

$$EDY = \sum_{j=1}^n \left\{ \Delta EFPY_j \exp \left[ -\frac{Q_i}{R} \left( \frac{1}{T_{head,j}} - \frac{1}{T_{ref}} \right) \right] \right\}$$

Where:

EDY = total effective degradation years, normalized to a reference temperature of 600 °F

$\Delta EFPY_j$  = operating time in years at  $T_{head,j}$

$Q_i$  = activation energy for crack initiation (50 kcal/mole)

R = universal gas constant ( $1.103 \times 10^{-3}$  kcal/mole°R)

$T_{head,j}$  = 100% power head temperature during time period  $j$  (°R = °F + 459.67)

$T_{ref}$  = reference temperature (600 °F = 1059.67 °R)

$n$  = number of different head temperatures during plant history

This calculation shall be performed with best estimate values for each parameter at the end of each operating cycle for the RPV head that will be in service during the subsequent operating cycle. The calculated value of EDY shall determine the susceptibility category and the appropriate inspection for the RPV head during each refueling outage.

B. All Licensees shall use the following criteria to assign the RPV head at their facility to the appropriate PWSCC susceptibility category:

High—(1) Plants with a calculated value of EDY greater than 12, OR (2) Plants with an RPV head that has experienced cracking in a penetration nozzle or J-groove weld due to PWSCC.

Moderate—Plants with a calculated value of EDY less than or equal to 12 and greater than or equal to 8 AND no previous inspection findings requiring classification as High.

Low—Plants with a calculated value of EDY less than 8 AND no previous inspection findings requiring classification as High.

C. All Licensees shall perform inspections of the RPV head<sup>1</sup> using the following techniques and frequencies.<sup>2</sup>

<sup>1</sup> This Order imposes additional inspection requirements. Licensees are required to address any findings from these inspections (*i.e.*, perform analyses and repairs) in accordance with existing requirements in the ASME Code and 10 CFR 50.55a. The NRC has issued guidance to address flaw evaluations for RPV head penetration nozzles (see letter dated November 21, 2001, from J. Strosnider, NRC, to A. Marion, Nuclear Energy Institute) and will, as necessary, issue revised guidance pending the updating of the ASME Code and related NRC regulations.

<sup>2</sup> The requirements of this Order are generally consistent with inspection plans that the NRC staff accepted in letters to some Licensees regarding their responses to Bulletin 2002-02. If the NRC staff has already accepted a specific variation from the

(1) For those plants in the High category, RPV head and head penetration nozzle inspections shall be performed using the following techniques every refueling outage.<sup>3</sup>

(a) Bare metal visual examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle), AND

(b) Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (*i.e.*, nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

(2) For those plants in the Moderate category, RPV head and head penetration inspections shall be performed such that at least the requirements of 2(a) or 2(b) are performed each refueling outage. In addition the requirements of 2(a) and 2(b) shall each be performed at least once over the course of every two (2) refueling outages.

(a) Bare metal visual examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle).

(b) Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (*i.e.*, nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

requirements of this Order (*e.g.*, inspections to less than two (2) inches above the J-groove weld), the Licensee may continue with the previously accepted inspection plan for the next refueling outage after issuance of this Order, provided that in its response to this Order the Licensee identifies all discrepancies between the requirements of this Order and the previously accepted inspection plan. Licensees proposing to deviate from the requirements of this Order for subsequent refueling outages shall seek relaxation of this Order pursuant to the procedure specified at the end of this Section.

<sup>3</sup> For repaired RPV head penetration nozzles that establish a new pressure boundary, the ultrasonic testing inspection shall include the weld and at least one (1) inch above the weld in the nozzle base material. For RPV head penetration nozzles or J-groove welds repaired using a weld overlay, the overlay shall be examined by either ultrasonic, eddy current, or dye penetrant testing in addition to the examinations required by (1)(b)(i) or (1)(b)(ii).

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

(3) For those plants in the Low category, RPV head and head penetration nozzle inspections shall be performed as follows. An inspection meeting the requirements of 3(a) must be completed at least every third refueling outage or every five (5) years, whichever occurs first. If an inspection meeting the requirements of 3(a) was not performed during the refueling outage immediately preceding the issuance of this Order, the Licensee must complete an inspection meeting the requirements of 3(a) within the first two (2) refueling outages following issuance of this Order. The requirements of 3(b) must be completed at least once over the course of five (5) years after the issuance of this Order and thereafter at least every four (4) refueling outages or every seven (7) years, whichever occurs first.

(a) Bare metal visual examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle).

(b) Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (*i.e.*, nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, or

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

D. During each refueling outage, visual inspections shall be performed to identify potential boric acid leaks from pressure-retaining components above the RPV head. For any plant with boron deposits on the surface of the RPV head or related insulation, discovered either during the inspections required by this Order or otherwise and regardless of the source of the deposit, before returning the plant to operation the Licensee shall perform inspections of the affected RPV head surface and penetrations appropriate to the conditions found to verify the integrity of the affected area and penetrations.