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I. DISCUSSION OF CRITERIA SELECTION

The primary objectives in establishing the applicable design criteria for the modifications to the MSG for use in sodium-water reaction testing are listed below.

1. Utilize Section III, Class 1 design criteria consistent with application to a limited life test object.
2. Avoid inelastic analysis.
3. Take advantage of the short test time.

Some of the pertinent considerations for implementing the above objectives are:

1. During the specified design life of 200 hr at 900°F, creep rupture effects are negligible, as can be seen from Figure 1, which is a plot of S_m and S_t from Code Case 1331-8. At 900°F, for times less than several thousand hours, the primary stress allowable is governed by S_m , which is a function of short time tensile properties, rather than S_t , which is a function of creep characteristics.
2. For the temperature and time duration experienced during steam generator operation to date, including this anticipated test program, there has not been any reduction in properties of the steam heads and sodium shell due to carbon transport. (Ref. ER-036-203-001, "ASME Code Case 1331-8 Properties for Decarburized 2-1/4 Mo Alloy Steel in LMFBR Service," by Anderson and Meyer, 9/28/73.)
3. A maximum of eight tests are planned with an inspection after each test to identify any structural damage to the pressure boundary.
4. Part of the structure to be tested is existing hardware and "as-built" dimensions can be used to evaluate the stresses resulting from the planned test program.

Fig. 85 2% Cr/1 Mo: S_{mt} vs. temperature limiting criteria

5. The steam side of the MSG will be essentially isothermal prior to and during the test. Heating and cycling rates will be slow. The sodium side will experience large thermal transients during the test, but, prior to the test, the sodium side will also be essentially isothermal. Prior to the test, there will be a difference in sodium inlet and outlet temperature that corresponds to the conditions for which the MSG was designed.

The above considerations have led to the following philosophy in selection of design criteria.

1. The Section III, Class 1 design rules will be used without Code Case 1331. Since Section III only provides values of S_m for 2-1/4 Cr-1 Mo up to 700°F, the S_m values from Code Case 1331-8 will be used. The rationale behind this is shown on Figure 1. As previously discussed, the allowable primary stress is not a function of the creep characteristics.
2. Except as noted below, secondary stress and fatigue evaluation is not required. The existing structure on the steam side of the MSG was designed for pressures and thermal transients exceeding the test conditions. On the sodium side, prior to the test, the temperatures and pressures are also less severe than the conditions for which the MSG was designed. The new structure added to the MSG will only see eight cycles and there will be inspections after each test. The primary purpose of secondary stress limits is to insure that the assumptions of the fatigue analysis are valid. Since fatigue is not a basic consideration for as few as eight cycles with inspections after each cycle, the secondary stress evaluation is also not required.
3. Because of the thermal shocks which occur in the sodium during a test, a thermal ratchet evaluation will be performed to insure that there is not excessive deformation and strain.

4. The expected sodium side pressure is based on a single tube rupture and is considered as an Emergency condition for stress evaluation. This is consistent with the small number of tests, the criteria for which the basic MSG shell was designed and the plan to inspect after each test. The possibility of a seven tube rupture equivalent pressure will be evaluated as a Faulted condition.
5. The steam side temperatures and pressures will be evaluated as Design Conditions using the Section III design rules and material properties from Code Case 1331-8.