POWER DISTRIBUTION LIMITS

3/4.2.3 MINIMUM CRITICAL POWER RATIO

LIMITING CONDITION FOR OPERATION

3.2.3 The MINIMUM CRITICAL POWER RATIO (MCPR) shall be equal to or greater than the MCPR limit shown in Figure 3.2.3-1 times the K_f shown in Figure 3.2.3-2, with:

$$\tau = \frac{(\tau_{ave} - \tau_B)}{\tau_A - \tau_B}$$

where:

τ_A = 1.096 seconds, control rod average scram insertion time limit to notch 36 per Specification 3.1.3.3,

$$\tau_B = 0.852 + 1.65\left[\frac{N_1}{\sum_{i=1}^{n} N_i}\right]^{\frac{1}{2}} 0.06,$$

$$\tau_{ave} = \frac{\sum_{i=1}^{n} N_i \tau_i}{\sum_{i=1}^{n} N_i},$$

n = number of surveillance tests performed to date in cycle,

N_i = number of active control rods measured in the i^{th} surveillance test,

τ_i = average scram time to notch 36 of all rods measured in the i^{th} surveillance test, and

N_1 = total number of active rods measured in Specification 4.1.3.2.a.

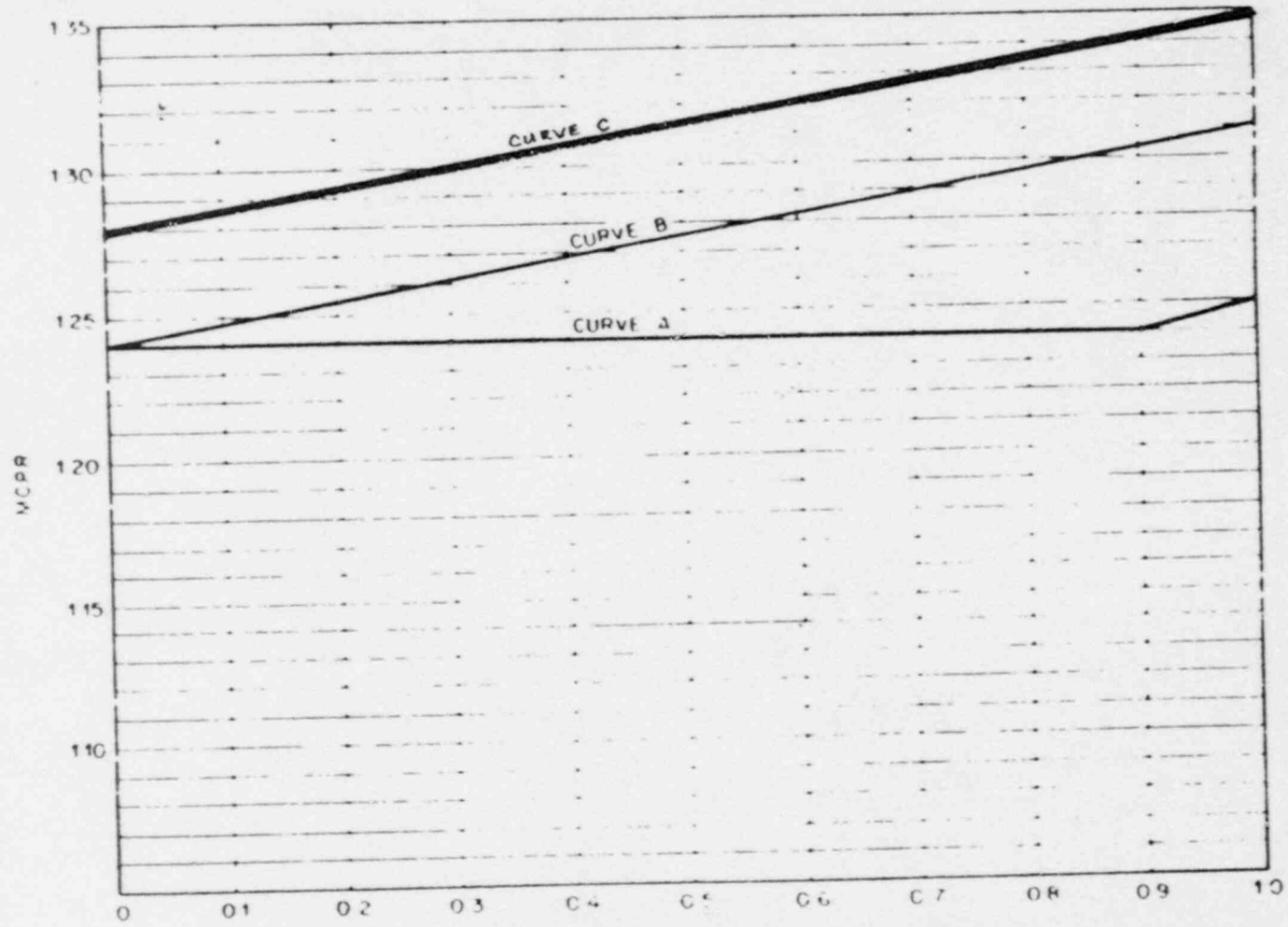
APPLICABILITY:

OPERATIONAL CONDITION 1, when THERMAL POWER is greater than or equal to 25% of RATED THERMAL POWER.

ACTION

a. With MCPR less than the applicable MCPR limit shown in Figures 3.2.3-1 and 3.2.3-2, initiate corrective action within 15 minutes and restore MCPR to within the required limit within 2 hours or reduce THERMAL POWER to less than 25% of RATED THERMAL POWER within the next 4 hours.

b. With the main turbine bypass system and/or Moisture Separator Reheater inoperable per Specification 3.7.9, operation may continue and the provisions of Specification 3.0.4 are not applicable provided that, within one hour, MCPR is determined to be equal to or greater than the MCPR limit as shown in Figure 3.2.3-1 by the main turbine bypass and/or Moisture Separator Reheater inoperable curves times the applicable K_f shown in Figure 3.2.3-2.



CURVE A - MCPR LIMIT WITH MAIN TURBINE BYPASS
CURVE B - MCPR LIMIT WITHOUT MAIN TURBINE BYPASS OR WITHOUT MOISTURE SEPARATOR REHEATER
CURVE C - MCPR LIMIT WITHOUT MAIN TURBINE BYPASS AND WITHOUT MOISTURE SEPARATOR REHEATER

MINIMUM CRITICAL POWER RATIO (MCPR) VERSUS τ AT RATED FLOW

FIGURE 3.2.3-1

3/4.2.3 MINIMUM CRITICAL POWER RATIO

The required operating limit MCPRs at steady-state operating conditions as specified in Specification 3.2.3 are derived from the established fuel cladding integrity Safety Limit MCPR of 1.06, and an analysis of abnormal operational transients. For any abnormal operating transients analysis evaluation with the initial condition of the reactor being at the steady state operating limit, it is required that the resulting MCPR does not decrease below the Safety Limit MCPR at any time during the transient assuming instrument trip setting given in Specification 2.2.

To assure that the fuel cladding integrity Safety Limit is not exceeded during any anticipated abnormal operational transient, the most limiting transients have been analyzed to determine which result in the largest reduction in CRITICAL POWER RATIO (CPR). The type of transients evaluated were loss of flow, increase in pressure and power, positive reactivity insertion, and coolant temperature decrease. The limiting transient yields the largest delta MCPR. When added to the Safety Limit MCPR of 1.06, the required minimum operating limit MCPR of Specification 3.2.3 is obtained and presented in Figure 3.2.3-1.

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The evaluation of a given transient begins with the system initial parameters shown in ~~FSAR~~ UFSAR Table ~~15D.0-1~~ 15.0-1 that are input to a GE-core dynamic behavior transient computer program. The code used to evaluate pressurization events is described in NEDO-24154[3] and the program used in nonpressurization events is described in NEDO-10802[2]. The outputs of this program along with the initial MCPR form the input for further analyses of the thermally limiting bundle with the single channel transient thermal hydraulic TASC code described in NEDE-25149[4]. The principal result of this evaluation is the reduction in MCPR caused by the transient.

The purpose of the K_f factor of Figure 3.2.3-2 is to define operating limits at other than rated core flow conditions. At less than 100% of rated flow the required MCPR is the product of the MCPR and the K_f factor. The K_f factors assure that the Safety Limit MCPR will not be violated during a flow increase transient resulting from a motor-generator speed control failure. The K_f factors may be applied to both manual and automatic flow control modes.

The K_f factor values shown in Figure 3.2.3-2 were developed generically and are applicable to all BWR/2, BWR/3, and BWR/4 reactors. The K_f factors were derived using the flow control line corresponding to RATED THERMAL POWER at rated core flow.

For the manual flow control mode, the K_f factors were calculated such that for the maximum flow rate, as limited by the pump scoop tube setpoint and the corresponding THERMAL POWER along the rated flow control line, the limiting bundle's relative power was adjusted until the MCPR changes with different core flows. The ratio of the MCPR calculated at a given point of core flow, divided by the operating limit MCPR, determines the K_f.

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The MCPR curves illustrated in Figure 3.2.3-1 were derived as described above for the following assumed operating conditions:

Curve A - MCPR limit with the main turbine bypass system and moisture separator reheater available. This represents a total reactor steam flow bypass capability of approximately 36 percent.

Curve B - MCPR limit with the main turbine bypass system inoperative and moisture separator reheater available. This represents a total reactor steam flow bypass capability of approximately 10 percent.

Curve C - MCPR limit with both the main turbine bypass system and moisture separator reheater inoperative. This represents no reactor steam flow bypass capability.

Curve A provides the MCPR limit assuming operation above 25 percent RATED THERMAL POWER with both the moisture separator reheater and main turbine bypass system operable. The curve was developed based upon the operating MCPR limits for a Rod Withdrawal Error transient (UFSAR, Section 15.4.2) and a Main Turbine Trip with Turbine Bypass Failure transient (UFSAR, Section 15.2.3). The analysis of the Main Turbine Trip with Turbine Bypass Failure takes credit for the steam flow to the moisture separator reheater.

Curve B provides the MCPR limit assuming operation above 25 percent RATED THERMAL POWER with the moisture separator reheater operable and the main turbine bypass system inoperable. The curve was developed based upon the operating MCPR limits for a Feedwater Controller Failure with Inoperable Turbine Bypass transient. The analysis of the Feedwater Controller Failure transient also takes credit for steam flow to the moisture separator reheater.

Operation with the main turbine bypass inoperable or with a moisture separator reheater inoperable results in a total reactor steam flow bypass capability of approximately 10 percent and 26 percent, respectively. The impact of operation with the moisture separator reheater inoperable but with bypass operable and utilization of Curve B is conservative because the 26 percent bypass capability is less limiting with regard to the existing analysis used to establish Curve B which assumes only 10 percent bypass capability (with the main turbine bypass system inoperable). Therefore, the operation above 25 percent RATED THERMAL POWER with either the moisture separator reheater inoperable or main turbine bypass system inoperable is bounded by the existing Curve B.

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Curve C provides the MCPR limit assuming operation above 25 percent RATED THERMAL POWER with both the moisture separator reheater and main turbine bypass system inoperable. The curve was developed based upon the operating MCPR limits for a Feedwater Controller Failure with Inoperable Turbine Bypass transient assuming no steam flow through the moisture separator reheater.

There is no mode change restraint should the main turbine bypass or the moisture separator reheater be inoperable. However, should the main turbine bypass system or the moisture separator reheater be inoperable as 25 percent RATED THERMAL POWER is exceeded, the MCPR check must be completed within one hour.

3/4.7.9 MAIN TURBINE BYPASS SYSTEM

LIMITING CONDITION FOR OPERATION

3.7.9 The main turbine bypass system and Moisture Separator Reheater shall be OPERABLE.

APPLICABILITY: OPERATIONAL CONDITION 1 when THERMAL POWER is greater than or equal to 25% of RATED THERMAL POWER.

ACTION: With the main turbine bypass system or Moisture Separator Reheater inoperable, restore the system to OPERABLE status within 1 hour or take the ACTION required by Specification 3.2.3.

SURVEILLANCE REQUIREMENTS

4.7.9 The main turbine bypass system shall be demonstrated OPERABLE at least once per:

a. 92 days and during each COLD SHUTDOWN, by cycling each turbine bypass valve through at least one complete cycle of full travel, and

b. 18 months by:

1. Performing a system functional test which includes simulated automatic actuation and verifying that each automatic valve actuates to its correct position.

2. Demonstrating TURBINE BYPASS SYSTEM RESPONSE TIME to be less than or equal to 300 milliseconds.

3/4.7.9 MAIN TURBINE BYPASS SYSTEM

~~The main turbine bypass system is required to be OPERABLE consistent with the assumptions of the feedwater controller failure analysis for FSAR Chapter 15.~~

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3/4 7.9 MAIN TURBINE BYPASS SYSTEM

The main turbine bypass system is an active bypass system designed to open the bypass valves in the event of a turbine trip to decrease the severity of the pressure transient. Each valve is sized to pass a nominal 13 percent reactor steam flow in the full-open position for a controlled total bypass of approximately 26 percent reactor steam flow. The main turbine bypass system is required to be OPERABLE consistent with the assumptions of the Feedwater Controller Failure with Inoperable Turbine Bypass analysis.

The primary purpose of the moisture separator reheater is to improve cycle efficiency by using primary system steam to heat the high pressure turbine exhaust before it enters the low-pressure turbines. In doing so, it also provides a passive steam bypass flow of about 10 percent that mitigates the early effects of over-pressure transients. The moisture separator reheater is required to be OPERABLE consistent with the assumptions of the Main Turbine Trip with Turbine Bypass Failure analysis and the Feedwater Controller Failure analysis.

The operation with one or both of the main turbine bypasses inoperable or the moisture separator reheater inoperable to perform preventive or corrective maintenance above 25 percent RATED THERMAL POWER, requires, after one hour, the evaluation of the MCPR in accordance with Specification 3.2.3. If the MCPR is within the bounds established by Specification 3.2.3, power increases to or operation above 25 percent RATED THERMAL POWER is allowed.