ATTACHMENT 1

SECTION 6.0

OF

ABB COMBUSTION ENGINEERING NUCLEAR SERVICES

REPORT C-MECH-ER-021 DATED OCTOBER 11, 1993

6.0 SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE

The Waterford 3 reactor has 6 surveillance capsules designed to monitor the changes in beltline material properties (Ref. 21). The governing withdrawal schedule for these capsules as required by 10 CFR 50, Appendix H, is defined in Table 5.3-10 of the Waterford 3 Final Safety Analysis Report (FSAR) (Ref. 22). This current withdrawal schedule is presented in Table 7 along with the capsule identification number and original target fluence as presented in Reference 3.

Capsule 2, located at the 97 degree position, (also referred to as capsule W-97) was removed, and the encapsulated specimens were tested. A major result in the W-97 capsule report pertinent to the capsule removal schedule was a change in the capsule lead factors. The lead factor is defined as the ratio of neutron flux density at the location of the specimens in a surveillance capsule to the neutron flux density of the inside surface at the peak fluence location (Ref. 23). For capsules W-104 and W-284 the lead factor was revised from 1.5 to 0.81 (Ref. 3) and for the remaining capsules (W-83, W-97, W-263 and W-277) the lead factor was revised from 1.5 to 1.26 in Reference 3.

A revised schedule was developed using the lead factors provided by Reference 3 and the guidance of ASTM E185-82 in accordance with current 10 CFR 50, Appendix H requirements. Factors external to the ASTM E185-82 procedure that were also considered included:

1. Coordination with the generation of P-T limits and LTOP evaluation beyond 20 EFPY. - If additional surveillance capsule information is to be used to support the generation of P-T limits and an LTOP evaluation beyond 20 EFPY, the next capsule withdrawal must allow for enough time to analyze the encapsulated materials as well as develop new P-T limits and LTOP requirements prior to 20 EFPY.

2. Potential for use of Position 2 of Regulatory Guide 1.99, Rev. 2 - Surveillance capsule data may be used in conjunction with Position 2 of R.G. 1.99, Rev. 2 to predict mean shift in reference temperature (ΔRT_{NDT}) and decrease in upper shelf energy (USE) once credible surveillance data is obtained. One requirement for credibility is that, "the surveillance data for the correlation

monitor material in the capsule should fall within the scatter band of the data base for that material" (Reference 8).

Capsule W-97 did not contain correlation material (Ref. 21), so the next capsule withdrawn must contain correlation material in order to allow for the use of Position 2 of R.G. 1.99, Rev. 2. The two capsules that contain correlation material are W-104 and W-263 (Ref. 21).

3. The reactor coolant cold leg temperature for Waterford 3 has been reduced by 8°F from 553°F to 545°F (Ref. 13). The effect, if any, of this temperature reduction on the reactor vessel beltline materials must be monitored.

   The new operating condition was evaluated, and it was determined that the requirements of 10 CFR 50, Appendix G and 10 CFR 50.61 are not affected by the temperature reduction of the cold leg (Ref. 13). However, variations in the adjusted reference temperature (ART) and upper shelf energy (USE) of the surveillance material from predicted decreases must be monitored to verify the validity of the previous studies. This evaluation should be made at the time of the second surveillance capsule withdrawal, and modifications to the shift in ART and USE predictions can be made if necessary. The timing of the second capsule withdrawal should be such that significant variations from predictions can be detected early enough to ensure that the P-T limits based on the ART predictions remain conservative.

4. The surveillance capsule withdrawal schedule should be managed with consideration given to plant license renewal. Enough capsules must be tested to assure confidence in beltline material properties, but capsules should also be conserved to allow for future testing beyond the current design lifetime.

The guidelines provided in Section 7, "Irradiation Requirements" and Subsection 7.6, "Number of Surveillance Capsules and Withdrawal Schedule" of ASTM E185-82 (Ref. 23) are currently required by 10 CFR 50, Appendix H for establishing the surveillance capsule withdrawal schedule. A review of the proposed revised standards (Ref. 24) showed no changes affecting the method for determining the withdrawal schedule. Therefore, future modifications to 10 CFR 50 Appendix H by reference to this revised ASTM E185-93 standard are not expected to alter the capsule withdrawal

requirements.

According to ASME E185-82 (Ref. 23), the peak vessel inside fluence at EOL and the corresponding transition temperature shift must be estimated to determine the number of capsules required for removal. Waterford 3 has a peak EOL fluence of 3.69×10^{19} n/cm^2 (Ref. 3) and a 1/4t fluence of 2.20×10^{19} n/cm^2 (using equation 3 of R.G. 1.99, Rev. 2 to attenuate fluence to the 1/4t location).

Based on the calculations of RT_{PTS} (Table 6), the largest shift in reference temperature (ΔRT_{NDT}) at EOL is 59.4°F (note that the method in 10 CFR 50.61 for calculating ΔRT_{PTS} and the R.G. 1.99, Rev. 2 method for calculating ΔRT_{NDT} produce equivalent results). Using ASTM E185-82, it was determined that 3 capsules must be withdrawn in the following order.

First Capsule: (Removed and tested)

Second Capsule: At 15 EFPY or at the time when the accumulated neutron fluence of the capsule corresponds to the approximate EOL fluence at the reactor vessel inner wall location, whichever comes first.

Third (Final) Capsule: At EOL but not less than once or greater than twice the peak EOL vessel fluence. This may be modified on the basis of previous tests. This capsule may be held without testing following withdrawal.

The second capsule to be withdrawn could be either W-104 or W-263 to obtain credible surveillance data. However, capsule W-104 has a low lead factor (0.81), whereas capsule W-263 has a high lead factor (1.26). It is preferred to withdraw capsule W-263 for the second capsule, as the capsule fluence would be greater than the peak surface fluence received by the vessel. Capsule W-263 would be expected to receive a fluence equivalent to the EOL fluence at the reactor vessel inner wall at 25.4 EFPY (32 EFPY/1.26).

Given the criteria for withdrawal of the second capsule (above), capsule W-263 should be withdrawn at 15 EFPY. The capsule fluence corresponding to 15 EFPY was estimated to be 2.18 x 10^{19} n/cm^2 using the lead factor of 1.26 and linear interpolation of the EOL vessel fluence of 3.69 x 10^{19} n/cm^2 given in Reference 3.

Modifying the withdrawal schedule to meet the current edition of ASTM standards calls for the last capsule to be removed between 25.4 and 50.8 EFPY. It is suggested that capsule withdrawal occur no later than 32 EFPY because this time corresponds to the plant ECL. This will correspond to a capsule fluence of 4.65 x 10^{19} n/cm^2.

Given the requirements of 10 CFR 50, Appendix H and ASTM E185-82 along with the plant-specific considerations for Waterford 3, Table 8 presents the recommended schedule for the Waterford 3 reactor vessel surveillance capsule removal program:

This schedule meets ASTM E185-82 requirements for capsule withdrawal (Ref. 23) as currently required by 10 CFR 50, Appendix H. It allows for detection of any effect on ΔRT_{NDT} or decrease in USE which could result from the reduction in cold leg temperature. This schedule should make available credible surveillance data for analyses following Position 2 of Regulatory Guide 1.99, Revision 2 (Ref. 8), and it provides for capsule withdrawal and testing prior to a P-T limit modification following 20 EFPY. This schedule will also allow for a sufficient number of standby capsules (3) to be maintained for possible license renewal or to provide for other future contingencies.

ATTACHMENT 2

REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM -

WITHDRAWAL SCHEDULE

BEFORE

TABLE 4.4-5

REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM - WITHDRAWAL SCHEDULE

CAPSULE NUMBER	VESSEL LOCATION	LEAD FACTOR	WITHDRAWAL TIME (EFPY)*
1	83°	1.50	Standby
2	97°	1.50	4.0 EFPY
3	1u4°	1.50	11.0 EFPY
6	284°	1.50	18.0 EFPY
4	263°	1.50	Standby
5	277°	1.50	Standby

*Withdrawal time may be modified to coincide with those refueling outages or plant shutdowns most closely approaching the withdrawal schedule.

ATTACHMENT 3

REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM -

WITHDRAWAL SCHEDULE

AFTER

REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM - WITHDRAWAL SCHEDULE

Capsule No.	Capsule I.D.	Azimuthal Location (deg.)	Lead Factor	Removal Time (EFPY)	Target Fluence (n/cm^2)
1	W-83	83	1.26	Standby	---
2*	W-97	97	1.26	4.44	6.47×10^{18}
3	W-104	104	0.81	Standby	---
4	W-263	263	1.26	15	2.18×10^{19}
5	W-277	277	1.26	25.4 to 50.8 Recommended ≤ 32	3.69×10^{19} to 7.38×10^{19} Recommended $\leq 4.65 \times 10^{19}$
6	W-284	284	0.81	Standby	---

*Values represent actual data on removed capsule.