ATTACHMENT A

NEW AND REVISED PAGES FOR THE

SEFOR TECHNICAL SPECIFICATIONS

REVISION 2 OF

PROPOSED CHANGE NO. 4

3.13 Operating Limits

Applicability

Applies to parameters observed or measured during steady state reactor operation.

Objective

To establish limits on important parameters which will detect anomalous reactor behavior and to establish limits for steady state operation with known loss of clad integrity.

Specification

A. The limits for unexplained behavior shall be as given below. If these limits are exceeded, the actions specified in Section 4.9.B shall be taken.

1. An unexplained increase of more than 500 mr/hr in the reading of the cover gas monitor shall be considered anomalous.

2. A change in steady state reactivity of more than $\pm$10 cents from the predicted value at the reactor operating conditions shall be considered anomalous.

3. Changes to the equation used to predict reactivity shall be reported to the DRL if such changes, excluding those due to core loading adjustments and burnup, result in a change of more than $\pm$20 cents from the equation previously reported to the DRL, when the equation is evaluated at a power level of 20 MWt with an average coolant temperature of 760°F.

4. The main primary coolant flow rate shall be considered anomalous if it differs by more than ±300 GPM from the calculated flow rate for flow rates above 1000 GPM, or if it deviates from an established flow rate by more than ±300 GPM at flow rates below 1000 GPM.

5. The auxiliary primary flow rate shall be considered anomalous if it differs by more than ±20 GPM from the calculated flow rate.

6. A difference of more than 60°F between the upper reactor vessel outlet temperature and the Resistance Temperature Detectors (RTD's) in the reactor vessel main primary outlet pipe shall be considered anomalous.

B. The reactor shall not be operated, except for diagnostic tests, if the cover gas monitor reading exceeds 9000 mr/hr.

Bases

The reactor and auxiliary systems (including the radwaste system) have been designed so that steady state operation with five failed fuel rods can be accommodated[1,2]. The cover gas monitor is capable of detecting loss of clad integrity if it occurs[3]. The cover gas monitor will also respond to fission products escaping from pin hole leaks, which may occur in some fuel rods but which are not classed as cladding failures or defective fuel.[4]

Analyses of the reactor cover gas have shown that the normal background activity is due to 38 sec Ne^{23} and 1.8 hr A^{41}, with Ne^{23} being the major contributor. Due to the short half-life of Ne^{23}, the cover gas monitor may show a temporary increase on the order of 100 mr/hr due to cover gas system transients, such as cover gas pressure control valve operation. Such increases would not be considered anomalous, since the Ne^{23} comes from the sodium, rather than the fuel.

The normal background activity due to A^{41} and Ne^{23} may result in a cover gas monitor reading of as much as 100 mr/hr at 20 MWt, depending on operating conditions, such as sodium temperature and sampling flow rate.

The activity in the cover gas may also increase due to pin hole leaks in some fuel rods or as the result of cladding failures. The initial increase in activity from any cause will be treated as an anomaly if it exceeds the specified limit, and appropriate actions will be taken. When reactor operation is subsequently resumed, as provided for in Section 4.9 and other relevant sections of the Technical Specifications, the new level of activity will be considered to be the normal background for purposes of identifying subsequent anomalous conditions.

Changes in cover gas activity are reported as required by paragraph 6.6.A.4 of the Technical Specifications.

If the fission gases were released from an average fuel rod due to cladding failure following operation at 20 MWt for three days, the cover gas monitor reading would increase by 1610 mr/hr due to the fission gases[5]. The specified anomaly limit is approximately one-third of this value, which provides additional safety margin. The fission gases actually present in any fuel rod will depend on its operating history, but the value of 500 mr/hr represents a reasonable lower limit for detection of a significant release of fission gases. This limit also assures the capability of detecting a change in cover gas activity due to a loss of cladding integrity which exposes fuel to the sodium.

The SEFOR reactor operates over a wide range of temperature and power conditions in the course of the defined experimental program. To follow normal experimental reactor conditions requires a predictive capability for a broad range of conditions. To establish definitive criteria for anomalous reactivity, careful reactivity balances and comparisons have been maintained during zero power testing, fuel arrangement and the power ascension to 10 MWt. Inconsequential random and systematic errors normally are less than the ±10 cents maximum disparity between predicted and measured reactivity values.[6] The limit is restrictive enough to alert the operator and staff to items of consequence, e.g. significant changes in the reactor coefficients, erroneous fuel arrangements or other problems.

The equation used to predict the steady state reactivity value at given reactor operating conditions was given in Reference 6. Changes may be made to this equation from time to time, based on changes in core loading, fuel restructuring, or other changes which are properly identified. All changes will be documented and will be reviewed by the Site Safety Committee. The specified reporting requirement allows the necessary flexibility for making appropriate changes and also provides assurance that the DRL will be informed of significant or unforeseen changes in core reactivity.

Comparison of the coolant flow rate to the pump characteristic provides a cross comparison between the pump performance and the magnetic flowmeter. The plant is protected from abrupt and large losses of flow by the low flow trips at 80% of the set point flow rate for the main coolant system. The requirement for comparison of measured flow to predicted flow will alert the operator to any deterioration in performance of either the pump or the magnetic flowmeter. The specified limits are large enough to exclude variations due to random errors and repeatability considerations, but small enough to detect incipient problems before they have a detrimental effect on reactor cooling.(6)

Because the outlet temperatures vary so widely over the course of the experiments, it is necessary to have criteria which will be applicable to all conditions. The comparison between the vessel exit RTD's and the upper reactor vessel outlet temperatures provides a cross-check on both instruments. The allowable variation was obtained by examining the difference between these two temperature devices over the testing completed up to 10 MWt, including the natural circulation tests. The value of $\pm 60°F$ is slightly larger than any variation obtained to date. Calculations indicate that for full flow, full power, there should be 12°F difference for the as-designed core, although larger differences may occur due to local temperature variations.(6) A difference in these temperatures of 60°F would correspond to approximately 35% of the total vessel flow bypassing the core compared to the design condition of 10% bypass leakage. It could also be caused by changes in flow distribution due to orificing effects at low flow rates. These conditions are not detrimental to the core.(7) The resulting upper region temperatures would be below the trip limit of 900°F for these sensors. The 60°F limit would assure detection of such a condition before the situation became serious.

The criterion for continued reactor operation with possible or known loss of cladding integrity is based on the ability of the cover gas monitor to detect additional changes in cover gas activity. The cover gas monitor has a full scale capability of 10,000 mr/hr. If the reading were to exceed 9000 mr/hr, detection of changes on the order of 500 mr/hr could not be assured.

A full scale reading of 10,000 mr/hr could be caused by various levels of cover gas activity, depending on isotopic composition. For example, if cladding defects in five average rods permitted the release of fission gases with no additional hold up time, the cover gas monitor would reach its full scale reading after three days' operation at 20 MWt[5].

Reactor operation for the purpose of performing diagnostic tests is permitted when the cover gas monitor reading exceeds the specified limit, so that cover gas samples and other data can be obtained to aid in the diagnosis of the problem.

Data obtained from the isotopic analysis of cover gas samples and the results of fuel rod examinations, required by other sections of the Technical Specifications, will be used to determine whether or not there is evidence that the core contains defective fuel rods. Excursion tests are prohibited if there is such evidence,[8] but steady state operation is permissible.[9]

References

1. SEFOR Technical Specifications, p 3.7-4, bases for 3.7.H.

2. SEFOR FDSAR, Supplement 21, Section I.

3. SEFOR FDSAR, Supplement 21, Section II.

4. SEFOR Technical Specificatins, pp 3.3-5, 6, bases for 3.3.K.

5. Table II: Rev. 2 of Proposed Change No. 4 to the SEFOR Technical Specifications, December 22, 1970.

6. Rev. 1 of Proposed Change No. 4 to the SEFOR Technical Specifications, December 11, 1970.

7. SEFOR FDSAR, Supplement 18, pp 9-11.

8. SEFOR Technical Specifications, paragraph 3.12.B.10.

9. SEFOR Technical Specifications, Section 4.9.B.