SUMMARY

The original reactor vessel heads for DC Cook Unit 1 and 2 were replaced in 2006 and 2007, respectively. The replacement heads featured new designs for the thermocouple sealing assembly and reactor vessel head vent penetration.

Subsequent to the head replacements, Cook's owner (I&M) reported recurring leakage from the thermocouple sealing assembly and reactor vessel head vent that resulted in boric acid residue collecting on the heads. Such leakage sources were not found to have repeatedly occurred prior to the replacements. Thus, it appears that the new head designs introduced this mode of leakage. The safety evaluations prepared for the head replacements apparently failed to detect this new failure mode, or the increased likelihood that a previously analyzed failure mode (i.e., unidentified leakage) would result.

Despite repeatedly documenting problems with leakage from the thermocouple sealing assembly and reactor vessel head vent line in the corrective action program, no apparent efforts were undertaken until very recently (circa 2018) to resolve the problems. I&M has not yet completed its investigation into why the problems, which itself labeled "unacceptable," were acceptable to so many persons for so many years. Had I&M fixed the problems then, it would not be in a self-induced dilemma now.

Now, I&M seeks the Nuclear Regulatory Commission's (NRC's) permission to skip mandated examinations of control rod drive mechanism nozzles for cracks, pleading hardship. These nozzles, if cracked through wall, may be the source of the boric acid residue found on the outer surface of the Unit 1 reactor vessel head. Leakage from the thermocouple sealing assembly is allowable, as long as it remains below 0.8 gallons per minute when combined with other leaks from unidentified sources. Leakage from the nozzles is not allowable — any leakage requires that the reactor be shut down within hours.

I&M "justifies" its request based on the fact that the Unit 1 head was replaced in 2006 with a new and improved design. I&M fails to mention that this "new and improved" design also featured new designs for the thermocouple sealing assembly and reactor vessel head vent penetration. Those design changes introduced recurring leakage problems – perhaps explaining why I&M is silent about these facts.

I&M further "justifies" its request based on its operational leakage monitoring program. But in doing so, I&m either ignores or improperly dismisses a lesson learnable from the Davis-Besse nozzle leakage case. The operational leakage monitoring program failed to detect years of nozzle leakage at Davis-Besse, raising very reasonable doubts as to why it might work now at Cook should a nozzle or two leak.

It would be a undue burden on public health and safety for the NRC to approve the relief request sought by I&M when the situation is self-inflicted by years of willful neglect by the company.

Attached are excerpts from I&M and NRC documents supporting the conclusions stated above.

David Lochbaum
October 7, 2020

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 4 first full paragraph:

The I&M qualified examiner concluded that the relevant conditions did not have active leakage characteristics because the pattern of residue on the nozzles was not consistent with the traditional patterns seen in Control Rod Drive Mechanisms (CRDM) nozzle leaks based on Reference 9. A review of previous inspection results showed similar levels of corrosion, boric acid deposits, and discoloration, although the U1C30 inspection did identify more nozzles with relevant conditions. The leakage is understood to be from the in-core instrumentation (ICI) thermocouple sealing assembly (TECSA) and outage worker practices related to head vent piping removal and refueling activities. Although the sources of leakage provide the likely cause of the conditions, based on the guidance in RIS 2018-06, it could not absolutely be refuted that the relevant conditions identified in the as-found examination were not masking relevant conditions indicative of nozzle leakage.

POINT: I&M contends that the boric acid residue found on the Cook Unit 1 reactor vessel head comes from TECSA leakage and leakage when workers remove the reactor vessel head vent piping and NOT from cracked and leaking CRDM nozzle(s).

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 7 first bulleted paragraph:

The thermocouple columns are a part of Upper Internal Equipment and allow the core thermocouples to pass through the RVCH. The TECSA mounts on the thermocouple nozzle adapter on the RVCH. The TECSA function is to maintain the RCS pressure boundary and support the thermocouple column. The TECSA have been prone to leak at low pressures. I&M has documented TECSA leakage in the corrective action program on previous occasions. Discussions with the seal vendor indicated that "transient weepage" can to occur from the TECSA at lower pressures and the leakage stops at normal operating pressure. The weepage from the TECSA seals has flowed down the ICI tubes, over the penetrations and down the RVCH. The TECSA leakage contributes to the conditions identified on Nozzle Penetrations 74, 75, 76, 77, and 79.

POINT: I&M concedes that TECSA leakage has been a recurring problem affecting multiple CRDM nozzles. I&M further concedes that TECSA leakage has been entered into the corrective action program on numerous occasions.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Attachment 1 to Enclosure 1, page 3 last paragraph:

PENETRATION 74
Relevant Condition – Boric Acid Deposits
Location – Azimuth 337.5°
Leakage pathway(s) – TECSA, ICI tube cut-out

Penetration 74 is an ICI penetration, with a known history of TECSA leakage (as evidenced by the staining down the ICI tube). This leakage, along with spillage from the associated ICI tube cut-out, has resulted in light boric acid deposits at the penetration.

POINT: This reactor vessel head penetration has experienced boric acid deposits attributed to TECSA leakage on multiple occasions in the past.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Attachment 1 to Enclosure 1, page 4 first paragraph:
PENETRATION 75 **Relevant Condition – Areas of Corrosion, Boric Acid Deposits, Discoloration** **Location – Azimuth 22.5°** **Leakage pathway(s) - TECSA, insulation panel seam, ICI tube cut-out** **Penetration 75 is an ICI penetration, with a known history of TECSA leakage (as evidenced by the staining down the ICI tube). This leakage, along with spillage flowing from the insulation seam shared with Penetrations 10, 23, and 64 and the associated ICI tube cut-out, has resulted in areas of corrosion, light boric acid deposits, and discoloration at the penetration.**
POINT: This reactor vessel head penetration has experienced boric acid deposits attributed to TECSA leakage on multiple occasions in the past.
Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Attachment 1 to Enclosure 1, page 4 second paragraph:
PENETRATION 76 **Relevant Condition – Areas of Corrosion, Boric Acid Deposits** **Location - Azimuth 67.5°** **Leakage pathway(s) - TECSA, ICI tube cut-out** **Penetration 76 is an ICI penetration, with a known history of TECSA leakage (as evidenced by the staining down the ICI tube). This leakage, along with spillage from the associated ICI tube cut-out, has resulted in areas of corrosion and light boric acid deposits at the penetration.**
POINT: This reactor vessel head penetration has experienced boric acid deposits attributed to TECSA leakage on multiple occasions in the past.
Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Attachment 1 to Enclosure 1, page 4 third paragraph:
PENETRATION 77 **Relevant Condition – Boric Acid Deposits, Discoloration** **Location - Azimuth 157.5°** **Leakage pathway(s) - TECSA, ICI tube cut-out** **Penetration 77 is an ICI penetration, with a known history of TECSA leakage (as evidenced by the staining down the ICI tube). This leakage, along with spillage from the associated ICI tube cut-out, has resulted in light boric acid deposits and discoloration at the penetration.**
POINT: This reactor vessel head penetration has experienced boric acid deposits attributed to TECSA leakage on multiple occasions in the past.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Attachment 1 to Enclosure 1, page 4 fourth paragraph:

PENETRATION 79
Relevant Condition – Boric Acid Deposits
Location - Azimuth 247.5°
Leakage pathway(s) - TECSA, ICI tube cut-out

Penetration 79 is an ICI penetration, with a known history of TECSA leakage (as evidenced by the staining down the ICI tube). This leakage, along with spillage from the associated ICI tube cut-out, has resulted in light boric acid deposits at the penetration.

POINT: This reactor vessel head penetration has experienced boric acid deposits attributed to TECSA leakage on multiple occasions in the past.

NRC Regulatory Guide 1.45 dated 05-2008 (ML073200271) pages 2-3:

RCPB leakage is leakage from a nonisolable fault in the material of an RCS component, pipe wall (including welds), or vessel wall. Leakage from seals, gaskets, and mechanical connections (e.g., bolts, valve seals) is not considered RCPB leakage although these components are part of the RCPB, as defined in 10 CFR 50.2, "Definitions" (Ref. 2). Thus, RCPB leakage is indicative of degradation of pressure-retaining components that could ultimately result in a loss of component structural integrity.

POINT: TECSA leakage is apparently not considered to be reactor coolant pressure boundary (RCPB) leakage. CRDM nozzle leakage would be RCPB leakage.

DC Cook Unit 1 Technical Specification 3.4.13:

3.4.13 RCS Operational LEAKAGE

LCO 3.4.13 RCS operational LEAKAGE shall be limited to:

a. No pressure boundary LEAKAGE;

b. 0.8 gpm unidentified LEAKAGE;

c. 10 gpm identified LEAKAGE; and

d. 150 gallons per day primary to secondary LEAKAGE through any one steam generator (SG).

APPLICABILITY: MODES 1, 2, 3, and 4.

POINT: Zero RCPB leakage is permitted in Modes 1, 2, 3 and 4 while 0.8 gallons per minute (gpm) of unidentified leakage and 10 gpm of identified leakage are allowed.

DC Cook Unit 1 Technical Specification 3.4.13 Action D:

D. Required Action and associated Completion Time of Condition A, B, or C not met. OR Pressure boundary LEAKAGE exists. OR Primary to secondary LEAKAGE not within limit.	D.1 AND D.2	Be in MODE 3. Be in MODE 5.	6 hours 36 hours

POINT: Any RCPB leakage during Modes 1 and 2 requires that the unit be hot standby (Mode 3) within dix hours and placed in cold shutdown (Mode 5) within 36 hours. Shutdown is only required when unidentified and identified leak rates cannot be reduced within Technical Specification limits within the specified time period.

DC Cook Unit 1 Technical Specification Table 1.1:

Table 1.1-1 (page 1 of 1)
MODES

MODE	TITLE	REACTIVITY CONDITION (k_{eff})	% RATED THERMAL POWER[a]	AVERAGE REACTOR COOLANT TEMPERATURE (°F)
1	Power Operation	≥ 0.99	> 5	NA
2	Startup	≥ 0.99	≤ 5	NA
3	Hot Standby	< 0.99	NA	≥ 350
4	Hot Shutdown[b]	< 0.99	NA	350 > T_{avg} > 200
5	Cold Shutdown[b]	< 0.99	NA	≤ 200
6	Refueling[c]	NA	NA	NA

POINT: Self evident.

NRC Inspection Report dated 02-12-2007 (ML070450022) Enclosure, page 4 first paragraph:

From September 5 through September 8, 2006, from September 25 through September 29, 2006, and from October 10 through October 13, 2006, the inspectors reviewed the licensee's screening documents for the design changes associated with the Unit 1 RVCH replacement to determine, for each change, whether the requirements of 10 CFR 50.59 had been appropriately applied. Specifically, the inspector reviewed 1-MOD-55520, "Replace Unit 1 Reactor Vessel Closure Head (1-OME-1)," which included a review of the function of each changed component, the change description and scope of one 10 CFR 50.59 screening for the following changes:

- new RVCH constructed from a single piece forging;
- new RVCH J-grove weld profile;
- elimination of twelve spare "dummy" penetrations;
- elimination of one spare thermocouple penetration;
- elimination of seven part length control rod drive mechanism (CRDM) penetrations;
- new CRDM mechanical assemblies;
- new thermocouple column sealing assemblies (TECSA) replace core exit thermocouple columns;
- new dedicated reactor vessel level instrumentation system (RVLIS) penetration nozzle;
- new dedicated reactor vessel head vent (RVHV) penetration nozzle; and
- the use of Inconel Alloy 600 was prohibited in fabrication of the new RVCH. For example, the penetration tube material was changed from Inconel Alloy 600 to Inconel Alloy 690 which is more resistant to primary water stress corrosion cracking.

POINT: The reactor vessel closure head (RVCH) on DC Cook Unit 1 was replaced during a refueling outage in fall 2006 with a new head.

NRC Inspection Report dated 02-12-2007 (ML070450022) Enclosure, page 41 first paragraph:

The design of the Unit 1 replacement RVCH is similar to the original, with some notable exceptions including:

- the new RVCH is constructed from a single piece forging;
- the new RVCH design has an improved J-grove weld profile;
- the new RVCH design eliminates twelve spare "dummy" penetrations;
- the new RVCH design eliminates one spare thermocouple penetration;
- the new RVCH design eliminates seven part length CRDM penetrations;
- new CRDM mechanical assemblies;
- new TECSAs replace core exit thermocouple columns;
- the new RVCH design has a dedicated RVLIS penetration nozzle;
- the new RVCH design has a dedicated reactor RVHV penetration nozzle; and

POINT: The replacement reactor vessel head involved a design change from the original head in that the TECSAs replaced the core exit thermocouple columns. In addition, the replacement head featured a decided head vent penetration nozzle.

NRC Inspection Report dated 01-24-2008 (ML080250115) Enclosure, page 9 first paragraph:

From June 11 through June 15, 2007, and from June 25 through June 29, 2007, the inspector reviewed licensee documents for the design changes associated with the Unit 2 RVCH replacement to determine, for each change, whether the requirements of 10 CFR 50.59 had been appropriately applied. Specifically, the inspector reviewed modification 2-MOD-55516, "Replace Unit 2 Reactor Vessel Closure Head (2-OME-1)," which included a review of the function of each changed component, the change description, and the scope of one 10 CFR 50.59 screening for the following changes:

- new RVCH constructed from a single piece forging;
- new RVCH J-grove weld profile;
- elimination of twelve spare "dummy" penetrations;
- elimination of seven part length control rod drive mechanism (CRDM) penetrations;
- new CRDM mechanical assemblies;
- new thermocouple column sealing assemblies (TECSA) replace core exit thermocouple column assemblies;
- new dedicated reactor vessel head vent (RVHV) penetration nozzle;
- modification of o-ring retainer clip assembly; and

POINT: The reactor vessel closure head (RVCH) on DC Cook Unit 2 was replaced during a refueling outage in 2007 with a new head.

NRC Inspection Report dated 01-24-2008 (ML080250115) Enclosure, pages 42-43:

The design of the Unit 2 replacement RVCH is similar to the original, with some notable exceptions including:

- the new RVCH is constructed from a single piece forging;
- the new RVCH design has an improved J-grove weld profile;
- the new RVCH design eliminates twelve spare "dummy" penetrations;
- the new RVCH design eliminates seven part length CRDM penetrations;
- new CRDM mechanical assemblies;
- new TECSAs replace core exit thermocouple column assemblies;
- the new RVCH design has a dedicated reactor RVHV penetration nozzle;

POINT: The replacement reactor vessel head involved a design change from the original head in that the TECSAs replaced the core exit thermocouple columns. In addition, the replacement head featured a decided head vent penetration nozzle.

Indiana Michigan letter dated April 1, 2002 (ML020930113) Attachment 1, page 4 fourth paragraph:

A 100 percent bare metal inspection of the reactor vessel head has not been performed. However, in 1994, using a remote camera, a bare metal inspection of the 34 outermost penetrations was performed to detect evidence of RCS leakage. No leakage from the vessel head was detected during this examination. During the same outage, three canopy seal weld leaks that had been identified were repaired. Three panels of insulation were moved or removed for boric acid cleaning. The majority of the boric acid was cleaned, but minor amounts of dried boric acid crystals were allowed to remain on the head. Upon completion of cleaning, a bare metal VT-1 examination of these areas was performed using both direct visual and a remote camera system. The VT-1 examination was found to be acceptable. The three leaking canopy seal welds were repaired prior to returning Unit 1 to power.

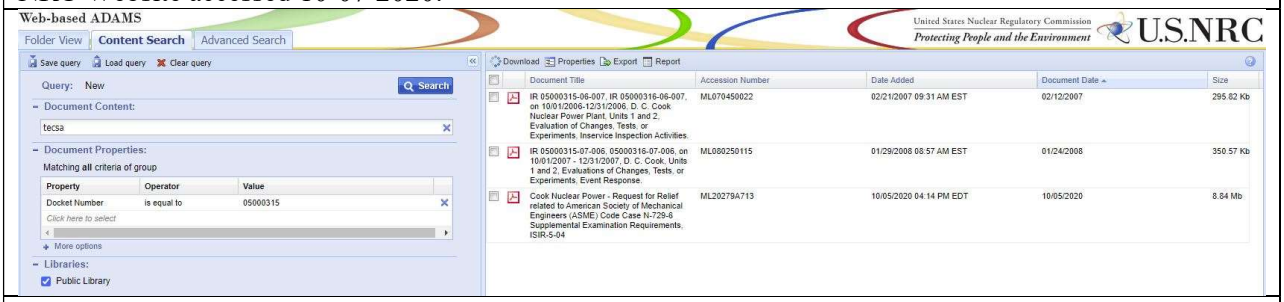
POINT: Records in NRC's ADAMS library were searched for information about leakage prior to the replacement of the reactor vessel head on Unit 1 in fall 2006 and on Unit 2 the following year. The only record found suggests that while some leakage from canopy seal welds had been experienced with the original reactor vessel head, it was not an atypical event. In other words, in-core thermocouple column assemblies and the reactor vessel head vent connection were not found to have been reported as sources of leakage prior to the replacement of the reactor vessel heads.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 8 first bulleted paragraph:

- **In 2018, a new parts vendor was utilized to provide the TECSA components. I&M identified issues with existing part quality and vendor instruction. The new parts, which were receipt inspected against quality requirements, are being installed beginning in U1C30.**
- **Beginning in U1C29, the methodology for the TECSA inspection was changed to allow for performing the TECSA inspections when the RVCH is removed and on the stand. This allows greater access during the inspection and cleaning of the seating surfaces. Following implementation of this new inspection method leakage was not observed in the subsequent startup.**
- **I&M also initiated a corrective action to determine why the continuing TECSA leakage was not corrected earlier.**

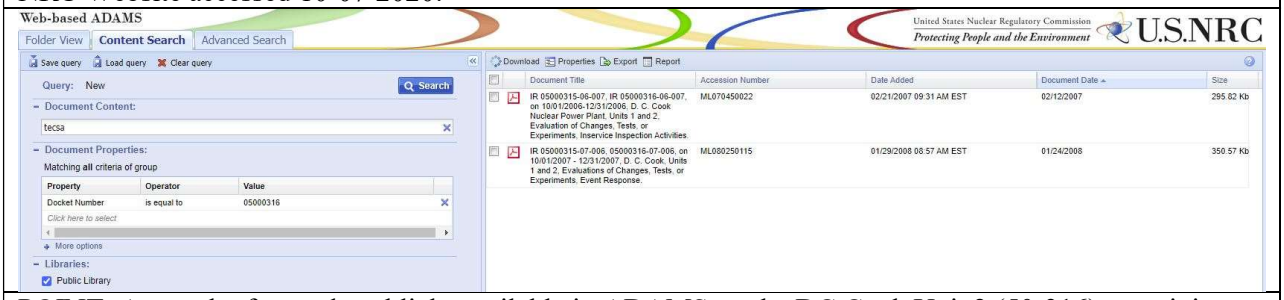
POINT: If, as I&M contends, "leakage [from the TECSAs] was not observed in the subsequent startup" after a new inspection method was implemented beginning in U1C29, why is TECSA leakage now being cited as the source for the boric acid residue atop the Unit 1 reactor vessel head? As noted above, I&M contends that TECSA leakage affecting multiple CRDM nozzles has been a recurring problem. I&M states that a corrective action was initiated to determine why the continuing TESCA leakage was not corrected sooner. This vital question should be answered BEFORE any relief request can be granted.

NRC Website accessed 10-07-2020:



POINT: A search of records publicly available in ADAMS on the DC Cook Unit 1 (50-315) containing the phrase "TECSA" returned just three records (the two aforementioned NRC inspection reports and the recent relief request). The search did NOT return any Updated Final Safety Analysis Report or 10 CFR 50.59 annual summary reports mentioning TECSA as might be expected since the replacement heads are of a different design.

NRC Website accessed 10-07-2020:



POINT: A search of records publicly available in ADAMS on the DC Cook Unit 2 (50-316) containing the phrase "TECSA" returned just two records (the aforementioned NRC inspection reports). The search did NOT return any Updated Final Safety Analysis Report or 10 CFR 50.59 annual summary reports mentioning TECSA as might be expected since the replacement heads are of a different design.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 7 second bulleted paragraph:

A dedicated nozzle, near the center of the reactor head, connects to vent piping, which vents to the upper containment volume to provide reactor vessel head venting of non-condensable gas while maintaining adequate core cooling and containment integrity. The vent pipe is removed upon entering into each outage. When removing the head vent piping, water has been shown to leak from the flanged connection and associated hose onto the head. The leakage has resulted in multiple flow lines of light corrosion and diffuse boric acid deposits. Previous cleaning of these flow lines has left patches of discoloration on general areas and around the CRDM penetrations in the flow paths. During removal, the orientation of the flanged connection and piping is not always in the exact same location. Variations in worker preferences, during each outage, has caused multiple spill locations. The worker practices are identified to contribute to all of the 17 identified penetrations and general areas on the RVCH.

POINT: I&M contends that workers have repeatedly leaked borated water onto the reactor vessel head when removing the head vent piping.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 8 second bulleted paragraph:

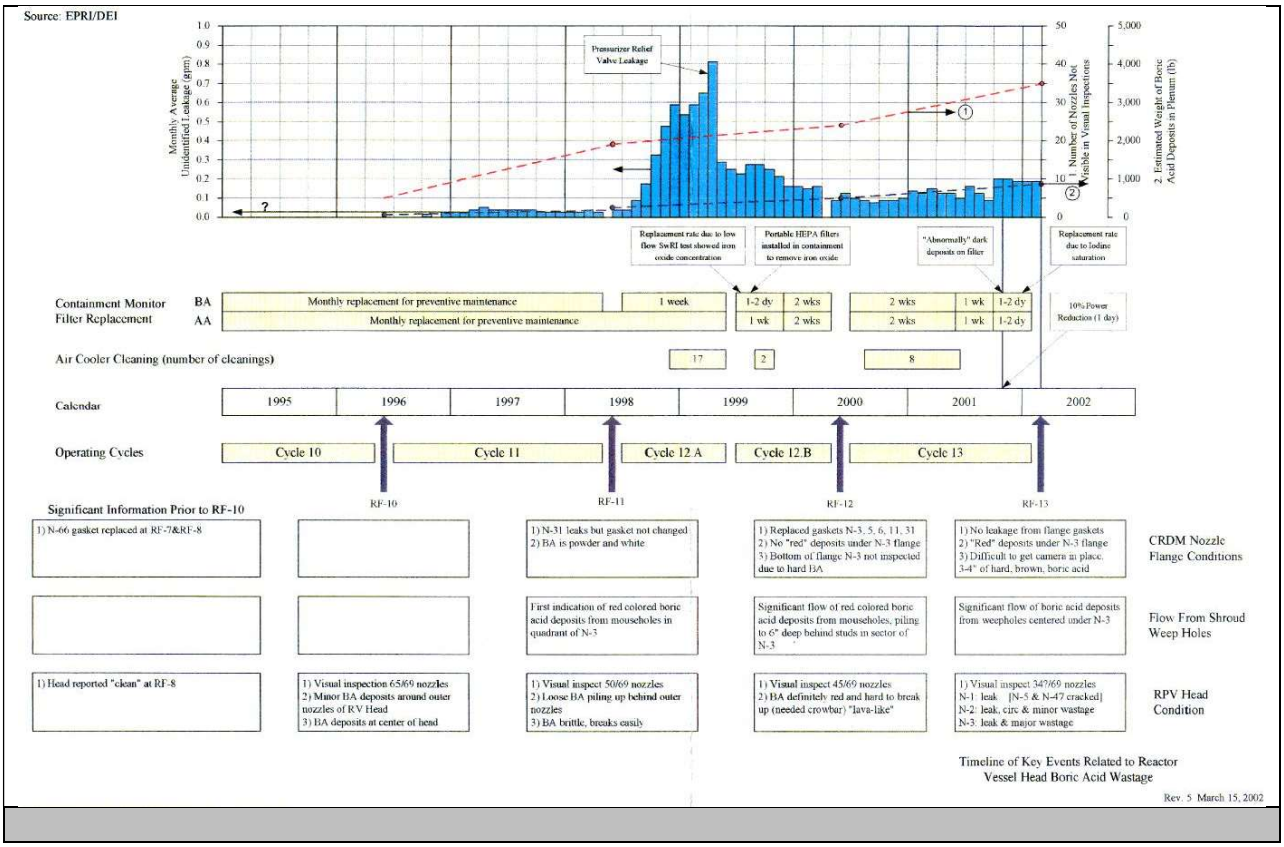
- **I&M recently changed contractors supporting vent pipe removal and have implemented corrective actions to ensure prevention of spillage on the head. I&M oversight continually reinforces the standard that vent pipe leakage is unacceptable.**
- **I&M initiated a corrective action to provide training to eliminate worker practices that lead to vent water inadvertently contacting the head.**

POINT: If, as I&M contends, "I&M oversight continually reinforces the standard that vent pipe leakage is unacceptable, why has I&M repeatedly accepted vent pipe leakage? As noted above, I&M contends that TECSA leakage affecting multiple CRDM nozzles has been a recurring problem. I&M states that a corrective action was initiated to actually train workers performing this practice. Workers performing this task should be trained on how to do it properly BEFORE performing the task improperly.

Cook 1 Relief Request dated 10-05-2020 (ML20279A713) Enclosure 1, page 9 last paragraph:

CNP leakage detection program serves two distinct purposes related to this relief request. The first purpose is to support the conclusion that a RVCH nozzle leak does not currently exist. The operational leakage for CNP was reviewed for the previous 15 months. The unidentified leakage over this entire period was between 0 and 0.05 gpm. There was no increase in RCS leakage that would be indicative of a through wall leak of the RVCH nozzles.

POINT: I&M reports that unidentified leakage over the past 15 months varied between 0 and 0.05 gpm, concluding that there was "no increase in RCS leakage that would be indicative of a through wall leak of the RVCH nozzles." This conclusion is invalid for at least two reasons. First, Technical Specification 3.4.13 allow zero (0) nozzle leakage. Zero. None. Hence, unidentified leakage of 0.05 gpm could very well be coming from a through wall nozzle leak. Second, the conclusion either ignores or dismisses a key lesson learnable from the Davis-Besse near-miss. The chart below was prepared by FirstEnergy following discovery in spring 2002 of significant reactor vessel head degradation at Davis-Besse. It plots unidentified leakage from 1995 to 2002, inclusive. For much of that period, the leak rate was less than 0.05 gpm. There was a significant increase attributed to pressurizer relief valve leakage. The chart dates back to 1995 because FirstaEnergy and its consultants estimated that CRDM nozzle cracking and associated leakage could have begun six years prior to discovery in spring 2002. During refueling outage 11 (RF-11) in 1998, workers noted the "First indication of red-colored boric acid deposits from mouseholes." The red-colored deposits and unidentified leak rates failed to prevent reactor operation until March 2002. This alleged indicator did not work in the past and cannot be relied upon to work in the future.


Source: EPRI/DEI
Monthly Average Unidentified Leakage (gpm)
1. Number of Nozzles Not Visible in Visual Inspections
2. Estimated Weight of Boric Acid Deposits in Plenum (lb)
Pressurizer Relief Valve Leakage
Replacement rate due to low flow SwRI test showed iron oxide concentration
Portable HEPA filters installed in containment to remove iron oxide
"Abnormally" dark deposits on filter
Replacement rate due to iodine saturation
Containment Monitor Filter Replacement
BA
AA
Monthly replacement for preventive maintenance
1 week
1-2 dy
2 wks
1 wk
2 wks
2 wks
1 wk
1-2 dy
10% Power Reduction (1 day)
Air Cooler Cleaning (number of cleanings)
17
2
8
Calendar
1995
1996
1997
1998
1999
2000
2001
2002
Operating Cycles
Cycle 10
Cycle 11
Cycle 12 A
Cycle 12 B
Cycle 13
RF-10
RF-11
RF-12
RF-13
Significant Information Prior to RF-10
1) N-66 gasket replaced at RF-7&RF-8
1) N-31 leaks but gasket not changed
2) BA is powder and white
1) Replaced gaskets N-3, 5, 6, 11, 31
2) No "red" deposits under N-3 flange
3) Bottom of flange N-3 not inspected due to hard BA
1) No leakage from flange gaskets
2) "Red" deposits under N-3 flange
3) Difficult to get camera in place. 3-4" of hard, brown, boric acid
CRDM Nozzle Flange Conditions
First indication of red colored boric acid deposits from mouseholes in quadrant of N-3
Significant flow of red colored boric acid deposits from mouseholes, piling to 6" deep behind studs in sector of N-3
Significant flow of boric acid deposits from weepholes centered under N-3
Flow From Shroud Weep Holes
1) Head reported "clean" at RF-8
1) Visual inspection 65/69 nozzles
2) Minor BA deposits around outer nozzles of RV Head
3) BA deposits at center of head
1) Visual inspect 50/69 nozzles
2) Loose BA piling up behind outer nozzles
3) BA brittle, breaks easily
1) Visual inspect 45/69 nozzles
2) BA definitely red and hard to break up (needed crowbar) "lava-like"
1) Visual inspect 347/69 nozzles
N-1: leak [N-5 & N-47 cracked]
N-2: leak, circ & minor wastage
N-3: leak & major wastage
RPV Head Condition
Timeline of Key Events Related to Reactor Vessel Head Boric Acid Wastage
Rev. 5 March 15, 2002