

## LIMITING CONDITIONS FOR OPERATION

### 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.
2. During operation where the core is critical or during heatup by nonnuclear means or cooldown following shutdown, the reactor vessel metal and fluid temperatures shall be at or above the temperatures shown on the limiting curves of Figures 3.6.1.a or 3.6.1.b. This specification applies when the reactor vessel head is tensioned.
3. The reactor vessel metal temperatures for the bottom head region and beltline region shall be at or above the temperatures shown on the limiting curves of Figure 3.6.2 during inservice hydrostatic or leak testing. The Adjusted Reference Temperature (ART) for the beltline region must be determined from the appropriate beltline curve (13, 18, or 21 EFPY) depending on the current accumulated number of effective full power years (EFPY).

## SURVEILLANCE REQUIREMENTS

### 4.6 Primary System Boundary

#### Applicability:

Applies 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 50°F.
  - a. Bottom head drain.
  - b. Recirculation loops A and B.
2. Reactor vessel 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.
3. 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 ASTM E 185-73 to the degree possible.

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## 3.6.A (cont'd.)

4. 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 80°F.
5. 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.
6. The reactor recirculation pumps shall not be started unless the coolant temperatures between the dome and the bottom head drain are within 145°F.

## 4.6.A (cont'd.)

The reactor vessel surveillance specimens shall be removed and examined to determine changes in their material properties as required by 10 CFR 50 Appendix H.

4. 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.
5. 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.
6. 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.

### 3.6.A & 4.6.A BASES (cont'd)

As described in the safety analysis report, detailed stress analyses have been made on the reactor vessel for both steady-state and transient conditions with respect to material fatigue. The results of these analyses are compared to allowable stress limits. Requiring the coolant temperature in an idle recirculation loop to be within 50°F of the operating loop temperature before a recirculation pump is started assures that the changes in coolant temperature at the reactor vessel nozzles and bottom head region are acceptable.

The coolant in the bottom of the vessel is at a lower temperature than that in the upper regions of the vessel when there is no recirculation flow. This colder water is forced up when recirculation pumps are started. This will not result in stresses which exceed ASME Boiler and Pressure Vessel Code, Section III limits when the temperature differential is not greater than 145°F.

The first surveillance capsule was removed at 6.8 EFPY of operation and base metal, weld metal and HAZ specimens were tested. In addition, flux wires were tested to experimentally determine the integrated neutron flux (fluence) at the surveillance capsule location. The test results are presented in General Electric Report MDE-103-0986. Measured shifts in  $RT_{NDT}$  of the base metal and weld metal were compared to predicted values per Regulatory Guide 1.99, Revision 1 which was in effect at that time. The measured values were higher than predicted, so the 1.99 methods were modified to reflect the surveillance data. The test results for the flux wires were used with analytically determined lead factors to determine the peak end-of-life (EOL) fluence at the 1/4 T Vessel wall depth. The value corresponding to 40 years operation (32 EFPY) is  $1.5 \times 10^{18}$  n/cm<sup>2</sup>.

Subsequent to this evaluation, the NRC issued Regulatory Guide 1.99, Revision 2. This revision requires that two surveillance capsules be tested before the test results are factored into the adjusted reference temperature (ART) shift predictions. The adjusted reference temperature of a beltline material is defined as the initial  $RT_{NDT}$  plus the  $RT_{NDT}$  due to irradiation. Therefore, the curves developed from the initial surveillance capsule testing were re-evaluated in accordance with the guidance provided in Regulatory Guide 1.99 Revision 2. Based strictly on the chemistry factors provided in Regulatory Guide 1.99, Revision 2, and considering each beltline material chemistry and peak fluence at a given EFPY, the pressure temperature curves in Figures 3.6.1.a and 3.6.1.b, which reflect a beltline ART of 110°F, were determined to be valid for 21 EFPY. Figure 3.6.2, the pressure test curve, was re-evaluated in like manner and includes curves for 13, 18 and 21 EFPY to provide more flexibility in pressure testing. Figure 3.6.2 also has a separate curve for the bottom head region. The bottom head curve does not shift with increased operation; therefore, the bottom head temperature can be monitored against lower temperature requirements than the beltline during pressure testing. The surveillance capsule withdrawal schedule for the remaining specimens is located in Section IV.2.7 of the CNS USAR.

#### B. Coolant Chemistry

Materials in the primary system are primarily Type-304 stainless steel and Zircaloy cladding. The reactor water chemistry limits are established to provide an environment favorable to these materials. Limits are placed on conductivity and chloride concentrations. Conductivity is limited because it can be continuously and reliably measured and gives an indication of abnormal conditions and the presence of unusual materials in the coolant. Chloride limits are specified to prevent stress corrosion cracking of stainless steel.

Several investigations have shown that in neutral solutions some oxygen is required to cause stress corrosion cracking of stainless steel, while in the absence of oxygen no cracking occurs. One of these is the chloride-oxygen relationship of Williams<sup>2</sup>, where it is shown that at high chloride concentration little oxygen is required to cause stress corrosion cracking of stainless steel, and at high oxygen concentration little chloride is required to cause cracking. These measurements were determined in a wetting and drying situation using alkaline-phosphate-treated boiler water and therefore, are of limited significance to BWR conditions. They are, however, a qualitative indication of trends.

<sup>2</sup>W. L. Williams, Corrosion 13, 1957, p. 539t.

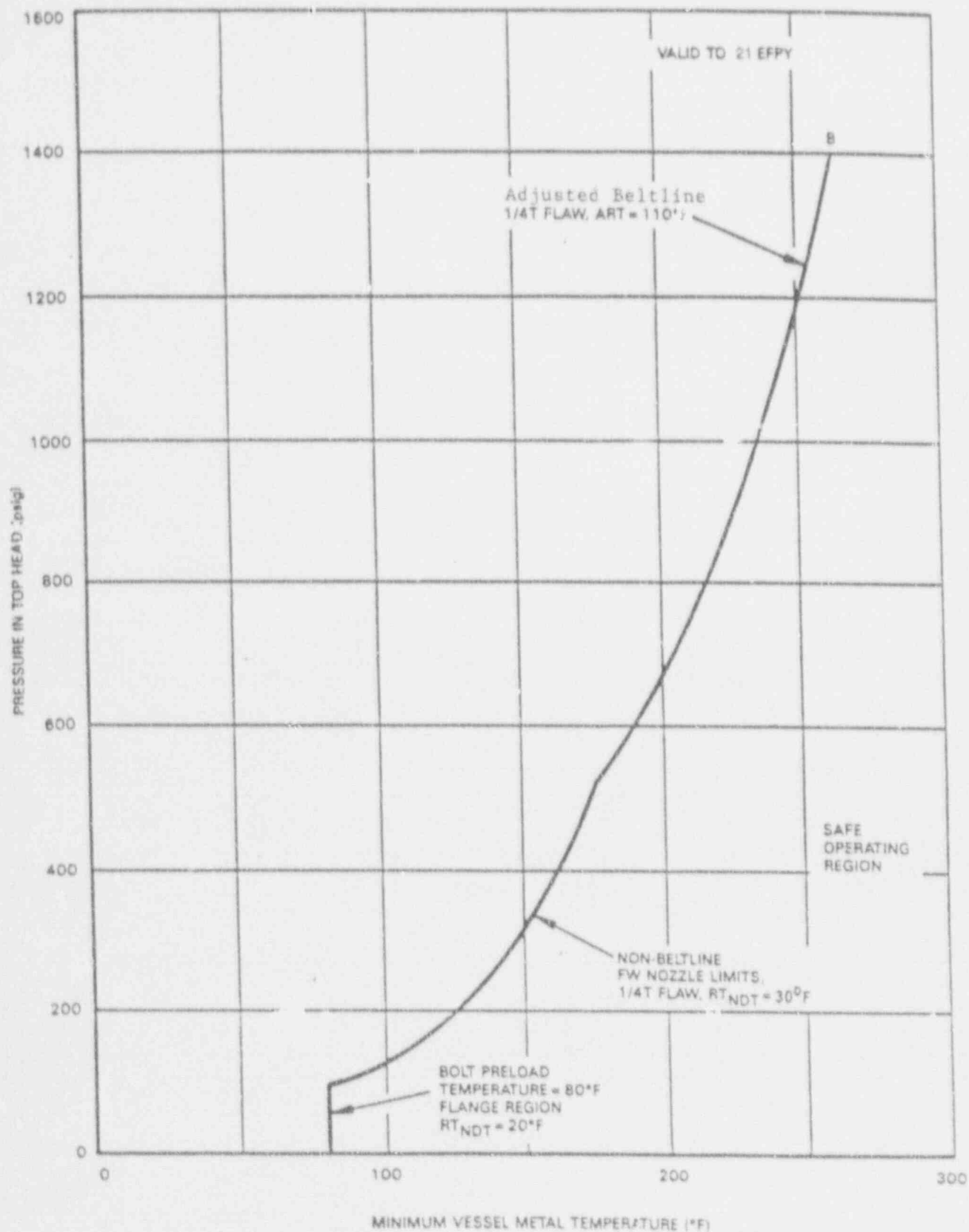


Figure 3.6.1.a Minimum Temperature for Non-Nuclear Heatup or Core Cooldown Following Nuclear Shutdown

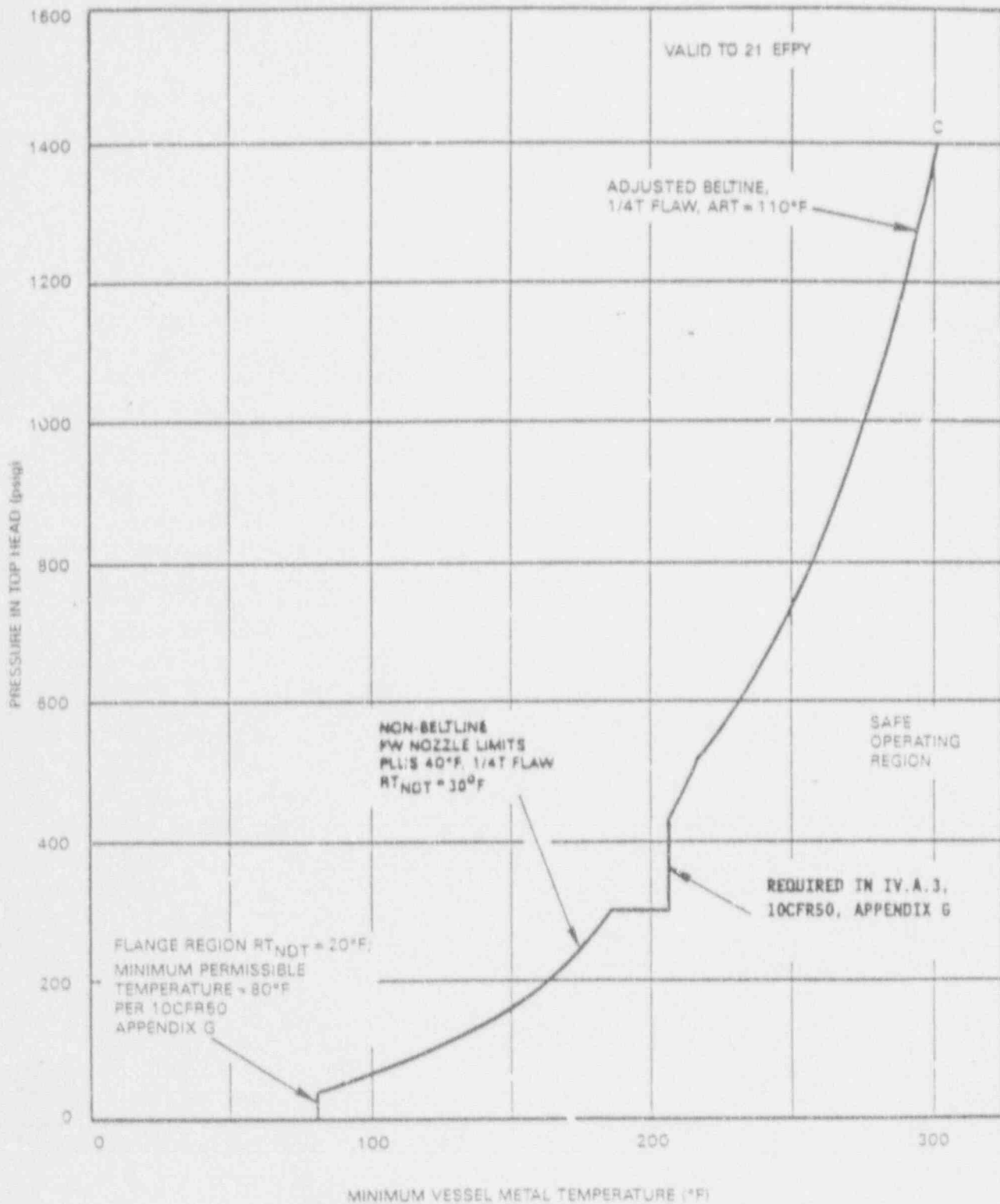


Figure 3.6.1.b Minimum Temperature for Core Operation (Criticality) - Includes 40°F Margin Required by 10CFR50 Appendix G

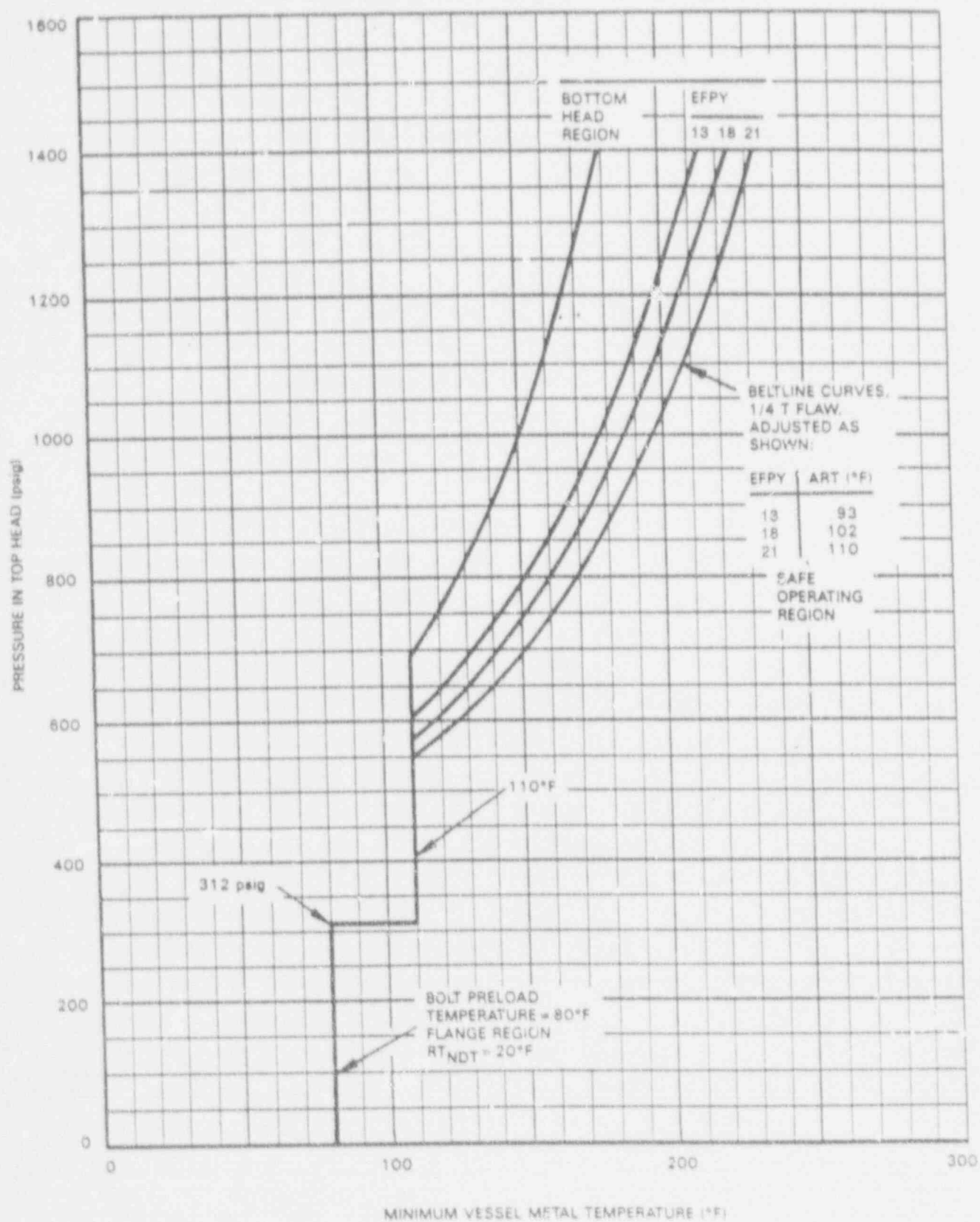


Figure 3.6.2 Minimum Temperature for Pressure Tests Such as Required by Section XI



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