



# Union of Concerned Scientists

Citizens and Scientists for Environmental Solutions

## Davis-Besse: One Year Later

Nearly one year ago, on March 6, 2002, workers repairing a cracked control rod drive mechanism (CRDM) nozzle at the Davis-Besse Nuclear Power Station in Ohio discovered a football-sized cavity in the reactor vessel head.<sup>1</sup> Their finding is linked to two other discoveries 15 years earlier. On March 13, 1987, workers at Turkey Point Unit 4 in Florida discovered that a small leak of borated water had corroded the reactor vessel head. Their revelation prompted the Nuclear Regulatory Commission (NRC) to require all owners of pressurized water reactors, including Davis-Besse, to take specific measures to protect plant equipment from boric acid corrosion.<sup>2</sup> On March 24, 1987, the NRC learned that control room operators at the Peach Bottom Atomic Power Station in Pennsylvania had been discovered sleeping while on duty. That revelation prompted the NRC to issue an order on March 31<sup>st</sup> requiring Peach Bottom Unit 3 to be immediately shut down.<sup>3</sup>

The three findings spanning 15 years are intertwined. Turkey Point demonstrated that a small amount of boric acid leaking onto the reactor vessel head corrodes carbon steel at a high rate. Had the FirstEnergy Nuclear Operating Company, the owner of Davis-Besse, remembered Turkey Point's lesson, the serious damage at Davis-Besse would have been averted. Peach Bottom demonstrated that a pervasive safety culture problem creates unacceptable conditions for operating a nuclear power plant. Had NRC remembered either Turkey Point's or Peach Bottom's lesson, they would have issued the order they drafted to shut down Davis-Besse. It would have been the first shut down order issued by the agency since the Peach Bottom order. But both FirstEnergy and the NRC forgot the past and relived the wrong event from March 1987 by having yet another reactor vessel head damaged by boric acid corrosion.

Many individuals, from both within and outside the NRC, have accused the agency's move towards risk-informed decision-making as the reason for its failure to issue the order to shut down Davis-Besse. On the contrary, the NRC's handling of circumferential cracking of control rod drive mechanism (CRDM) nozzles as reported by the Oconee nuclear plant in February 2001 was a successful demonstration of proper application of risk-informed decision-making — with the sole and significant exception of its mistake in not issuing the shut down order for Davis-Besse. But even that mistake, as bad as it was, does not impugn the risk-informed decision-making process for the simple reason that the NRC deviated from that process. Had the NRC adhered to its risk-informed decision-making process, it would have issued the shut down order for Davis-Besse and capped off a stellar example of how this process can and should be used.

In February 2001, the NRC learned of a new aging mechanism, the circumferential cracking of stainless steel CRDM nozzles based on inspection results from Oconee. The NRC properly reacted to this finding by revisiting the nuclear industry's inspection regime for CRDM nozzles. It determined that the existing inspection regime did not provide adequate assurance that circumferential cracks would be identified and repaired. The NRC did not require all plant owners to immediately address this inspection shortfall, which would have imposed an unnecessary regulatory burden on those plants with low susceptibility for the problem. Nor did the NRC allow all plant owners to address the shortfall at their next regularly scheduled refueling outage, which would have imposed an unnecessary challenge to safety margins at those plants with high susceptibility. Instead, the NRC applied risk-informed decision-making by issuing Bulletin 2001-01 in August 2001 to all owners of pressurized water reactors. This Bulletin required the high

susceptible reactors to resolve the inspection shortfall by December 2001, the medium susceptible reactors to resolve the inspection shortfall at their next regularly scheduled outage, and merely collected information from the low susceptible reactors.

Only two reactors with high susceptibility for circumferential cracking of CRDM nozzles did not conform to the inspection requirements of Bulletin 2001-01: D.C. Cook Unit 2 and Davis-Besse. The NRC applied risk-informed decision-making to these two exceptions. The NRC determined there was adequate assurance that D.C. Cook Unit 2 could safely operate until its scheduled refueling outage beginning January 19, 2002. The NRC determined it lack adequate assurance that Davis-Besse could safely operate past December 31, 2001, and sent a proposed shut down order up to its Commissioners.

At this point, the NRC abandoned its risk-informed decision-making process. The FirstEnergy Nuclear Operating Company, the owner of Davis-Besse, was prepared to contest an order. Rather than fight, the NRC switched to a compromise where Davis-Besse would be allowed to operate until its rescheduled refueling outage beginning February 16, 2002. To balance the increased likelihood of a meltdown, the NRC required FirstEnergy to implement a number of compensatory measures at Davis-Besse.

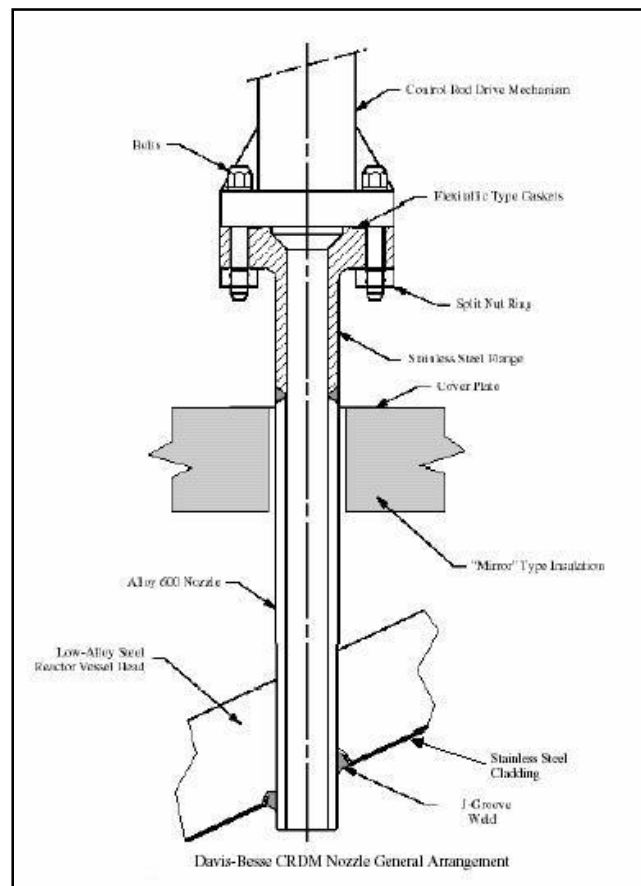
Had the NRC issued the shut down order, it would not have prevented the gaping cavity in the reactor vessel head at Davis-Besse. It would simply have meant that the cavity would have been found sooner. More importantly, it would have meant that the reactor would have been operated for less time with that serious problem. Most importantly, it would have been abiding by the risk-informed decision-making process under all conditions, not just when it is convenient and popular.

This paper examines the reasons why the NRC did not issue the shut down order for Davis-Besse.

### CRDM Nozzle Cracking Background

Control rods regulate the nuclear chain reaction inside the reactor core. Control rods are moved into the reactor core to slow or stop the chain reaction and are withdrawn to increase the chain reaction.

The physical movement of a control rod is performed by a control rod drive mechanism (CRDM). The CRDMs are located above the reactor vessel containing the reactor core. A metal rod links the control rod inside the reactor core to its CRDM outside the reactor vessel. The CRDM lifts the metal rod to withdraw the control rod and lowers the metal rod to insert the control rod. The CRDM nozzle is a stainless steel tube around the metal linking rod as it passes through the domed surface of the reactor vessel head. One end of the CRDM nozzle is bolted to the bottom end of the CRDM while the other end is welded to the stainless steel cladding on the inner surface of the reactor vessel head. Because the lower end of the CRDM nozzle is open inside the reactor vessel, borated water under high pressure fills the nozzle to the flange where it is bolted to the CRDM.



Workers inspecting the outer surface of the reactor vessel heat at Oconee Unit 3 in South Carolina on February 18, 2001, found boric acid crystals around 9 of the 69 CRDM nozzles.<sup>4</sup> The white “collars” shown in the picture were telltale signs that borated water had leaked through cracks in the CRDM



nozzles. It marked the first time that leaking CRDM nozzles had been identified at a U.S. reactor. It also was the first time that circumferential cracks (i.e. horizontal around the arc of the nozzle) had been identified in CRDM nozzles at a U.S. reactor. All cracks identified until then had not grown to the point of leaking and had been oriented axially (i.e., vertically along the length of the nozzle).

CRDM nozzle cracking had been monitored in both U.S. and foreign nuclear power plants for nearly a decade. Oconee's finding that CRDM nozzle cracking was taking on new dimensions by propagating to the point of leaking and growing in the circumferential direction prompted the NRC to revisit the accepted inspection regime. The NRC met with industry representatives on April 12, 2001, to discuss the issue.<sup>5</sup> In the ensuing discussions, the NRC placed the 69 operating pressurized water reactors into three susceptibility categories for Oconee-like cracking problems. The reactors that had already identified cracked CRDM nozzles along with the reactors within 5 operating years\* of Oconee Unit 3 were deemed to be highly susceptible. Reactors between 5 and 30 operating years of Oconee Unit 3 had moderate susceptibility. Reactors more than 30 operating years away from Oconee Unit 3 had low susceptibility.

On August 3, 2001, the NRC notified the owners of U.S. pressurized water reactors of its revised plans for CRDM nozzle cracking in light of the new Oconee phenomena. For the twelve reactors in the highly susceptibility category (Arkansas Nuclear One Unit 1 in Arkansas; D.C. Cook Unit 2 in Michigan; Davis-Besse in Ohio; North Anna Units 1 and 2 in Virginia; Oconee Units 1, 2, and 3 in South Carolina; Robinson Unit 2 in South Carolina; Surry Units 1 and 2 in Virginia; and Three Mile Island Unit 1 in Pennsylvania<sup>6</sup>), the NRC required either inspections by December 31, 2001, or technical bases for concluding that reactor did not and could not have circumferential CRDM nozzle cracks. The NRC gave owners 30 days to respond.

The plant owners submitted their responses to the NRC by September 4, 2001. Despite the tragic events of September 11, the NRC evaluated the responses for the 69 pressurized water reactors in about three weeks.<sup>7</sup>

Four of the highly susceptible reactors (North Anna Unit 1, Oconee Unit 3, Surry Unit 1, and Three Mile Island Unit 1) were being shut down in fall 2001 for refueling and/or maintenance outages and committed to conduct thorough inspections, termed qualified visual examinations, of 100 percent of their CRDM nozzles. Four other highly susceptible reactors (Arkansas Nuclear One Unit 1, Oconee Units 1 and 2, and Robinson Unit 2) had already performed qualified visual examinations of 100 percent of their CRDM nozzles at their most recent outages and used those inspection results as the technical bases for operating past December 31, 2001, to scheduled refueling outages in 2002. Two other highly susceptible reactors (North Anna Unit 2 and Surry Unit 2) were voluntarily shut down by their owner for unscheduled outages in late 2001 to conduct qualified visual examinations of 100 percent of their CRDM nozzles. That left only two highly susceptible reactors (D.C. Cook Unit 2 and Davis-Besse) that neither shut down in late 2001 for inspections nor relied on results from previous qualified visual inspections of their CRDM nozzles.<sup>8</sup>

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\* Operating years differed from calendar years because periods when the reactor was shut down were excluded and adjustments were made to compensate for the reactors running at various temperatures, which affects the growth rate for cracks.

D. C. Cook Unit 2 shut down on January 19, 2002, for refueling. Workers performed eddy current testing on the CRDM nozzles and identified three tiny axial cracks in a 1-inch by 2-inch area on the inside surface of CRDM Nozzle #74. The cracks were determined to be acceptable for continued service. No CRDM nozzles leaks were found and extensive nozzle repairs were not even necessary for the very minor cracks that were found.<sup>9</sup>

Davis-Besse shut down on February 16, 2002, for refueling. Inspections of the CRDM nozzles revealed several cracks. While workers were repairing CRDM Nozzle #3 on March 5<sup>th</sup>, the repair rig and nozzle shifted to the side. Investigating this unexpected movement the following day, workers discovered damage to the reactor vessel head. They removed boric acid crystals and corrosion products from the area to expose a large, gaping cavity in the reactor vessel head extending all the way down to the thin stainless steel liner. This veneer, not installed to be an integral part of the reactor coolant pressure boundary, luckily performed this function and kept the reactor cooling water inside the reactor vessel. Rather than attempt to repair the severe damage, FirstEnergy opted to replace the reactor vessel head with an unused one purchased from a cancelled nuclear power plant in Michigan.



The extensive damage to the reactor vessel head at Davis-Besse may have been unprecedented, but it was not unanticipated. Davis-Besse was the only reactor among the 69 pressurized water reactors within the scope of Bulletin 2001-01 covered by an order drafted by the NRC staff and formally transmitted by Samuel J. Collins, Director of the Office of Nuclear Regulation, to William D. Travers, Executive Director for Operations, with the stated intention of being issued five days after Dr. Travers informed the Commission.<sup>10</sup> Dr. Travers informed the Commission on November 21, 2001.<sup>11</sup> The proposed order would have required FirstEnergy to shut Davis-Besse down by December 31, 2001, for CRDM nozzle inspections. But the NRC failed to follow through with its stated intention. Instead, the agency reached a compromise with FirstEnergy on November 28, 2001, to allow Davis-Besse to continue operating until February 16, 2002.

Much has been written in the past year about the safety culture at Davis-Besse that permitted such a serious problem to develop. Consider the following conclusions:

*A corporate culture had been allowed to develop, from the top down, that down played, rejected, or ignored problems. Management was defensive from the top down. Problems frequently were not reported up the line organization, and those that were often were not dealt with effectively. The climate for this organizational behavior was set from the highest levels of corporate management.*

and

*It is clear to us that the problems ... are the direct result of the low standards and lack of accountability accepted by corporate, and, in fact, fostered on the plant by a lethargic and defensive corporate organization.*

and

*The situation that existed ... was worse than had been conveyed to the Industry Panel and to INPO by ... management. ... It is an embarrassment to the industry and the nation.<sup>12</sup>*

While these remarks may sound like they were written especially for Davis-Besse, they were actually penned nearly 15 years ago by the head of the Institute of Nuclear Power Operations about the Peach Bottom nuclear plant in Pennsylvania. The remarks are relevant today, not just because they fit the conditions at Davis-Besse like a glove but because they also mirror the NRC's regulatory reaction, then and now.

Then, the NRC Region I office received information on March 24, 1987, from a whistleblower that control room operators at Peach Bottom were sleeping while on duty. The NRC dispatched inspectors to the site who confirmed this information. On March 31, 1987, the NRC ordered Philadelphia Electric to shutdown Peach Bottom.<sup>13</sup> The NRC said it viewed the continued operation of the plant as "an immediate threat to the public health and safety."<sup>14</sup> It marked the last order to shut down an operating reactor issued by the NRC.

Now, the NRC received information in February 2001 from workers at Oconee that challenged the agency's conclusions regarding the safety threat from cracked CRDM nozzles. In the agency's own words:

*The recent identification of circumferential cracking in CRDM nozzles at ONS2 and ONS3, along with axial cracking in the J-groove welds at these two units and at ONS1 and ANO1, has resulted in the staff reassessing its conclusion in GL 97-01 that cracking of VHP [vessel head penetration] nozzles is not an immediate safety concern.<sup>15</sup>*

The NRC staff constructed a much stronger safety case against continued operation of Davis-Besse than it assembled, even after the fact, against Peach Bottom. But the NRC staff did not issue the shut down order for Davis-Besse it had sent to its Commission. This failure is troubling for the following reasons:

1. The NRC knew that allowing Davis-Besse to continue operating was wrong, yet allowed it anyway.
2. The NRC and FirstEnergy agreed there was a high likelihood that Davis-Besse was violating the conditions of its operating license, but failed to act upon this potential safety violation.
3. The NRC based its proposed shut down order on a "potentially hazardous condition" that it allowed to be replaced by mere "window dressing."
4. The NRC and FirstEnergy claim the order was unnecessary because the NRC could have shut Davis-Besse down with a phone call — yet at least three such phone calls were made without that effect.
5. The NRC made plant-specific alterations to its generic CRDM nozzle cracking resolution plan without significant input from its most reliable source of plant-specific information – its regional and resident staff.
6. The NRC, by coercing Dominion Energy into shutting down North Anna Unit 2 and Surry Unit 2 but permitting FirstEnergy to continue operating Davis-Besse, established a perverse risk/reward system which penalizes plant owners with the proper safety focus and rewards poor performing plant owners. Instead of shepherding the nuclear flock towards safety, this approach encourages plants owners to take the wrong path.

### **The NRC knew that allowing Davis-Besse to operate beyond December 31, 2001, was wrong**

The NRC determined that Davis-Besse was one of twelve reactors highly susceptible to CRDM nozzle cracking. Dominion Energy owned and operated four reactors in the highly susceptible category: two reactors at North Anna and two reactors at Surry. Dominion originally planned to operate one North Anna reactor and one Surry reactor until scheduled refueling outages in 2002. But Dominion changed its mind and instead shut down the North Anna and Surry reactors in late 2001 just for the CRDM nozzle inspections.

The proposed shut down order for Davis-Besse was prepared by the NRC's Division of Licensing Project Management.\* At that time, John Zwolinski headed up this division. The NRC's Office of the Inspector General (OIG) asked Mr. Zwolinski about Dominion's decision to voluntarily shut down the North Anna and Surry reactors for the CRDM nozzle inspections:

*My impression of how Dominion handled North Anna and Surry was a licensee that understood the phenomena, and were sensitive to where their plants were, had not performed these inspections before ever, and they were going to go in. And look, it sounded to me like they were going to do the right thing. And they chose to do what they did, which was viewed by the staff, I think, as positive.<sup>16</sup>*

The OIG investigators followed up on the implication that FirstEnergy had done the wrong thing:

OIG: *And would you say that Davis-Besse didn't choose to do the right thing?*

Mr. Zwolinski: *Confronted with the evidence that we had, other like plants, and so on and so forth, I would say that they did not choose to do the right thing, regardless of how everything has turned out.<sup>17</sup>*

And Mr. Zwolinski was not alone in his characterization of Dominion's decision. The OIG investigators also talked with a staffer in the NRC's Division of Engineering:

*[Dominion Energy] considered it to be a sufficiently serious issue and they needed to have the assurance that they didn't have the problem, and they did it [shut down].<sup>18</sup>*

Even Samuel J. Collins, the Director of the NRC's Office of Nuclear Reactor Regulation and the individual who would have signed the proposed shut down order had it been issued, concurred — twice:

*The majority of the plants, however, I think took the right action, even though was in the midst of a cycle, to shut down and make that inspection.<sup>19</sup>*

and

*All that aside, they [Dominion] made what we believe is a prudent decision and for that I think they would be remembered as a licensee who tries to do the right thing.<sup>20</sup>*

Brian Sheron, the NRC's Associate Director for Project Licensing and Technical Assessment and the senior manager most engaged on the CRDM nozzle cracking issue between August and December 2001, exceeded Collin's regard for Dominion's decision:

*I praise them for doing what they did.<sup>21</sup>*

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\* The very first version of the proposed shut down order was drafted by the NRC's Division of Engineering. Responsibility for the order was soon transferred to the Division of Licensing Project Management.

With NRC extolling the virtues of Dominion's prudent decision to do the right thing, what was the right thing? As Dominion informed the NRC in writing on November 14, 2001:

*In our initial response, we committed to perform a bare-metal visual inspection of the reactor vessel heads for both North Anna Unit 1 and Surry Unit 1 during their scheduled Fall 2001 refueling outages. A qualified bare-metal visual inspection had been completed on North Anna Unit 1 and Surry Unit 1. From our inspection results and other inspection results, we had intended to establish a statistical basis for determining appropriate scope and schedule for future inspection activities for North Anna Unit 2 and Surry Unit 2. ... However, based on overall industry inspection results to date, Dominion has determined the use of a statistical basis to determine inspection scope and schedule is impractical. Accordingly, a qualified bare-metal inspection of the reactor vessel head penetrations for North Anna Unit 2 was recently completed. In addition, Dominion intends to commence a qualified bare-metal visual inspection of the reactor vessel head penetrations for Surry Unit 2 prior to December 31, 2001.<sup>22</sup>*

Thus, Dominion essentially defined using a "statistical basis for determining appropriate scope and schedule for future inspection activities" as the wrong thing and "a qualified bare-metal inspection of reactor vessel head penetrations ... prior to December 31, 2001," as the right thing.

The NRC knew that the right thing involved inspections of the CRDM nozzles before December 31, 2001, and that the wrong thing involved using an "impractical" statistical analysis to defer those inspections. Yet, the agency knowingly permitted FirstEnergy to do the wrong thing for Davis-Besse by using a statistical analysis to postpone the CRDM nozzle inspections beyond December 31, 2001.

It is extremely significant that the NRC drafted an order to shut down Davis-Besse. The last time the NRC issued an order to shut down an operating reactor was in March 1987. Shut down orders are seldom even drafted as a contingency, as reported by an NRC senior manager who joined the agency in 1973 when it was still the Atomic Energy Commission:

*Orders are a big thing. It was a fairly substantial justification and there's a lot of legal stuff that gets hung on it. So the staff had not drafted orders or even written orders in a long time, so this was something that we needed to go back and learn how to do.<sup>23</sup>*

It is neither routine nor business-as-usual for the NRC to draft an order to shut down an operating reactor. It is an extremely valid signal of the level of concern the NRC had about safety at Davis-Besse.

**The NRC and FirstEnergy agreed that there was a high likelihood that Davis-Besse was violating the conditions of its operating license, but failed to act upon this potential safety violation**

The week before NRC senior manager Brian Sheron called FirstEnergy President Robert Saunders and informed him that the agency was not persuaded by the company's response to Bulletin 2001-01 and wanted the CRDM nozzles at Davis-Besse to be inspected by December 31, 2001, the NRC staff issued a procedure to be used by its inspectors when auditing the CRDM nozzle inspections. According to this procedure:

*Recent experience with VHP nozzle cracking also raises concerns regarding compliance with NRC requirements, for example, plant technical specifications (TSs) do not permit reactor coolant pressure boundary leakage.<sup>24</sup>*

The NRC's Office of the Inspector General (OIG) asked NRC senior manager Jack Strosnider about the burden of proof necessary to invoke the technical specification ban on reactor coolant pressure boundary leakage:

*OIG: Is high likelihood of CRDM nozzle leakage, without absolute proof, sufficient basis for a shut down order?*

*Mr. Strosnider: And my answer would be, yes, it's enough.<sup>25</sup>*

Did the NRC conclude there was a 'high likelihood of CRDM nozzle leakage' at Davis-Besse in November 2001? Yes:

*I had said in a public meeting [in November 2001] that their projection of having 3.5 [CRDM nozzle] leakers still in the plant would be reasonably consistent with what we'd expect from the other plants. We found that looking at the other plants, the statistics would come out to expecting something like 1 to 3 leakers at Davis-Besse, and about a 50/50 chance of having a circ [circumferential] crack at Davis-Besse. When they finally did the inspections, they had about four leakers and a small circ crack, so I mean, they weren't different from the expectations.<sup>26</sup>*

Did FirstEnergy conclude there was a 'high likelihood of CRDM nozzle leakage' at Davis-Besse in November 2001. Yes. An NRC staffer attending a presentation by FirstEnergy on November 28, 2001, was surprised to hear company representatives expect to find nearly two leaking CRDM nozzles:

*I said, "Okay, let me understand this. What you're saying is that whenever you shut down, on your proposed date in February, when you shut down you expect to find as many as 1.9 leaks." And I can't remember exactly what they said, but that basically, this is what they were presenting.<sup>27</sup>*

and

*My personal view is that there wasn't a single person in that room that didn't think that they probably did [have CRDM nozzle leak(s)].<sup>28</sup>*

A Framatome representative attending that meeting confirmed the NRC's staffer's account:

*"[Redacted] said that at a meeting between FENOC and NRC on November 28, 2001, FENOC acknowledged to NRC staff that it was possible that Davis-Besse would find one (1) leaking control rod drive mechanism (CRDM) nozzle during its next inspection. However, he said he was not aware of FENOC personnel acknowledging the existence of CRDM nozzle leaks prior to that meeting."<sup>29</sup>*

And finally, the proposed order transmitted to the Commission by NRC Executive Director for Operations William Travers on November 21, 2001, stated:

*Furthermore, Technical Specification, Section 3/4.4.6, which is part of the Davis-Besse Nuclear Power Station, Unit No. 1 operating license, requires the plant to shut down with any PRESSURE BOUNDARY LEAKAGE. The technical specification bases specifically state that ‘PRESSURE BOUNDARY LEAKAGE of any magnitude is unacceptable since it may be indicative of an impending gross failure of the pressure boundary.’ The gross failure of the pressure boundary is the failure of a circumferential flaw in the nozzle which would lead to the ejection of a control rod drive mechanism and a small to medium size loss-of-coolant accident. Given that all of the other Babcock & Wilcox-designed plants have identified reactor coolant pressure boundary leakage, it is **highly probable that Davis-Besse Nuclear Power Station, Unit No. 1, is also currently experiencing pressure boundary leakage and is operating in violation of its technical specifications.**<sup>30</sup> [emphasis added]*

If the primary area of disagreement involved the number of leaking CRDM nozzles and not the presence of at least one, why wasn't this consensus enough to invoke the technical specifications and its requirement to shut down? According to the NRC staffer in the November 28<sup>th</sup> meeting:

*And then I said, ‘Okay, well, how many do you have today?’ And that’s when others in the room, most of whom were all these risk people and managers, basically reacted to my question as – and the way I received their reaction was that, well, you know, that’s – that’s not a pertinent question because this is just a statistical analysis. This is all part of doing a risk analysis. And several of the managers looked me straight in the eye, just shook their head, telling me, the way I received that was ‘don’t go there.’<sup>31</sup>*

and

OIG: *Okay, who were the NRC managers that discouraged your line of questioning?’*

Staffer: *I remember that Sam [Collins] looked me straight in the eye and just shook his head.<sup>32</sup>*

So, NRC senior management steered the discussion away from leaking CRDM nozzles. That intentional avoidance was sustained. After the meeting with FirstEnergy on November 28, 2001, ended, the NRC staff caucused to vote on whether the proposed shut down order should be issued. NRC senior manager Brian Sheron chaired this meeting:

*It [the November 28<sup>th</sup> vote] wasn’t about compliance with the tech specs. And Brian Sheron came in, right at the beginning of the meeting, at the caucus, and he says, ‘This is not about leaks.’<sup>33</sup>*

and

*And it was clear, in that [second November 28<sup>th</sup>] meeting, that the focus or the decision-making process, by the staff, was going to be based on the risk analysis, because the management stated, very clearly, that this is not about leaks. It’s about core damage frequency.<sup>34</sup>*

Thus, the NRC — a regulatory agency as evidenced by its middle name — deliberately set aside any consideration of whether Davis-Besse was violating a federal safety regulation and instead concentrated on the odds of a meltdown. The regulatory agency intentionally chose to use a statistical analysis, the very same statistical analysis that Dominion judged ‘impractical’ and rejected when it decided to shut down North Anna Unit 2 and Surry Unit 2 for CRDM nozzle inspections in late 2001, to justify its decision to defer the CRDM nozzle inspections at Davis-Besse.

Some of the NRC staffers in the November 28<sup>th</sup> caucus voted against the deferral. They explained that there was insufficient information to support a statistical analysis:

*But, this [the high uncertainty about the risk numbers] was the basis for - - for my vote to shut Davis-Besse down and make it look. Okay. That and the fact that every - - they were the last of the B&W plants to look.<sup>35</sup>*

and

*Given the track record of the B&W reactors [with regard to CRDM nozzle cracking and leaking], okay, these numbers [the Davis-Besse core damage risk numbers by the NRC staff] to me were virtually meaningless.<sup>36</sup>*

and

*And also a lot of people lose sight of the fact that in the PRA [probabilistic risk assessment] you have – as – as opposed to a deterministic analysis, you actually need more information. Okay. And they really didn't – we did not have sufficient information which is really why wanted these guys to shut down and look.<sup>37</sup>*

and

*There's a tendency to start believing that what you have — what you can see, is all there is and to just manipulate what you've been able to cobble together as a model and say, what does that tell me? And not ask the question, what am I missing? Because I don't know enough to put it in the model.<sup>38</sup>*

and

*I was pretty sure that it [FENOC's information] was, you know, inaccurate and incomplete, and that was the reason my decision was to recommend that they not approve operation on the basis of that information, or anything else we had beyond the 31<sup>st</sup> of December.<sup>39</sup>*

and

*..but I had reached a conclusion that it wasn't sufficient to make a good probabilistic decision at that point, that we didn't know enough to really be risk-informed yet.<sup>40</sup>*

Among the information that NRC was lacking was the fact that leaking boric acid could damage the reactor vessel head, as explained by an NRC senior manager who was also in the November 28<sup>th</sup> caucus:

*And what you see is a consequence at Davis-Besse that, well, wait a minute, this degradation led to another type of degradation, which we didn't anticipate.<sup>41</sup>*

The NRC did not anticipate that boric acid leaking from CRDM nozzles could degrade the reactor vessel head at the Davis-Besse Nuclear Power Station (DBNPS). They should have anticipated this future given this past:

*On March 13, 1987, personnel at Turkey Point Unit 4 discovered more than 500 lbs. of boric acid crystals on the RV head. There also was a large amount of boric acid crystals in the exhaust cooling ducts for the control rod drive mechanisms (CRDMs). After removal of this boric acid and steam cleaning of the RV head, severe corrosion of various components on the RV head was noted. ... This event at Turkey Point Unit 4 has once again demonstrated that boric acid will rapidly corrode ferritic (carbon) steel components and it also again demonstrated that if a small leakage occurs near hot surfaces and/or surroundings, then the boric acid solution will boil and concentrate, becoming more acidic and thus more corrosive. In addition, the evaporation of the water will cause the boric acid crystals to accumulate at that point.<sup>42</sup>*

and

*On August 7, 1987, after an unplanned shutdown, Salem Unit 2 was brought to a cold shutdown condition. Inspection teams entered the containment building to look for reactor coolant leaks that would account for the increased radioactivity in containment air that was noted before the shutdown. The team assigned to the reactor head area found boric acid crystals on a seam in the ventilation cowling surrounding the reactor head area. The licensee then removed some of the cowling and insulation and discovered a mound of boric acid residue at one edge of the reactor vessel head. A pile of rust-colored boric acid crystals 3 feet by 5 feet by 1 foot high had*

*accumulated on the head, and a thin white film of boric acid crystals had coated several areas of the head and extended 1 to 2 feet up the control rod mechanism housings. The source of the boric acid was reactor coolant leakage through three pinholes in the seal weld at the base of the threaded connection (conoseal) for thermocouple instrumentation. During the previous operating period, reactor coolant leakage had not exceeded 0.4 gallon per minute (gpm).*<sup>43</sup>

That the NRC had no excuse for not knowing that leaking boric acid could damage reactor vessel heads was identified by the agency's Lessons Learned Task Force:

*DBNPS was at least the third U.S. nuclear plant to report RPV [reactor pressure vessel] head wastage caused by boric acid-induced corrosion. Two previous events include the Turkey Point Unit 4 event (March 1987), and the Salem Unit 2 event (August 1987). ... The Turkey Point Unit 4 and Salem Unit 2 events and their lessons-learned from 1987 should have been an indicator to DBNPS that RPV head wastage from boric acid accumulation was possible, and should have been included in their boric acid corrosion control program. Information gained through interviews of the DBNPS and NRC staff indicated that a mind set had developed that boric acid corrosion on the RPV head would not result in significant wastage because of the elevated temperature of the RPV head, resulting in dry boric acid deposits. Given this mind set, there was a presumption that boric acid deposits would not be a concern because the corrosion rates would be extremely low. However, a review of the operating experience revealed a number of events in which expected dry boric acid deposits contained wet boric acid solutions, which resulted in more degradation than anticipated. This indicates that one of the past lessons, i.e., the inability to predict environmental conditions, particularly inside the containment building, was forgotten or never fully appreciated.*<sup>44</sup>

Also among the information that NRC, at least the headquarters staff, lacked was a complete understanding of the condition of the reactor vessel head at Davis-Besse:

*I don't know if REDACTED showed you a picture of the head with – with the boric acid flowing out of these weep holes or not [i.e., the infamous red photo]. Okay. If I would have seen that and the color of some of that stuff involved, okay, yes, it – it would have been a different result.*<sup>45</sup>

But the NRC headquarters staff did look at some videotapes of the Davis-Besse reactor vessel head and saw boric acid deposits it did not understand:

*We also looked at some videotapes that they had taken at previous head inspections and - - and saw what I consider to be unexplained boric acid deposits on top of the head, okay, and which was never explained.*<sup>46</sup>

The NRC saw visual evidence of unexplained boric acid deposits on top of the Davis-Besse reactor vessel head. In Bulletin 2001-01 that they issued on August 3, 2001, the NRC established the protocol for treating unexplained boric acid deposits:

*As a remedial measure, the RPV head may have to be cleaned at a prior outage for effective identification of new deposits from VHP nozzle cracking if new deposits cannot be discriminated from existing deposits from other sources. However, the NRC staff believes that boric acid deposits that cannot be dispositioned as coming from another source should be considered, as a conservative assumption, to be from VHP nozzles, and appropriate corrective actions may be necessary. In addition, the use of special tooling or procedures may be required to provide assurance that the visual examinations will be effective in detecting the relevant conditions.*<sup>47</sup>

The NRC had very strong evidence, albeit circumstantial, that one or more CRDM nozzles was leaking at Davis-Besse. They had visual evidence that they could not explain and their own guidance directed them to consider to be from leaking CRDM nozzles. The technical specification, or operating license, granted to Davis-Besse by the NRC prohibits any leakage through any CRDM nozzle.\* The technical specifications require Davis-Besse to be shut down within six hours after CRDM nozzle leakage begins.

But the NRC did not vote on whether there was sufficient grounds of a technical specification violation that would have required Davis-Besse to shut down within six hours. Instead, they voted on whether the “impractical” statistical analysis for the odds of a meltdown provided sufficient grounds to allow Davis - Besse to continue operating for six weeks beyond the December 31<sup>st</sup> deadline.

NRC senior manager Brian Sheron, along with other NRC managers, contend that they require absolute proof of a technical specification violation before they can take action. The NRC’s Office of the Inspector General queried Mr. Sheron about this very high threshold:

*OIG: So, if you have every reason to believe that there is pressure boundary leaks at a plant, your hands are tied, you can’t really take action.*

*Mr. Sheron: Right.*<sup>48</sup>

In essence, the NRC adopted the manner of an irresponsible cinema owner who, when told of smoke billowing from this crowded theater, continues to sell Milk Duds and popcorn rather than evacuate the audience and call the Fire Department on the flimsiest of excuses that “you haven’t shown me a fi re.”

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\* The technical specifications permit up to one gallon per minute of leakage through the CRDM nozzle flanges. But that leakage source was not the same as that from axial and/or circumferential cracking of the CRDM nozzles, which was the subject of the inspections sought by Bulletin 2001-01.

**The NRC based its proposed shut down order on a “potentially hazardous condition” that it allowed to be mitigated by mere “window dressing”**

On November 16, 2001, Mr. Samuel J. Collins transmitted an order to Dr. William D. Travers that, when issued, would require Davis-Besse to shut down by December 31, 2001. Mr. Collins explained his basis for the order as being “*I have determined that a potentially hazardous condition may exist such that the integrity of the reactor coolant pressure boundary may not be maintained at the Davis-Besse Nuclear Power Station, Unit No. 1.*”<sup>49</sup>

The proposed order described the “potentially hazardous condition” as follows:

*Based on the large uncertainties that currently exist regarding this cracking mechanism and the extent of VHP cracking observed at these plants, it is reasonable to assume that the reactor coolant pressure boundaries could be compromised at Davis-Besse Nuclear Power Station, Unit No. 1, and Donald C. Cook Nuclear Plant, Unit No. 2. Due to the existence of this potentially hazardous condition, the recommended inspections are required to be performed prior to operation after December 31, 2001. Based on the above, adequate protection of the public health and safety cannot be assured without successful completion of the recommended inspections. It is unacceptable for a facility to continue operation beyond December 31, 2001, without performing the recommended inspections.*

*The results of these inspections have not revealed conditions of incipient failure. However, considering the uncertainties and variability in plant susceptibilities, the inspections have identified conditions supporting the need to perform inspections in the near term to verify the absence of conditions worse than those found to date. In light of these results, operation of facilities considered to be highly susceptible to this cracking phenomenon beyond December 31, 2001, is unacceptable unless the recommended inspections to identify this potentially hazardous condition are completed and found acceptable by the staff.*

*As indicated from the recent operating experience described previously, nine out of ten of the plants in the same population as Davis-Besse Nuclear Power Station, Unit No. 1, that have performed recent inspections have found evidence of cracking in the vessel head penetration nozzles.*

*For the population of seven plants designed by Babcock & Wilcox, six have performed recent examination of their nozzles. All six of the plants have identified leaking and cracked nozzles.*

*Since Davis-Besse Nuclear Power Station, Unit No. 1, is in the population of highly susceptible plants that have found vessel head penetration nozzle cracking, and in some cases the cracking has been significant, i.e., circumferential, it is reasonable to expect that Davis-Besse Nuclear Power Station, Unit No. 1, could have significant cracking, which would violate the reactor coolant pressure boundary integrity.*

*Given that all of the other Babcock & Wilcox-designed plants have identified reactor coolant pressure boundary leakage, it is highly probable that Davis-Besse Nuclear Power Station, Unit No. 1, is also currently experiencing pressure boundary leakage and is operating in violation of its technical specifications.*

*However, as noted above, compliance with the regulations is not adequate to detect flaws which could result in the failure of the reactor coolant pressure boundary, one of the three barriers which could result in the failure of the reactor coolant pressure boundary, one of the three*

*barriers to release of radioactive materials from the reactor core, and thus the second principle regarding the ‘defense -in-depth’ philosophy is not satisfied.*

*Failure of the licensees for Davis-Besse Nuclear Power Station, Unit No. 1, to conduct inspections of the reactor vessel head penetration nozzles in a manner that is sufficient to detect the extent of degradation caused by a mechanism known to be degrading other similar plants in that portion of the vessel and prior to a significant reduction in safety margin, is inconsistent with these GDC. The level of degradation that has been found in other similar plants, if left uncorrected, could result in a gross failure of the reactor coolant pressure boundary (loss-of-coolant accident).*

FirstEnergy later offered to take “compensatory measures” if the NRC would allow Davis-Besse to continue operating until February 16, 2002. The NRC decided these “compensatory measures” offset its concerns about the “potentially hazardous condition” and therefore agreed to let Davis -Besse operate until February 16<sup>th</sup>. What did the NRC really think about the value of the “compensatory measures”?

*It [compensatory measures] was window dressing. Okay. Well, he said we’re going to do this, we’re going to do that, but what’s the net effect of it? Es sentially nothing.<sup>50</sup>*

and

*My sense of the compensatory measures was that they were largely window dressing.<sup>51</sup>*

But these are merely the opinions of two technical staffers with nearly 45 years of regulatory experience between them. What about the opinion of NRC senior manager Samuel J. Collins, the would-be signer of the proposed order:

*All of those types of things [compensatory measures], that’s nice to have and it may be enough to move some people to from one place to another, but when you get right down to what impact is on risk and significance, it’s not that great.<sup>52</sup>*

Thus, the “potentially hazardous condition” at Davis -Besse, as evidenced by 90 percent of the other highly susceptible reactors having cracked CRDM nozzles and 100 percent of the other Babcock & Wilcox reactors having leaking CRDM nozzles, was offset by “window dressing” at worst or measures that were “not that great” at best.

Mr. Collins told OIG that the information provided by FirstEnergy during the November 28, 2001, meeting was “not that great.” Mr. Collins also told OIG:

*OIG: So absent the information that was provided to staff on November 28 by the licensee ... the staff was prepared to go forward with the order?*

*Mr. Collins: That’s correct.<sup>53</sup>*

The minimal value of the compensatory measures make it seem the NRC was so desperate not to have to issue the order that they would have traded for any information, perhaps as trivial as a grocery list, from FirstEnergy. This may be the worst trade since the Boston Red Sox dealt Babe Ruth to the New York Yankees.

**The NRC and FirstEnergy claim the order was unnecessary because the NRC could have shut Davis-Besse down with a phone call — yet at least three such phone calls were made without that effect**

The NRC's Samuel J. Collins, whose staff spent considerable hours drafting and redrafting the proposed shut down order for Davis-Besse, stated:

*I wouldn't put undue emphasis on the order because Davis-Besse would shut that plant down without the order.*<sup>54</sup>

FirstEnergy Nuclear Operating Company President Robert Saunders confirmed that he'd informed Mr. Collins that an order was not needed:

*Saunders stated that he told Collins that if NRC staff did not conclude that DBNPS could safely operate, he would initiate a plant shutdown without the need for an order. Saunders explained to OIG that FENOC intended to "do the right thing."*<sup>55</sup>

Thus, both the NRC and FirstEnergy claim that it only required a phone call, not an order, to shut Davis-Besse down for the CRDM nozzle inspections.<sup>56</sup> Maybe so, but the NRC made at least three such phone calls and none produced that outcome:

*During a call made September 28, 2001, Geisen said Brian Sheron, Office of Nuclear Reactor Regulation (NRR), NRC, spoke to a senior FENOC executive and requested that Davis-Besse shut down operations by December 31, 2001, pursuant to NRC Bulletin 2001-01. Geisen said FENOC received a second telephone call from NRC on November 3, 2001, during which NRC staff informed FENOC of an impending shutdown order.*<sup>57</sup>

and

*And I got a call from Sam Collins [on or about November 21, 2001], who said, 'I understand you're going to be moving into a new role. I want to make sure you're aware that we're preparing a shutdown order for Davis-Besse.'*<sup>58</sup>

The September 28, 2001, call was made to Mr. Saunders himself:

*Saunders said he received a telephone call from Brian Sheron, Office of Nuclear Reactor Regulation (NRR), NRC, in September 2001. During that conversation, he said Sheron informed him that FENOC's response to Bulletin 2001-01 for DBNPS was unsatisfactory.*<sup>59</sup>

NRC made at least three phone calls to FirstEnergy urging them to "do the right thing." NRC apparently had the wrong telephone numbers or failed to say "pretty please." Would FirstEnergy really shut Davis - Besse down had the NRC called the right number and uttered the right phrase? The actions taken by the company strongly suggest the answer is 'no!'

*In Davis-Besse — there — there were a whole series of meetings with Davis-Besse. Okay. And they — some late at night actually and they — they basically fought and clawed every inch of the way.*<sup>60</sup>

and

*Davis-Besse resisted all the way. They did not want to come down by December 31<sup>st</sup>.*<sup>61</sup>

and

*He [a Framatome employee who sat in on FirstEnergy's planning for a meeting with Congressional staffers] said they also noted that FENOC was prepared to contest a shutdown order if issued.*<sup>62</sup>

Prepared? What preparations were taken by FirstEnergy? From their very first meeting with the NRC after being informed by NRC senior manager Brian Sheron that the agency felt Davis-Besse needed to have its CRDM nozzles inspected by December 31, 2001, the company showed up to meetings with the NRC with its lawyer.<sup>63</sup> FirstEnergy and its lawyer contested another recent NRC order all the way towards arbitration.<sup>64</sup> By contrast, the owner of the H.B. Robinson reactor met with the NRC staff on October 24, 2001,<sup>65</sup> and the owner of D.C. Cook Unit 2 met with the NRC staff on November 20, 2001,<sup>66</sup> to discuss CRDM nozzle inspections and potential forced shut downs by December 31, 2001. Neither company brought along legal counsel.

In addition, FirstEnergy went straight to Capitol Hill seeking, and obtaining, congressional support:

*Campbell said FENOC personnel met with Congressional representatives on the afternoon of October 11, 2001. He said FENOC staff first met with Senate representatives (Andrew Wheeler, Marty Hall, and one other individual). He said FENOC personnel then met with Congressman Gilmore (5<sup>th</sup> District, Ohio) and his staff. ... Campbell said he would not be surprised if Senator Voinovich (R, Ohio) telephoned NRC Chairman Richard Meserve a day or two after FENOC's meetings on Capitol Hill.<sup>67</sup>*

UCS came across no evidence suggesting that any other reactor owner, even those facing unscheduled shut downs in fall 2001, got Capitol Hill to weigh in on the matter.

With FirstEnergy so well prepared to contest an issued shut down order, can any one really believe that the company would not have contested a phone request? Apparently, NRC senior manager Samuel J. Collins did not believe it. On November 21, 2001, the very day that NRC Executive Director for Operations William Travers transmitted the Davis-Besse shut down order to the Commissioners, Mr. Collins updated one of the Commissioners' technical assistants:

*Licensee will likely object to order even if permitted operation until end of Jan.<sup>68</sup>*

What would have happened had NRC issued the shut down order and FirstEnergy contested it? The NRC's Office of General Counsel answered that question on November 15, 2001:

*To state it perhaps more emphatically — the provisions of the order **ARE IN EFFECT** even if challenged **unless and until** determined otherwise by the ASLB [Atomic Safety & Licensing Board].[emphasis in original]<sup>69</sup>*

Maybe the NRC's phone call really would have worked. The order definitely would have worked, had it merely been issued.

**The NRC made plant-specific alterations to its generic resolution plan without significant input from its most reliable source of plant-specific information – its regional and resident staff**

With issuance of Bulletin 2001-01 in August 2001, the NRC headquarters staff established its expectations for the reactors defined as having high, medium, and low susceptibility to CRDM nozzle cracking. As long as all reactors within these categories conformed to the expectations, there was little need to involve the NRC regional and resident staffs in the process.

But when owners sought to deviate from these expectations, such as wanting to operate D.C. Cook Unit 2 and Davis-Besse beyond December 31, 2001, without performing the prescribed qualified visual inspections of the CRDM nozzles, the NRC regional and resident staffs should have been inserted into the process. After all, they had the greatest insights into plant-specific conditions that either supported or refuted the proposed deviations. But the NRC regional and resident staffs were virtually excluded from the entire process.

According to the NRC's Project Manager for Davis-Besse, who works at NRC headquarters:

*OIG: Was Region III involved with the Bulletin and how Davis-Besse was responding?*

*Project Manager: No, I don't think we - - at least I didn't have any contact with the Region. I don't recall. You know, looking at the e-mails and correspondence, I don't think the Region was involved with it.<sup>70</sup>*

According to James Caldwell, Deputy Regional Administrator for NRC Region III which contains both D.C. Cook Unit 2 and Davis-Besse:

*But beyond that, I don't think, that I didn't have any involvement, Davis-Besse's justification or otherwise. That was pretty much between the headquarters and the licensee.<sup>71</sup>*

According to the NRC Branch Chief in Region III responsible for Davis-Besse:

*OIG: Was there ever a time then Region, or when headquarters confirmed with Region 3 staff whether certain inspections were conducted at the plant or the extent to which the inspections were conducted?*

*Branch Chief: Not that I know of.<sup>72</sup>*

According to the NRC Resident Inspector then assigned full-time at Davis-Besse:

*[Simpkins] said 99 percent of the discussion of this bulletin was directly between the licensee and NRC Headquarters (the Office of Nuclear Reactor Regulation (NRR)). ... He said that the NRC resident office was kept completely out of the loop. Simpkins added that no one in NRR contacted the NRC resident office to obtain feedback about the conditions at Davis-Besse. ... [Simpkins] stated he obtained most of his information from the licensee during the morning meetings.<sup>73</sup>*

Thus, the NRC Resident Inspector was so far removed from the decision-making loop that he received most of his information about what was going on from FirstEnergy. The NRC often refers to its resident inspectors as the agency's eyes and ears. Thus, it seems odd that the agency would contemplate a safety decision without the benefit of sight or sound.

What kind of input did NRC headquarters miss out on? According to the NRC Resident Inspector then assigned full-time at Davis-Besse:

*Simpkins stated on November 1, 2001, he spoke with George Chung, Systems Engineer for Davis-Besse about an unrelated matter and afterwards he said he brought up the subject of the radiation elements and the red corrosion products from boric acid. Simpkins stated he asked Chung if he (the licensee) knew where the corrosion products were coming from. According to Simpkins, Chung said that he did not know where the products were coming from. Simpkins stated that with the idea of NRC Bulletin 2001-01 in the back of his mind, he then asked Chung if the boric acid could have come from the reactor head. He said Chung told him that they had inspected the reactor head and that it was clean.<sup>74</sup>*

Whether or not such information would have altered the decision is speculative. But the important point is that the NRC should not be making plant-specific safety decisions, especially ones using risk-informed criteria, without formally using its “eyes and ears.” Nuclear regulation is not like pinball, best played by the deaf, dumb, and blind kid. Nuclear regulation works best when all faculties are fully utilized.

It’s hard to understand how and why NRC headquarters excluded its regional and resident staffs from the decisions on allowing D.C. Cook Unit 2 and Davis-Besse to operate beyond December 31, 2001, without having conducted the prescribed qualified visual inspections of their CRDM nozzles. On September 20, 2001, NRC headquarters issued a procedure for its regional and resident staff to use when auditing the qualified visual inspections conducted at the highly susceptible reactors shut down in fall 2001. According to that procedure:

*The inspectors should be cognizant of extenuating circumstances at their respective plant(s), such as the operational history, physical layout, and material condition of the reactor vessel head, and any identified VHP nozzle leakage or other Alloy-600 PWSCC indications that would suggest a need for more aggressive licensee inspection practices.<sup>75</sup>*

That procedure detailed about 60 hours of auditing for the CRDM nozzle inspection effort.<sup>76</sup> Thus, had Davis-Besse shut down in fall 2001 for the CRDM nozzle inspections, NRC would have expended about 60 inspection hours examining how these inspections were performed. Yet the NRC essentially expended no effort examining the basis for NOT performing the inspections in fall 2001. If it’s worth 60 hours of region and resident attention verifying that CRDM nozzles are inspected properly, it’s worth a few hours of region and resident attention verifying that the inspections are deferred properly. After all, the regional and resident staff is best positioned to know about “extenuating circumstances” that would either support a deferral or argue against it.

When FirstEnergy sought to divert Davis-Besse off the established path, the NRC’s regional and resident staff should have been formally involved in the decision-making process. Whether their involvement would have altered the NRC’s actions is immaterial – they had information and insights germane to the issue at hand that should have been considered.

**The NRC established a perverse risk/reward system that pressures good performers towards bad practices**

The NRC reacted to the discovery of circumferential cracking of CRDM nozzles at Oconee by sending Bulletin 2001-01 in August 2001 to all owners of pressurized water reactors. The NRC evaluated the responses to that bulletin and determined that some of the owners of reactors deemed highly susceptible to CRDM nozzle cracking had not provided sufficient justification to support not inspecting their nozzles by the specified deadline of December 31, 2001. Accordingly, NRC senior manager Brian Sheron called these owners on September 28, 2001 to inform them that the NRC had not accepted their justifications. The following month, the NRC staff began drafting orders to shut down reactors by December 31, 2001, for the CRDM nozzle inspections.

The NRC's Office of the Inspector General asked NRC Deputy Executive Director for Reactor Programs Bill Kane why the shut down orders were crafted:

*Kane said the staff initiated development of shutdown orders when it started to receive 'push back' from licensees (i.e., reluctance to comply with the requirements contained in NRC Bulletin 2001-01).<sup>77</sup>*

In parallel with drafting the shut down orders, the NRC staff continued to meet with the plant owners. The owner of the H.B. Robinson nuclear reactor subsequently presented sufficient information to convince the NRC staff those prior inspections of the reactor vessel head constituted qualified visual inspections, thus justifying operation past December 31, 2001, for this highly susceptible reactor.

The owner of the D.C. Cook Unit 2 reactor presented sufficient information to convince the NRC staff that eddy current examinations of the CRDM nozzles during a previous outage provided sufficient basis to justify operation until January 19, 2002. It's interesting to note that the NRC staff did not request, yet alone require, compensatory measures in place at D.C. Cook Unit 2.

The owner of the North Anna Unit 2 and Surry Unit 2 reactors met with the NRC, but ultimately decided not to operate either reactor beyond December 31, 2001. Instead, both reactors were voluntarily shut down in late 2001 specifically for CRDM nozzle inspections.

The owner of the Davis-Besse reactor took a different approach. Prior to meeting with the NRC staff after receiving Brian Sheron's call on September 28<sup>th</sup>, FirstEnergy met with Congressional staffers and with technical assistants to the NRC Chairman and Commissioners. While there's no available evidence to suggest that either Congress or the Commission placed undue pressure on the NRC staff to forego CRDM nozzle inspections, these tactics clearly put the NRC staff on notice that FirstEnergy was prepared for a fight.

The record is unquestionable that the NRC staff wanted all of the highly susceptible reactors that did not have prior qualified visual inspections of their CRDM nozzles to shut down by December 31, 2001. By the end of November 2001, the NRC staff got its wishes for 10 of the 12 highly susceptible reactors. Only D.C. Cook Unit 2 and Davis-Besse remained. The NRC staff evaluated D.C. Cook Unit 2 and concluded that the reactor could safely operate until January 19, 2002. The NRC staff did not include D.C. Cook Unit 2 in its shut down order. The NRC staff did not impose compensatory measures on D.C. Cook Unit 2. The NRC staff concluded that D.C. Cook Unit 2 would probably not have cracked and leaking nozzles. When the inspections were performed at D.C. Cook Unit 2 in 2002, only one very small crack that did not require the nozzle to be replaced was found. No CRDM nozzles were leaking, as the NRC staff predicted.

The NRC staff clearly did not have the same comfort level with Davis-Besse. They sent their Commission an order that would have required the reactor to be shut down by December 31, 2001, for CRDM nozzle

inspections. When FirstEnergy demonstrated its willingness to contest an order, such as by bringing its lawyer to NRC meetings, the NRC staff reluctantly agreed to a compromise that allowed Davis-Besse to continue operating until February 16, 2002. But unlike D.C. Cook Unit 2, the NRC staff did not permit continued operation without compensatory measures intended to offset the increased odds of meltdown. That the odds of meltdown were increased was openly discussed during the November 28, 2001, meeting between the NRC staff and FirstEnergy:

*LOCA [loss of coolant accident] is high; for a short time.*<sup>78</sup>

While the tangible value of these compensatory measures appears inconsequential, their intangible value lies in the fact that they demonstrated that the NRC staff viewed the potential hazard at D.C. Cook Unit 2 significantly different from that at Davis-Besse. It was not considered necessary to reduce the operating temperature at D.C. Cook Unit 2 as it was at Davis-Besse. It was not considered necessary to restrict online maintenance or testing of emergency systems at D.C. Cook Unit 2 as it was at Davis-Besse. It was not considered necessary to post a dedicated operator for the switchover of emergency systems following a loss of coolant accident at D.C. Cook Unit 2 as it was at Davis-Besse. It was not considered necessary to "split the difference" on the refueling date at D.C. Cook Unit 2 as it was at Davis-Besse. It was not considered necessary to take these compensatory measures at D.C. Cook Unit 2 because it did not have the increased odds of a meltdown as at Davis-Besse.

That Davis-Besse turned out to have the worst CRDM nozzle problem in the United States was not a surprise to the NRC. After all, Davis-Besse was the *only* reactor in America covered by a proposed shut down order transmitted by NRC Executive Director for Operations William Travers to the Commissioners. Davis-Besse was the only reactor in the United States to operate beyond December 31, 2001, with compensatory measures in place. It is therefore not a coincidence that the only reactor receiving this NRC attention had the worst problem.

It appears that the NRC stopped being a regulator of Davis-Besse and instead became its enabler. Enabling is defined as being:

*Any behavior or action that assists the addict in the continuation of their addiction. Enabling is either intentional or unintentional, and is usually done out of love and misguided concern. Enabling allows the addict to continue their destructive behavior.*<sup>79</sup>

There is scant evidence that NRC loves or loved FirstEnergy, particularly since the discovery of the gaping cavity in the reactor vessel head. The red letter<sup>80</sup> sent by NRC to FirstEnergy in February 2003 was definitely not a Valentine's Card.

The misguided concern that formed the NRC's enabling was over the structural integrity of the CRDM nozzles as opposed to potential damage from boric acid leaking from cracked CRDM nozzles. After the NRC issued Bulletin 2001-01, UCS researched the subject in the NRC's Public Document Room. That literature review led UCS to conclude that the dominant hazard was corrosion of the reactor vessel head, not expulsion of the CRDM nozzle. We documented our conclusion in an issue brief released on August 13, 2001:

*The inner surface of the reactor vessel head is covered by stainless steel (represented in the figure by the thin gray region at the bottom edge). The stainless steel protects the reactor vessel head from corrosion by borated water (i.e., dilute boric acid). The outer surface of the reactor vessel head is unprotected. Borated water can weaken the reactor vessel metal through corrosion, particularly when evaporation causes the boron concentration to increase. If the weakened reactor vessel fails, water may leak out faster than the emergency systems can replace it.*<sup>81</sup>

UCS cannot claim special knowledge or insights as the basis for this forecast. We merely reviewed the material in the NRC's own library and reported what it said. It's not a case of "we told them so." It's a case of "they told us so." In any case, the NRC's misguided concern caused the agency to focus on CRDM cracking leading to expulsion and totally ignore the hazard from boric acid corrosion. The NRC's misguided concern enabled FirstEnergy, who subsequently confessed to being addicted to production at the sake of safety, to continue its destructive behavior, in this instance involving the figurative destruction of safety margins and the literal destruction of a reactor vessel head.

The NRC's handling of Davis-Besse is troubling for what it could mean in the future. FirstEnergy resisted NRC pressure to inspect the CRDM nozzles at Davis-Besse in 2001 and successfully postponed these inspections until February 16, 2002, when they had significantly less financial impacts. Those financial ramifications were well known to the NRC. Dominion Energy did not resist NRC pressure and volunteered to shut down its North Anna Unit 2 and Surry Unit 2 reactors in late 2001 for CRDM nozzle inspections, thus incurring a significant financial impact. Several NRC senior managers stated that Dominion did the right thing.

The NRC urged plant owners to do the right thing, but allowed plant owners to do the wrong thing. If the agency persists in merely urging the right thing rather than requiring it, they will be setting the stage for plant owners to follow FirstEnergy's rather than Dominion's example. When all it takes is showing up for a few meetings with your attorney, getting some friends on Capitol Hill to make a few calls, and agreeing to a few meaningless concessions to avoid a multi-million dollar shut down for safety inspections, there is increasing financial pressure to do so.

While no plant owner wants to replicate what FirstEnergy has gone through since March 2002, many plant owners might share FirstEnergy's confidence from November 2001 that "delay was okay." Most of the time, delay may very well be okay. But when the evidence against delay is as strong and compelling as it was in this Davis-Besse case, the NRC must stop enabling and start regulating. There will be times when delay is not okay. In those cases, the NRC must follow through on its good intentions. When conditions warrant, the NRC must issue orders to recalcitrant owners.

The NRC applied its risk-informed decision-making approach to the problem of circumferential cracking of CRDM nozzles. The approach worked admirably, until the NRC abandoned it when deciding to allow Davis-Besse to operate past December 31, 2001. Just as the infamous "red photo" has come to symbolize FirstEnergy's poor judgment, the NRC decision on November 28, 2001, should symbolize its own poor judgment.

Sadly, the Commission shows no inclination to accept, yet alone fix, the agency's shortfalls. The NRC's departing Chairman defended the November 28<sup>th</sup> decision by contesting the OIG's report. He stated that OIG had "done a significant disservice by your release of such an unfair analysis."<sup>82</sup> Having read the OIG report and literally hundreds of pages of transcripts that formed the basis for the report, UCS can both agree and disagree with the NRC Chairman. The OIG report was not an unfair analysis. There was a significant disservice done, but not by the NRC's Inspector General.

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<b>Chronology of the Davis-Besse Deferral Decision</b>	
<b>Date</b>	<b>Event</b>
February 18, 2001	Workers discovered boric acid crystals on the reactor vessel head around the edges of CRDM nozzles at Oconee. Subsequent examination revealed several axial and circumferential cracks, some through-wall, in CRDM nozzles.
April 12, 2001	NRC met with nuclear industry to discuss factors affecting CRDM nozzle cracking inception and growth.
August 3, 2001	NRC issued Bulletin 2001-01 to all operating pressurized water reactor owners. The Bulletin sorted the reactors into three susceptibility categories (high, medium, and low) with degree of response based on susceptibility. NRC conveyed its expectations that all reactors that had not conducted qualified visual inspections of CRDM nozzles would be shut down by December 31, 2001, to do so.
September 4, 2001	FirstEnergy submitted its response for Davis-Besse to Bulletin 2001-01 to the NRC. FirstEnergy expressed its intent to operate Davis-Besse until March 30, 2002, before shutting down for the CRDM nozzle inspections.
September 28, 2001	NRC senior manager Brian Sheron called FirstEnergy Nuclear Operating Company Robert Saunders to report that the NRC is not satisfied with the company's justification for Davis-Besse and asked that the company consider accelerating the CRDM nozzle inspections to no later than December 31, 2001.
October 3, 2001	FirstEnergy and NRC conducted conference call to discuss Davis-Besse's response to Bulletin 2001-01. FirstEnergy told the NRC staff that it had conducted 100 percent inspections of the reactor vessel head at past outages.
October 3, 2001	NRC staff briefed the Commissioners' technical assistants on Bulletin 2001-01 and reported that FirstEnergy's response for Davis-Besse was not acceptable.
October 10, 2001	FirstEnergy representatives, including its DC attorney, prepared for meeting that evening with Congressional staffers about Davis-Besse and Bulletin 2001-01. FirstEnergy representatives briefed Congressional staffers that evening.
October 11, 2001	FirstEnergy representatives, including its DC attorney, briefed the NRC Commissioners technical assistants.
October 12, 2001	NRC Chairman Meserve's technical assistant queried the NRC EDO staff on the process being used to issue the order to FirstEnergy to shut down Davis-Besse.
October 18, 2001	The NRC EDO staff asked the NRC staff for a copy of the draft order.
October 24, 2001	FirstEnergy representatives, accompanied by their DC attorney, briefed the NRC staff on its reasons for wanting to operate Davis-Besse until March 30, 2002. FirstEnergy's presentation slide used in this meeting reported that "All CRDM penetrations were verified to be free from "popcorn" type boron deposits using video recordings from 10RFO, 11RFO or 12RFO."
October 30, 2001	FirstEnergy submitted photographic evidence of the reactor vessel head and its CRDM nozzles to the NRC. FirstEnergy stated "Following 12RFO, the RPV head was cleaned with demineralized water to the extent possible to provide a clean head for evaluating future inspection results." FirstEnergy claimed the pictures contained "proprietary information" and the NRC withheld the pictures from public viewing.
October 30, 2001	NRC issued a request for additional information (RAI) to FirstEnergy about its response to Bulletin 2001-01.
November 1, 2001	FirstEnergy transmitted its risk assessment of CRDM nozzle cracking to the NRC. FirstEnergy reported the results could be categorized as small using the guidelines in Reg Guide 1.174.
November 5, 2001	The NRC's Project Manager for Davis-Besse informed the NRC staff and managers working on the draft order that a shut down for CRDM nozzle

<b>Chronology of the Davis-Besse Deferral Decision</b>	
<b>Date</b>	<b>Event</b>
	inspections would cost FirstEnergy about \$35 million, according to the FirstEnergy outage manager.
November 7, 2001	The NRC staff briefed NRC EDO William Travers about Bulletin 2001-01 and the proposed orders. The NRC staff reported that only two reactors that were highly susceptible for CRDM nozzle cracking had not been accepted – D.C. Cook Unit 2 and Davis-Besse.
November 8, 2001	The NRC staff met with FirstEnergy's David Geisen in a meeting closed to the public to view videotapes from past reactor vessel head inspections. The meeting was closed to the public because FirstEnergy claimed that the videotapes contained proprietary information.
November 8, 2001	The NRC staff circulated a copy of the draft shut down order for Davis-Besse to its Office of General Counsel, its Office of Enforcement, and others.
November 8, 2001	NRC senior manager Jack Strosnider e-mails colleagues within NRC that he'd had a conversation with FirstEnergy Vice President Guy Campbell during which Campbell agreed there was a high likelihood of leaking CRDM nozzles at Davis-Besse.
November 9, 2001	The NRC staff made a presentation to the Advisory Committee on Reactor Safeguards about Bulletin 2001-01.
November 9, 2001	The NRC staff met with FirstEnergy representatives
November 14, 2001	The NRC staff briefed the Commissioners' technical assistants on Bulletin 2001-01. It was reported that only two of the highly susceptible reactors, D.C. Cook Unit 2 and Davis-Besse, had not yet satisfied the NRC staff.
November 14, 2001	FirstEnergy representatives, accompanied by their DC attorney, and the NRC staff met to discuss the company's response to Bulletin 2001-01.
November 14, 2001	FirstEnergy representatives and the NRC staff had a conference call regarding its response to Bulletin 2001-01. The NRC told FirstEnergy that "the only means to provide reasonable assurance of VHP integrity would be to perform the inspections as recommended in the bulletin."
November 15, 2001	NRC's Office of the General Counsel advised the NRC staff that if FirstEnergy contested the shut down order, Davis-Besse would have to remain shut down until the Atomic Safety and Licensing Board over-ruled the order, if indeed that were to occur.
November 16, 2001	NRC's Director of the Office of Nuclear Reactor Regulation Samuel J. Collins transmitted Executive Director for Operations William Travers the proposed order to shut down Davis-Besse by December 31, 2001.
November 20, 2001	The NRC's Office of Public Affairs provided the NRC staff with a draft press release it intended to issue when the Davis-Besse shut down order was issued.
November 20, 2001	The NRC Resident Inspector at Davis-Besse reported back to NRC headquarters that FirstEnergy representatives during the morning meeting at the plant "expressed cautious optimism that the NRC would approve their plants to defer the inspections."
November 21, 2001	NRC's Director of the Office of Nuclear Reactor Regulation Samuel J. Collins visited NRC Commissioner technical assistant and reported his telephone conversation with FirstEnergy President Robert Saunders. Collins reported that Saunders said a shut down in January would have significant impact but that a shut down in February would have lesser impact. Collins also relayed that FirstEnergy would "likely object to order even if permitted operation until end of Jan."
November 21, 2001	NRC's Director of the Office of Nuclear Reactor Regulation Samuel J. Collins transmitted an order to EDO William Travers that would require Davis-Besse to be

<b>Chronology of the Davis-Besse Deferral Decision</b>	
<b>Date</b>	<b>Event</b>
	shut down by December 31, 2001.
November 21, 2001	NRC's Executive Director for Operations William Travers transmitted an order to the NRC Chairman and Commissioners that would require Davis-Besse to be shut down by December 31, 2001.
November 21, 2001	FirstEnergy requested a meeting with the NRC staff on November 28, 2001, to discuss CRDM nozzle inspections at Davis-Besse.
November 26, 2001	NRC senior manager Brian Sheron and other NRC staffs had a conference call with FirstEnergy. FirstEnergy senior manager Steve Moffitt "indicated that they could shut down for refueling on February 16 <sup>th</sup> at the earliest and would prefer to couple the CRDM inspections with the RFO."
November 27, 2001	FirstEnergy e-mailed materials to NRC staff in advance of the meeting scheduled for the next day. The materials included proposed compensatory measures.
November 28, 2001	FirstEnergy representatives met with NRC staff to discuss CRDM nozzle inspections at Davis-Besse.
November 28, 2001	NRC's Director of the Office of Nuclear Reactor Regulation Samuel J. Collins talked with FirstEnergy President Robert Saunders after the meeting. "Saunders said Collins may have told him prior to his departure from NRC Headquarters on November 28, 2001, that NRC would accept the compensatory measures offered by FENOC and would allow DBNPS to continue operations." <sup>83</sup>
November 28, 2001	NRC senior manager Brian Sheron chaired an NRC staff meeting to discuss the information received from FirstEnergy. "There was a straw poll hand vote taken of the people what were in the room at the time. There may have been 15 or so people. I recollect the vote was like 11 to 3, with 11 saying that the compensatory measures proposed by Davis-Besse were adequate to allow them to operate to February 16 <sup>th</sup> , and three of us did not think its compensatory measures were sufficient." <sup>84</sup>
November 29, 2001	The NRC staff briefed NRC EDO William Travers on the decision NOT to issue the order to shut down Davis-Besse. The NRC staff's concluding slide in the presentation reported that the decision failed to satisfy 4 of the 5 criteria from Reg. Guide 1.174.
November 30, 2001	The NRC staff briefed NRC Commissioners' technical assistants on the decision NOT to issue the order to shut down Davis-Besse. The NRC staff's concluding slide in the presentation reported that the decision failed to satisfy 4 of the 5 criteria from Reg. Guide 1.174.
November 30, 2001	FirstEnergy formally submitted information to the NRC supporting the information discussed during the November 28, 2001, meeting.
December 4, 2001	FirstEnergy complained to the NRC staff that a recent story in the Toledo <i>Blade</i> triggered many calls about the end of year shut down at Davis-Besse. FirstEnergy asked the NRC for a written statement about their compromise.
December 4, 2001	The NRC worked late into the evening to get a letter out to FirstEnergy announcing that it had allowed Davis-Besse to continue operating until February 16, 2001.
December 5, 2001	The NRC expedited placement of their December 4, 2001, letter to FirstEnergy in ADAMS. The normal process called for the letter to be placed in ADAMS five business days later.
December 6, 2001	NRC's Executive Director for Operations William Travers transmitted a memo to the NRC Chairman and Commissioners reporting that Davis-Besse would be allowed to operate until February 16, 2002.
March 6, 2002	Workers discover cavity in reactor vessel head at Davis-Besse while repairing

<b>Chronology of the Davis-Besse Deferral Decision</b>	
<b>Date</b>	<b>Event</b>
	cracked CRDM nozzle #3.
December 3, 2002	The NRC staff issued the basis for its decision to defer the CRDM nozzle inspections at Davis-Besse more than a year earlier.

## END NOTES

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- <sup>2</sup> Nuclear Regulatory Commission, Generic Letter 88-05, ‘Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants,’ March 17, 1988.
- <sup>3</sup> Letter dated May 12, 1987, from William F. Kane, Director – Division of Reactor Projects, Nuclear Regulatory Commission, to J. W. Gallagher, Vice President – Nuclear Operations, Philadelphia Electric Company, ‘Combined Inspection 50-277/87-10; 50-278/87-10.’
- <sup>4</sup> Nuclear Regulatory Commission, Information Notice 2001-05, ‘Through-Wall Circumferential Cracking of Reactor Pressure Vessel Head Control Rod Drive Mechanism Penetration Nozzles at Oconee Nuclear Station, Unit 3,’ April 30, 2001.
- <sup>5</sup> Nuclear Regulatory Commission, Information Notice 2001-05, ‘Through-Wall Circumferential Cracking of Reactor Pressure Vessel Head Control Rod Drive Mechanism Penetration Nozzles at Oconee Nuclear Station, Unit 3,’ April 30, 2001.
- <sup>6</sup> Nuclear Regulatory Commission internal e-mail dated August 31, 2001, from Jacob Zimmerman to distribution, ‘Bulletin 2001-01 Project Manager Guidance.’
- <sup>7</sup> Nuclear Regulatory Commission internal e-mail dated October 1, 2001, from Jacob Zimmerman, NRR Office, to Stacey Rosenberg, EDO Office, ‘EDO & Commissioner’s TA Briefing on Bulletin 2001-01.’
- <sup>8</sup> Nuclear Regulatory Commission internal e-mail dated November 5, 2001, from Lawrence Burkhart to Allen Hiser, Andrea Lee, and Jacob Zimmerman, ‘Updated Order.’
- <sup>9</sup> Letter dated March 28, 2002, from Michael W. Rencheck, Vice President – Strategic Business Improvements, Indiana Michigan Power Company, to Nuclear Regulatory Commission, ‘Donald C. Cook Nuclear Plant Unit 2 / Additional Information Requested by Nuclear Regulatory Commission Bulletin 2001-01.’
- <sup>10</sup> Memo dated November 21, 2001, from Samuel J. Collins, Director – Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission to William D. Travers, Executive Director for Operations, Nuclear Regulatory Commission, ‘Issuance of an Order for Davis-Besse Nuclear Power Station, Unit No. 1, Regarding Response to Nuclear Regulatory Commission (NRC) Bulletin 2001-01, ‘Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.’”
- <sup>11</sup> Memo dated November 21, 2001, from William D. Travers, Executive Director for Operations, Nuclear Regulatory Commission, to Chairman and Commissioners, Nuclear Regulatory Commission, ‘Issuance of Order Regarding Response to Nuclear Regulatory Commission (NRC) Bulletin 2001-01, ‘Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.’”
- <sup>12</sup> Letter dated January 11, 1988, from Zack T. Pate, President, Institute of Nuclear Power Operations, to Robert D. Harrison, Chairman – Special Committee, Philadelphia Electric Company.
- <sup>13</sup> Letter dated May 12, 1987, from William F. Kane, Director – Division of Reactor Projects, Nuclear Regulatory Commission, to J. W. Gallagher, Vice President – Nuclear Operations, Philadelphia Electric Company, ‘Combine d Inspection 50-277/87-10; 50-278/87-10.’
- <sup>14</sup> Laurie Hays, ‘Philadelphia Electric Nuclear Plant Shut Because of Alleged Sleeping by Operators,’ *Wall Street Journal*, April 1, 1987.
- <sup>15</sup> Nuclear Regulatory Commission, Bulletin No. 2001-01, ‘Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles,’ August 3, 2001.
- <sup>16</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with John Zwolinski, NRC Director of the Division of Licensing Project Management, September 3, 2002, page 54, lines 9 to 16.
- <sup>17</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with John Zwolinski, NRC Director of the Division of Licensing Project Management, September 3, 2002, page 54, lines 19 to 25.
- <sup>18</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Division of Engineering), May 2, 2002, page 55, lines 1 to 3.
- <sup>19</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Samuel J. Collins, NRC Director of the Office of Nuclear Reactor Regulation, June 6, 2002, page 11, lines 7 to 10.
- <sup>20</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Samuel J. Collins, NRC Director of the Office of Nuclear Reactor Regulation, September 9, 2002, page 74, lines 16 to 19.
- <sup>21</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Brian Sheron, NRC Associate Director for Project Licensing and Technical Assessment, August 22, 2002, page 42, line 13.
- <sup>22</sup> Letter dated November 14, 2001, from Leslie N. Hartz, Vice President – Nuclear Engineering, Virginia Electric and Power Company, to Nuclear Regulatory Commission, ‘Virginia Electric and Power Company / North Anna

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<sup>23</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Brian Sheron, NRC Director of the Division of Engineering, May 15, 2002, page 21, lines 11 to 16.

<sup>24</sup> Nuclear Regulatory Commission, Inspection Manual Temporary Instruction 2515/145, “Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles (NRC Bulletin 2001-01),” September 20, 2001.

<sup>25</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Jack Strosnider, NRC Director of the Division of Engineering, August 22, 2002, page 58, lines 22 to 23.

<sup>26</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Probabilistic Safety Assessment Branch), August 20, 2002, page 62, lines 1 to 12.

<sup>27</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 12, line 23 to page 13, line 16.

<sup>28</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 14, lines 4 to 6.

<sup>29</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with REDACTED (Framatome staffer), August 15, 2002.

<sup>30</sup> Memo dated November 21, 2001, from William D. Travers, Executive Director for Operations, Nuclear Regulatory Commission, to Chairman and Commissioners, Nuclear Regulatory Commission, “Issuance of Order Regarding Response to Nuclear Regulatory Commission (NRC) Bulletin 2001-01, ‘Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.’”

<sup>31</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 12, line 23 to page 13, line 16.

<sup>32</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 15, lines 18 to 22.

<sup>33</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 19, lines 20 to 23.

<sup>34</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Office of Enforcement Staffer), June 3, 2002, page 16, lines 15 to 20.

<sup>35</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (Former NRC Staffer who was the REDACTED of the author of Bulletin 2001-01), May 16, 2002, page 11, lines 5 to 8.

<sup>36</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (Former NRC Staffer who was the REDACTED of the author of Bulletin 2001-01), May 16, 2002, page 14, lines 17 to 19.

<sup>37</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (Former NRC Staffer who was the REDACTED of the author of Bulletin 2001-01), May 16, 2002, page 16, lines 4 to 10.

<sup>38</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Probabilistic Safety Assessment Branch), August 20, 2002, page 33, lines 10 to 15.

<sup>39</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Probabilistic Safety Assessment Branch), August 20, 2002, page 131, lines 21 to 25.

<sup>40</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Probabilistic Safety Assessment Branch), August 20, 2002, page 5, lines 8 to 11.

<sup>41</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Jack Strosnider, NRC Director of the Division of Engineering, August 22, 2002, page 68, lines 10 to 12.

<sup>42</sup> Nuclear Regulatory Commission, Information Notice 86-108 Supplement 1, “Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion,” April 20, 1987.

<sup>43</sup> Nuclear Regulatory Commission, Information Notice 86-108 Supplement 2, “Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion,” November 19, 1987.

<sup>44</sup> A. Howell, E. Hackett, J. Donoghue, R. Haag, R. Bywater, P. Castleman, T. Koshy, R. Lloyd, and J. Starefos, Lessons Learned Task Force, Nuclear Regulatory Commission, “Degradation of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report,” September 30, 2002, page 25, item (4).

<sup>45</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (Former NRC Staffer who was the REDACTED of the author of Bulletin 2001-01), May 16, 2002, page 39, lines 6 to 10.

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- <sup>47</sup> Nuclear Regulatory Commission, Bulletin No. 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," August 3, 2001.
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- <sup>49</sup> Memo dated November 16, 2001, from Samuel J. Collins, Director – Office of Nuclear Reactor Regulation, to William D. Travers, Executive Director for Operations, "Issuance of Orders Regarding Responses to Nuclear Regulatory Commission (NRC) Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles.""
- <sup>50</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (Former NRC Staffer who was the REDACTED of the author of Bulletin 2001-01), May 16, 2002, page 25, lines 7 to 9.
- <sup>51</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Staffer in the Probabilistic Safety Assessment Branch), August 20, 2002, page 46, lines 24 to 25.
- <sup>52</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Samuel J. Collins, NRC Director of the Office of Nuclear Reactor Regulation, September 9, 2002, page 41, lines 17 to 21.
- <sup>53</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Samuel J. Collins, NRC Director of the Office of Nuclear Reactor Regulation, June 6, 2002, page 8, line 19 to page 9, line 1.
- <sup>54</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Samuel J. Collins, NRC Director of the Office of Nuclear Reactor Regulation, September 9, 2002, page 21, lines 8 to 10.
- <sup>55</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with Robert Saunders, FirstEnergy Nuclear Operating Company President, October 22, 2002.
- <sup>56</sup> Office of the Inspector General, Nuclear Regulatory Commission, Case No. 02-03S, "NRC's Regulation of Davis - Besse Regarding Damage to the Reactor Vessel Head," December 30, 2002, page 20.
- <sup>57</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with Dave Geisen, FirstEnergy Nuclear Operating Company, September 23, 2002.
- <sup>58</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with Howard Bergendahl, FirstEnergy Davis-Besse Plant Manager, August 29, 2002, page 34, lines 14 to 18.
- <sup>59</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with Robert Saunders, President, FirstEnergy Nuclear Operating Company, October 22, 2002.
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- <sup>62</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with REDACTED (Framatome employee), September 12, 2002.
- <sup>63</sup> Nuclear Regulatory Commission, Meeting Summary, "Commission Technical Assistant Briefing – October 11, 2001."
- <sup>64</sup> Letter dated March 29, 2001, from John A. Grobe, NRC Director – Division of Reactor Safety, to Mr. Robert E. Saunders, President – FirstEnergy Nuclear Operating Company, "Office of Investigations Report No. 3-1999-025."
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- <sup>66</sup> Memo dated November 29, 2001, from John F. Stang, Senior Project Manager, Nuclear Regulatory Commission, "Meeting Summary of November 20, 2001, to Discuss the Licensee's Response to Bulletin 2001-01."
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- <sup>72</sup> Office of the Inspector General, Nuclear Regulatory Commission, Transcript of Interview with REDACTED (NRC Region III Branch Chief), May 28, 2002, page 9, lines 5 to 10.
- <sup>73</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with Douglas Simpkins, Davis-Besse Senior Resident Inspector, May 23, 2002.
- <sup>74</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with Douglas Simpkins, Davis-Besse Senior Resident Inspector, May 23, 2002.
- <sup>75</sup> Nuclear Regulatory Commission, Inspection Manual Temporary Instruction 2515/145, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles (NRC Bulletin 2001-01)," September 20, 2001.
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- <sup>77</sup> Office of the Inspector General, Nuclear Regulatory Commission, Summary of Interview with William Kane, NRC Deputy Executive Director for Reactor Programs, June 12, 2002.
- <sup>78</sup> Hand written notes dated November 28, 2001, by an NRC staffer.
- <sup>79</sup> <http://www.addictionresourceguide.com/glossary.html>
- <sup>80</sup> Letter dated February 25, 2003, from J. E. Dyer, Regional Administrator, Nuclear Regulatory Commission, to Lew Myers, Chief Operating Officer, FirstEnergy Nuclear Operating Company, "Davis -Besse Control Rod Drive Mechanism Penetration Cracking and Reactor Pressure Vessel Head Degradation Preliminary Significance Assessment (Report No. 50-346/2002-08(DRS))."
- <sup>81</sup> Union of Concerned Scientists, Issue Brief, "Not -So-Happy Anniversary: 10 Years of Band-Aid Fixes for CRDM Nozzle Cracking," August 13, 2001.
- <sup>82</sup> Memo dated January 8, 2003, from Richard A. Meserve, NRC Chairman, to Hubert T. Bell, NRC Inspector General, "Report on NRC's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head."
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