

with a through-wall axial crack and was in an area of the reactor vessel head that the Licensee had left covered with boric acid deposits for several years. On March 18, 2002, the NRC issued Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," which requested PWR Licensees to provide information on their reactor vessel head inspection and maintenance programs, the material condition of their reactor vessel heads, and their boric acid inspection programs. In their responses, the Licensees provided information about their boric acid inspection programs and their inspections and assessments to ensure that their respective plant did not have reactor vessel head degradation like that identified at Davis-Besse.

The experience at Davis-Besse and the discovery of leaks and nozzle cracking at other plants reinforced the need for more effective inspections of RPV head penetration nozzles. The absence of an effective inspection regime could, over time, result in unacceptable circumferential cracks in RPV head penetration nozzles or in the degradation of the RPV head by corrosion. These degradation mechanisms increase the probability of a more significant loss of reactor coolant pressure boundary through ejection of a nozzle or other rupture of the RPV head. The NRC issued Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs," dated August 9, 2002, requesting that Licensees provide information about their inspection programs and any plans to supplement existing visual inspections with additional measures (e.g., volumetric and surface examinations). Licensees have responded to Bulletin 2002-02 with descriptions of their inspection plans for at least the first refueling outage following the issuance of Bulletin 2002-02 or with a schedule to submit such descriptions before the next refueling outage. Many of the Licensees' responses to Bulletin 2002-02 did not describe long-term inspection plans. Instead the Licensees stated that they would follow guidance being developed by the industry-sponsored Materials Reliability Program.

Inspections performed at several PWR plants in late 2002 found leakage and cracks in nozzles or J-groove welds that have required repairs or prompted the replacement of the RPV head. In addition, as discussed in NRC Information Notice 2003-02, "Recent Experience with Reactor Coolant System Leakage and Boric Acid Corrosion," issued January 16, 2003, leakage has

recently occurred at some plants from connections above the RPV head and has required additional assessments and inspections to ensure that the leakage has not caused significant degradation of RPV heads.

III

Based on recent experience, current inspection requirements in the ASME Code and related NRC regulations do not provide adequate assurance that reactor coolant pressure boundary integrity will be maintained for all combinations of construction materials, operating conditions, and operating histories at PWRs. The long-term resolution of RPV head penetration inspection requirements is expected to involve changes to the ASME Code and NRC regulations, specifically 10 CFR 50.55a. Research being conducted by the NRC and industry is increasing our understanding of material performance, improving inspection capabilities, and supporting assessments of the risks to public health and safety associated with potential degradation of the RPV head and associated penetration nozzles. These research activities are important to the long term development of revisions to the ASME Code and NRC regulations.

The operating history of PWRs supports a general correlation among certain operating parameters, including the length of time plants have been in operation, and the likelihood of occurrence of PWSCC of nickel-based alloys used in RPV head penetration nozzles. Bulletin 2002-02 presented a three-tier categorization of susceptibility to RPV head penetration nozzle degradation based on reactor operating durations and temperatures. Licensees' responses to the Bulletin included an estimate of the effective degradation years (EDY) and the appropriate categorization of each plant into one of the three susceptibility categories. Each Licensee proposed an inspection plan for RPV head penetrations based upon the susceptibility to degradation via PWSCC (as represented by the value of EDY calculated for the facility). In addition, recent operating experience has shown that, under certain conditions, leakage from mechanical and welded connections above the RPV head can lead to the degradation of the low alloy steel head by boric acid corrosion.

Revising the ASME Code and subsequently the NRC regulations will take several years. The Licensees' actions to date in response to the NRC bulletins have provided reasonable assurance of adequate protection of public health and safety for the near

term operating cycles, but cannot be relied upon to do so for the entire interim period until NRC regulations are revised. Additional periodic inspections of RPV heads and associated penetration nozzles at PWRs, as a function of the unit's susceptibility to PWSCC and as appropriate to address the discovery of boron deposits, are necessary to provide reasonable assurance that plant operations do not pose an undue risk to the public health and safety. Consequently, it is necessary to establish a minimum set of RPV head inspection requirements, as a supplement to existing inspection and other requirements in the ASME Code and NRC regulations, through the issuance of an Order to PWR Licensees.

It is appropriate and necessary to the protection of public health and safety to establish a clear regulatory framework, pending the development of consensus standards and incorporation of revised inspection requirements into 10 CFR 50.55a, directly or through reference to a future version of the ASME Code. In order to provide reasonable assurance of adequate protection of public health and safety for the interim period, all PWR Licenses identified in the Attachment to this Order shall be modified to include the inspection requirements for RPV heads and associated penetration nozzles identified in Section IV of this Order. The NRC requirements imposed by this Order are based on the body of evidence available through February 2003. Continuing research and operating experience may support future changes to the requirements imposed through this Order. In addition, pursuant to 10 CFR 2.202, I find that in the circumstances described above, the public health, safety, and interest require that this Order be immediately effective.

IV

Accordingly, pursuant to sections 103, 104b, 161b, 161i, 161o, 182, and 186 of the Atomic Energy Act of 1954, as amended, and the Commission's regulations in 10 CFR 2.202 and 10 CFR part 50, *it is hereby ordered*, effective immediately, *that* all licenses identified in the attachment to this order are modified as follows:

A. To determine the required inspection(s) for each refueling outage at their facility, all Licensees shall calculate the susceptibility category of each reactor vessel head to PWSCC-related degradation, as represented by a value of EDY for the end of each operating cycle, using the following equation: