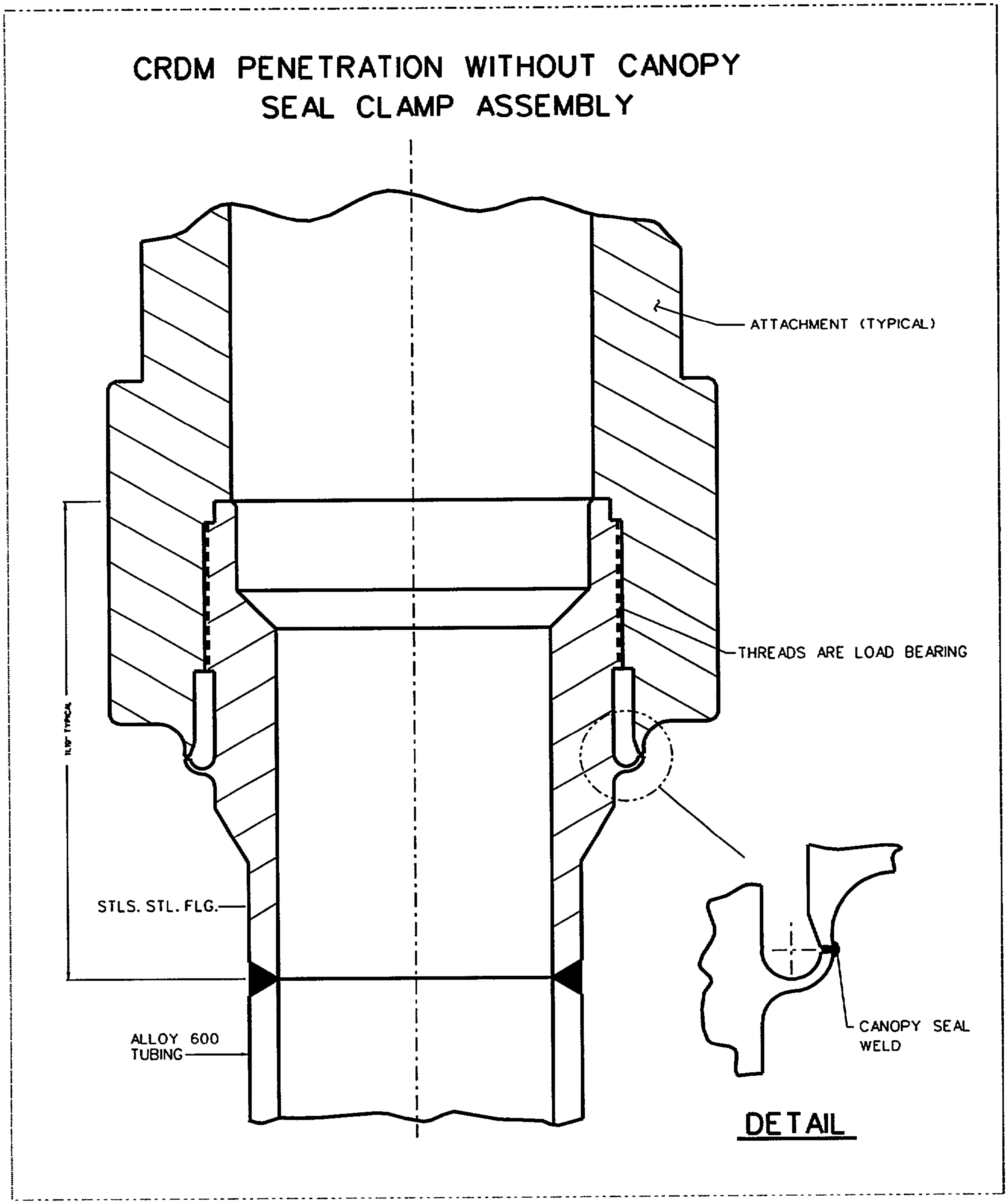

Figure 1. Typical Reactor Pressure Vessel Head Penetration Construction Illustrating Flange, Tube, and Attachment Relationship

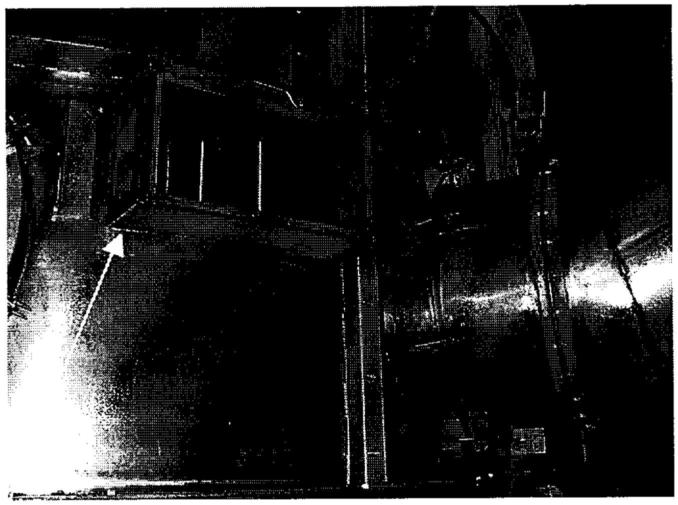

Figure 2. Viewing Port in the CRDM Cooling Shroud (with the head on vessel)

Figure 3. Typical Visual Indication of Leakage from Canopy Seal Weld Area

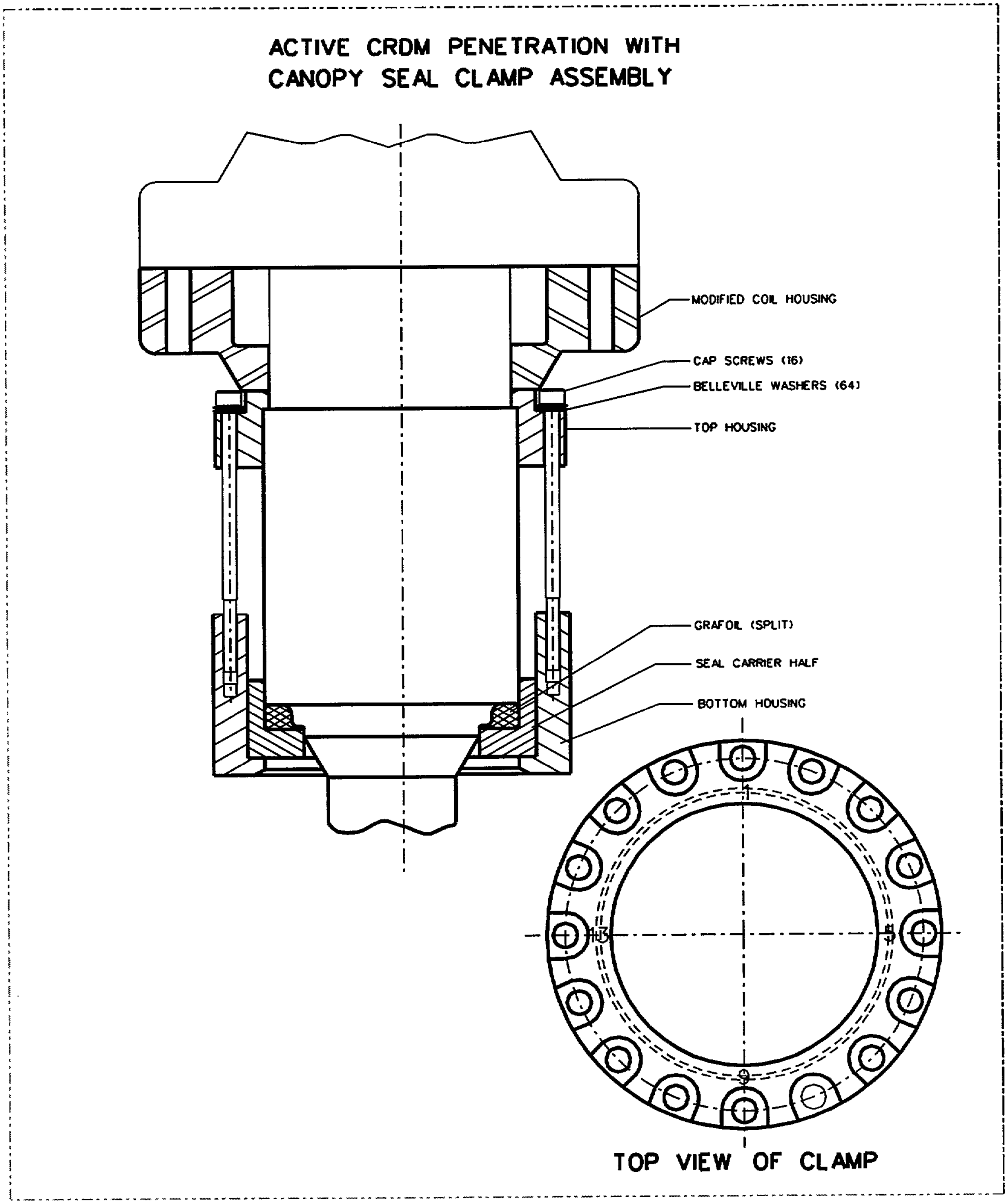

Figure 4. Typical Canopy Seal Clamp Assembly Cutaway