3.6 PRIMARY SYSTEM BOUNDARY

Applicability:

Applies to the operating status of the reactor coolant system.

Objective:

To assure the integrity and safe operation of the reactor coolant system.

Specification:

A. Thermal and Pressurization Limitations

1. The average rate of reactor coolant temperature change during normal heatup or cooldown shall not exceed 100°F/hr when averaged over a one-hour period except when the vessel temperatures are above 450°F. The shell flange to shell temperature differential shall not exceed 145°F.

2. The reactor vessel shall not be pressurized for hydrostatic and/or leakage tests, and critical core operation shall not be conducted unless the reactor vessel temperature is above that defined by the appropriate curves on Figures 3.6.1 and 3.6.2. In the event this requirement is not met, achieve stable reactor conditions with reactor vessel temperature above that defined by the appropriate curve and obtain an engineering evaluation to determine the appropriate course of action to take.

4.6 PRIMARY SYSTEM BOUNDARY

Applicability:

Applias to the periodic examination and testing requirements for the reactor cooling system.

Objective:

To determine the condition of the reactor coolant system and the operation of the safety devices related to it.

Specification:

A. Thermal and Pressurization Limitations

1. During heatups and cooldowns, the following temperatures shall be permanently logged at least every 15 minutes until the difference between any two readings taken over a 45 minute period is less than 5°F.

   a. Reactor vessel shell adjacent to shell flange

   b. Reactor vessel shell flange

   c. Recirculation loops A and B

2. Reactor vessel shell temperature and reactor coolant pressure shall be permanently logged at least every 15 minutes whenever the shell temperature is below 220°F and the reactor vessel is not vented.

   Test specimens of the reactor vessel base, weld and heat affected zone metal subjected to the highest fluence of greater than 1 Mev neutrons shall be installed in the reactor vessel adjacent to the vessel wall at the core midplane level. The specimens and sample program shall conform to the requirements of ASTM E 185-66. Selected

3.6.A Thermal and Pressurization Limitations (Cont'd)

3. The reactor vessel head bolting studs shall not be under tension unless the temperature of the vessel head flange and the head is greater than 55°F.

4. The pump in an idle recirculation loop shall not be started unless the temperatures of the coolant within the idle and operating recirculation loops are within 50°F of each other.

5. The reactor recirculation pumps shall not be started unless the coolant temperatures between the dome and the bottom head drain are within 145°F.

6. Thermal-Hydraulic Stability

Core thermal power shall not exceed 25% of rated thermal power without forced recirculation.

B. Coolant Chemistry

1. The reactor coolant system radioactivity concentration in water shall not exceed 20 microcuries of total iodine per ml of water.

2. The reactor coolant water shall not exceed the following limits with steaming rates less than 100,000 pounds per hour, except as specified in 3.6.B.3:

Conductivity ... 2 μmho/cm

Chloride ion ... 0.1 ppm

4.6.A Thermal and Pressurization Limitations (Cont'd)

neutron flux specimens shall be removed at the frequency required by Table 4.6.2 and tested to experimentally verify adjustments to Figures 3.6.1 and 3.6.2 for predicted NDTT irradiation shifts.

3. When the reactor vessel head bolting studs are tensioned and the reactor is in a Cold Condition, the reactor vessel shell temperature immediately below the head flange shall be permanently recorded.

4. Prior to and during startup of an idle recirculation loop, the temperature of the reactor coolant in the operating and idle loops shall be permanently logged.

5. Prior to starting a recirculation pump, the reactor coolant temperatures in the dome and in the bottom head drain shall be compared and permanently logged.

B. Coolant Chemistry

1. a. A reactor coolant sample shall be taken at least every 96 hours and analyzed for radioactivity content.

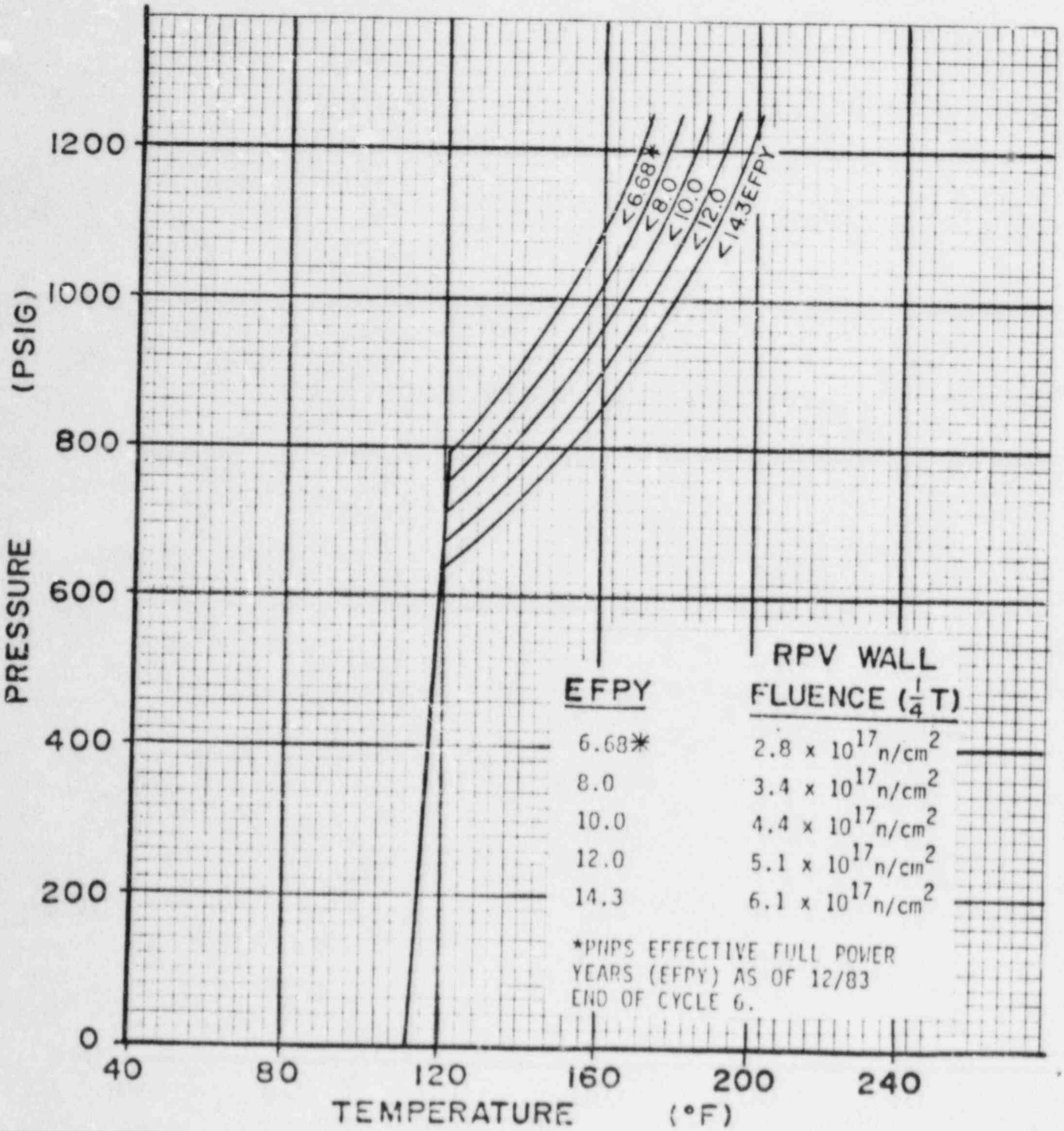
   b. Isotopic analysis of a reactor coolant sample shall be made at least once per month.

2. During startups and at steaming rates less than 100,000 pounds per hour, a sample of reactor coolant shall be taken every four hours and analyzed for chlorine content.

TABLE 4.6.2
REACTOR VESSEL MATERIAL
SURVEILLANCE PROGRAM WITHDRAWAL SCHEDULE

Capsule Number	Effective Full Power Years (EFPY)	Fluence (n/cm^2) (1/4 T)	RT_{NDT} (weld metal) (°F)
1	4.17	1.8×10^{17}	55
2	15 (approx.)	6.3×10^{17} (approx.)	91
3	End of Life	1.4×10^{18} (approx.)	136

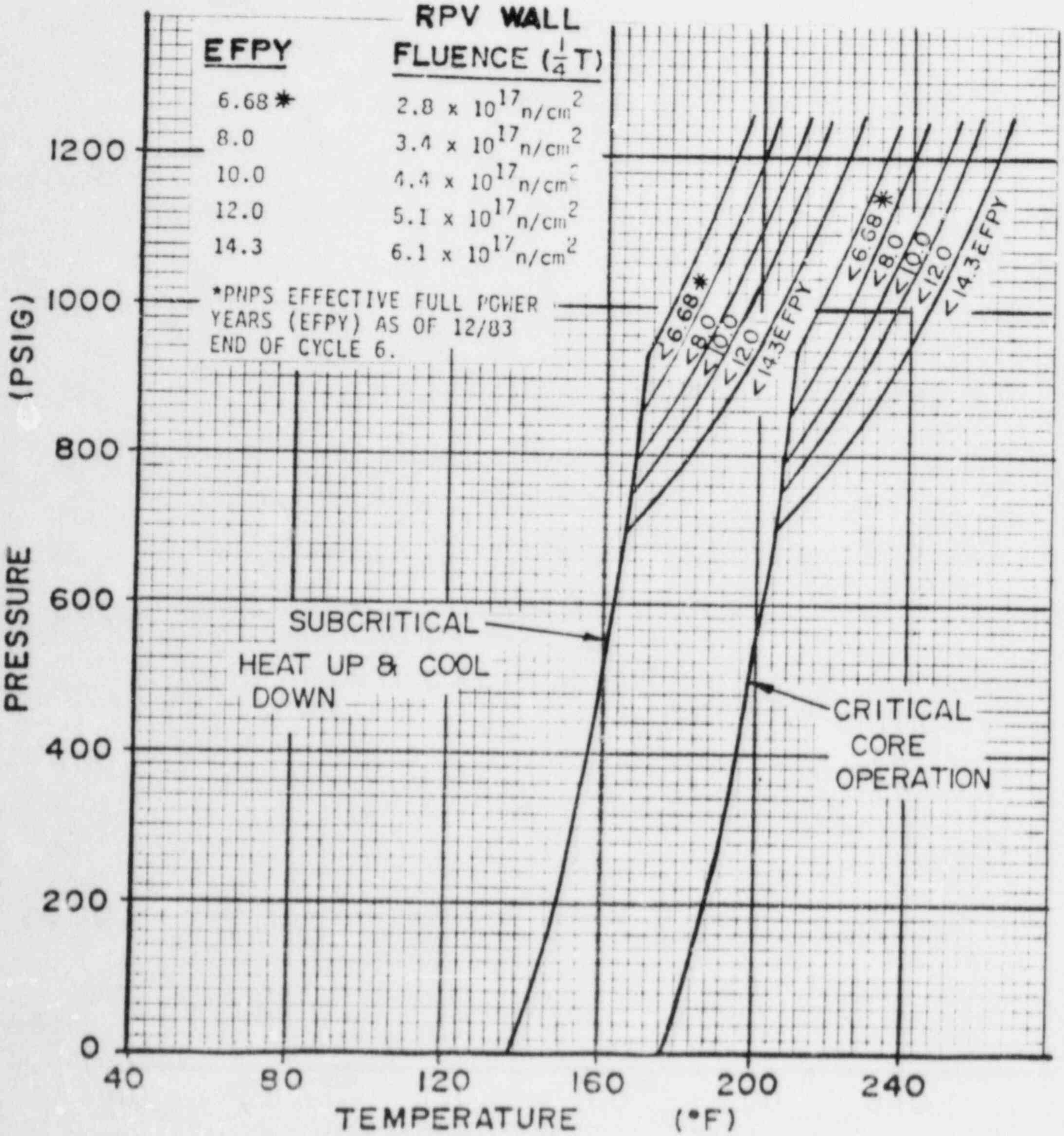
FIGURE 3.6.1
PILGRIM REACTOR VESSEL
PRESSURE - TEMPERATURE LIMITS
HYDROSTATIC AND LEAK TESTS



EFPY	RPV WALL FLUENCE ($\frac{1}{4}$T)
6.68*	$2.8 \times 10^{17} n/cm^2$
8.0	$3.4 \times 10^{17} n/cm^2$
10.0	$4.4 \times 10^{17} n/cm^2$
12.0	$5.1 \times 10^{17} n/cm^2$
14.3	$6.1 \times 10^{17} n/cm^2$

*PNPS EFFECTIVE FULL POWER YEARS (EFPY) AS OF 12/83 END OF CYCLE 6.

FIGURE 3.6.2
PILGRIM REACTOR VESSEL
PRESSURE - TEMPERATURE LIMITS
SUBCRITICAL/CRITICAL HEAT UP & COOL DOWN



AMENDMENT NO. 128A

Bases:

3.6.A and 4.6.A

Thermal and Pressurization Limitations (Cont'd)

The reactor coolant system is a primary barrier against the release of fission products to the environs. In order to provide assurance that this barrier is maintained at a high degree of integrity, restrictions have been placed on the operating conditions to which it can be subjected.

Appendix G to 10CFR50 defines the temperature-pressurization restrictions for hydrostatic and leak tests, pressurization, and critical operation. These limits have been calculated for Pilgrim and are contained in Figures 3.6.1 and 3.6.2.

For Pilgrim pressure-temperature restrictions, two locations in the reactor vessel are limiting. The closure region controls at lower pressures and the beltline controls at higher pressures.

The nil-ductility transition (NDT) temperature is defined as the temperature below which ferritic steel breaks in a brittle rather than ductile manner. Radiation exposure from fast neutrons (>1 mev) above about 10^{17} nvt may shift the NDT temperature of the vessel metal above the initial value. Impact tests from the first material surveillance capsule removed from the reactor vessel have established the magnitude of the RT_{NDT} shift for the beltline. The shift, which is greatest for the weld metal, is tabulated below for various fluence levels and EFPY of operation:

EFPY	RPV Wall Fluence (1/4T)	RT_{NDT}
6.68*	2.8×10^{17} n/cm^2	61°F
8.0	3.4×10^{17} n/cm^2	68°F
10.0	4.4×10^{17} n/cm^2	76°F
12.0	5.1×10^{17} n/cm^2	82°F
14.3	6.1×10^{17} n/cm^2	90°F

*PNPS Effective Full Power Years (EFPY) as of end of Cycle 6 (12/83)

Neutron flux wires and samples of vessel material are installed in the reactor vessel adjacent to the vessel wall at the core midplane level. The wires and samples will be periodically removed and tested to experimentally verify the values used for Figures 3.6.1 and 3.6.2. The withdrawal schedule of Table 4.6.2 has been established as required by 10CFR50, Appendix H.

The pressure-temperature limitations of Figures 3.6.1 and 3.6.2 applicable to the beltline reflect an initial RT_{NDT} of 0°F. This initial value is based

Bases:

3.6.A and 4.6.A

Thermal and Pressurization Limitations (Cont'd)

on unirradiated test data adjusted for specimen orientation in accordance with USNRC Branch Technical Position MTEB 5-2.

The pressure-temperature limitations of Figures 3.6.1 and 3.6.2 applicable to the closure region reflect an RT_{NDT} of -5°F, also based on test data adjusted for specimen orientation. The curves apply to 100% bolt preload condition, but are conservative for lesser bolt preload conditions.

For critical core operation when the water level is within the normal range for power operation and the pressure is less than 20% of the preservice system hydrostatic test pressure (313 psi), the minimum permissible temperature of the highly stressed regions of the closure flange is RT_{NDT} + 60 = 55°F.

The closure region is more limiting than the feedwater nozzle with regards to both stress intensity and RT_{NDT}. Therefore the pressure-temperature limits of the closure are controlling.