# PROPOSED CHANGE NO. 3

# FOR THE

# SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR

Re: LICENSE DR-15

DOCKET 50-231



GENERAL ELECTRIC COMPANY

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## Proposed Change No. 3
## for the
## Southwest Experimental Fast Oxide Reactor

### I. Introduction

Under the authority of License DR-15, General Electric operates the Southwest Experimental Fast Oxide Reactor at a site near Strickler, Arkansas.

A revision of the current Technical Specifications is desired as described herein. The applicable revised pages of the Technical Specifications are also included as Attachment A.

### II. Proposed Changes

Pursuant to the provisions of 10 CFR 50.59, General Electric requests that the Technical Specifications be changed by substituting the pages, numbered 3.3-1, 3.3-5, 3.10-3, 4.3-1 and 4.3-2 in Attachment A of this document, for corresponding pages of the current Technical Specifications. The proposed changes to the current Technical Specifications are indicated by brackets in the margin on the enclosed pages.

### III. Purpose of the Proposed Change

The present Technical Specifications require removal of guinea pig fuel rods located under the three innermost refueling ports during steady state reactor operations above 17.5 MWt. The purpose of the proposed change is to provide additional information to confirm the margin of safety for standard fuel rods by utilizing the guinea pig principle over the full operating range of the reactor.

This change will also provide data on the thermal performance of mixed oxide fuel in a fast neutron environment. These data may demonstrate that the currently used lower error band on fuel thermal conductivity is unnecessarily conservative and would, as a minimum, increase the confidence in the fuel design of the LMFBR Demonstration Plant.

Tests conducted during the SEFOR pre-operational R&D Program have demonstrated that the guinea pig fuel rods will exhibit safe performance at the 20 MWt power level, and fuel rod inspections, utilizing procedures called for in the Technical Specifications, will be used to verify the condition of the guinea pig rods after operation at 20 MWt.

IV. Reason for the Proposed Change

Guinea pig fuel rods under the innermost refueling ports operate at a peak linear power density which is 15% higher than that of a standard fuel rod nearest the center of the core. This relationship was used to establish the last three power levels in the approach to power, namely, 15, 17.5 and 20 MWt. Thus, examination of guinea pig fuel rods, which is required by the current Technical Specifications after operation at 15 and 17.5 MWt, will provide information which will verify the safety of operating the standard fuel rods at the next power level. By using this method, a maximum of six guinea pig fuel rods are exposed to operation at power generation rates previously untested in this reactor. If the guinea pig principle were not used, 90 to 100 standard fuel rods would be subjected to such exposure at each step in the approach to power.[1]

The present plan, calling for removal of the innermost guinea pig rods for operation at power levels above 17.5 MWt, provides advance information for standard fuel rods only up to the nominal reactor power level of 20 MWt. It does not verify the capability of the fuel rods at the LSSS (21 MWt) or at the safety limit (22 MWt). The pre-operational R&D Program has demonstrated that SEFOR fuel rods can be operated at power generation rates well above the rates corresponding to these reactor power levels without damage.[2,3]

Furthermore, they have shown that operation at significantly higher power levels does not result in loss of cladding integrity, although local diametral changes after such operation might exceed the amount allowed in Paragraph 3.3.K of the Technical Specifications.

In summary then, the proposal that the guinea pig fuel rods under the innermost refueling ports be left in the reactor during operation at 20 MWt is based on the following arguments:

1. Such operation will provide additional confirmation that the hottest standard fuel rods can operate safely at power generation rates corresponding to the reactor power safety limit of 22 MWt.

2. Tests conducted during the pre-operational R&D Program have demonstrated that fuel rods can operate safely at the maximum linear power densities which might be experienced by guinea pig rods under the innermost ports at the reactor safety limit of 22 MWt.

3. The guinea pig fuel rods will be examined after completion of initial tests at 20 MWt and must meet the requirements of Paragraph 3.3.K of the Technical Specifications.

4. The limits for fuel rod damage, as presently specified in 3.3.K of the Technical Specifications,are well below values which would result in a loss of cladding integrity.

## V. Discussion

### A. General Description

The guinea pig fuel rods[4,5] contain mixed oxide fuel enriched to 25% fissile $PuO_2$ rather than 18.7% as used for the standard fuel rods. Two of these rods may be located under each of six refueling ports, although some of these positions will contain standard fuel rods for comparison purposes. The three innermost ports are located such that the guinea pig rods under them operate at 15% greater power level than do standard rods located nearest the center of the core. The three outermost ports are located such that the guinea pig rod power level is the same as that of standard rods nearest the center of the core.

B. Planned Use of Guinea Pig Rods

While the guinea pig rods will perform a lead fuel function, it is not intended to use them in a manner that may cause their failure or to intentionally jeopardize their safe performance at any time. Measures normally taken to protect the hottest standard fuel rods have been applied to the operation of these rods. These measures include pre-operational full-scale testing at conditions of power and temperature exceeding the expected SEFOR test conditions.[(6)] In addition, the Technical Specifications provide for suitable periodic inspection of fuel rod condition, and require that certain specified criteria be met before proceeding with the next step in the approach to power.

C. Linear Power Density

It is predicted that the hottest standard fuel rod in the core will operate at a peak linear power density of 21.8 KW/ft when the reactor power level is 20 MWt. This value is based on the minimum allowable core loading of 600 fuel rods and assumes that all power generation is in the fuel. The present core loading is 636 fuel rods, although it may be necessary to increase (or decrease) this number by one or two rods, before reaching 20 MWt. Furthermore, physics data and calculations have established that only 94% of the energy defined as reactor power[(7)] is actually generated in the fuel. Thus, the linear power density actually experienced by the fuel rods at 20 MWt will be less than the 21.8 KW/ft indicated above, or about 19.4 KW/ft for the hottest standard fuel rod. The effects of using 630 fuel rods and 94% heat generation for linear power density calculations are illustrated in Figure 1.

The uncertainty in reactor heat balance data must also be considered. The effect of the maximum expected error of ±5% in heat balance data is shown by the different scale factors on the right side of Figure 1. Thus, if the heat balance data are 5% high at an indicated reactor power of 20 MWt, the true linear power density for a given fuel rod will be 5% lower than the calculated value, and vice versa.

D. Expected Operating Parameters

Using the curve for 630 fuel rods and 94% heat generation, Figure 1 indicates that the guinea pig rods under the innermost ports at 20 MWt reactor power will operate at a linear power density of 22.6 KW/ft with nominal heat balance data, or at 23.7 KW/ft if the heat balance data contain the maximum expected error of 5% on the low side. These power densities are within the safe operating region presently recognized by the Technical Specifications.

Initial operation at 20 MWt will be for a limited amount of time sufficient to obtain necessary heat balance and reactor coefficient data. Immediately following these tests, the reactor will be shut down and fuel rods (both guinea pig and standard) will be examined. Additional fuel rod examinations are called for prior to the start of and during the transient test program.

## VI. Safety Analysis

### A. Operating Conditions

The proposed change to the Technical Specifications would permit operation at 20 MWt with guinea pig rods under the innermost refueling ports. Operation at 20 MWt implies the possibility of reaching 21 MWt before reactor scram occurs, and also implies the possibility of momentary power overshoot to a value below the safety limit of 22 MWt. Consequently, the proposed change must be evaluated in terms of reactor safety at the 22 MWt power level.

B. Fuel Melting

The present power limits in the Technical Specifications were chosen to provide assurance that fuel melting would not occur in any of the fuel rods. This assurance will remain in effect for all fuel rods in the core except those guinea pig rods (maximum of six) located under the innermost ports. These guinea pig rods may experience some central fuel melting if the combination of parameters which determine this is unfavorable. However, operation with the expected core loading and with nominal values of calibration data and fuel parameters would not result in fuel melting at the reactor safety limit of 22 MWt. (See Figure 1).

C. R&D Test Results

The pre-operational R&D tests have demonstrated that the fuel cladding will maintain its integrity under conditions much more severe than the conditions permitted under the Technical Specifications.(8) These tests also showed that repeated cycles(2) to a linear power density of 28 KW/ft (above melting) did not result in cladding diameter changes beyond the allowable limits given in Paragraph 3.3.K of the Technical Specifications. Furthermore, capsule tests in which fuel pins experienced significant amount of fuel melting(3) showed maximum cladding diameter changes of 18 and 10 mils, as compared to the 10 mil limit in the Technical Specifications, with no loss of cladding integrity.(8) These data indicate that the threshold for loss of cladding integrity at SEFOR operating conditions is significantly above the limits established in Paragraph 3.3.K of the Technical Specifications.

D. Summary

Operation of the reactor at 20 MWt with up to six guinea pig fuel rods under the innermost ports will provide lead information to confirm that the standard fuel rods will not be damaged by operation up to the safety limit of 22 MWt reactor power. Fuel melting is not expected to occur in these guinea pig rods, although this cannot be assured when consideration is given to the worst combinations of factors which affect power density. However, even if fuel melting were to occur in the guinea pig fuel rods, the cladding would not be damaged,[8] and reactor safety would not be reduced.

References:


1. SEFOR FDSAR, Supplement 10, Figures I-3, I-5, and II-1.
2. SEFOR FDSAR, Supplement 3, Figure B-6, and Table 5-1.
3. SEFOR FDSAR, Supplement 3, Figures B-13 to B-16, and Table 5-1.
4. SEFOR FDSAR, Para. 4.2.2.2.
5. SEFOR FDSAR, Supplement 10, Para. 1.6.2.
6. SEFOR FDSAR, Supplement 3, Page IV-1.
7. Technical Specifications, Para. 1.5.
8. SEFOR FDSAR, Supplement 3, Section III (Conclusions).

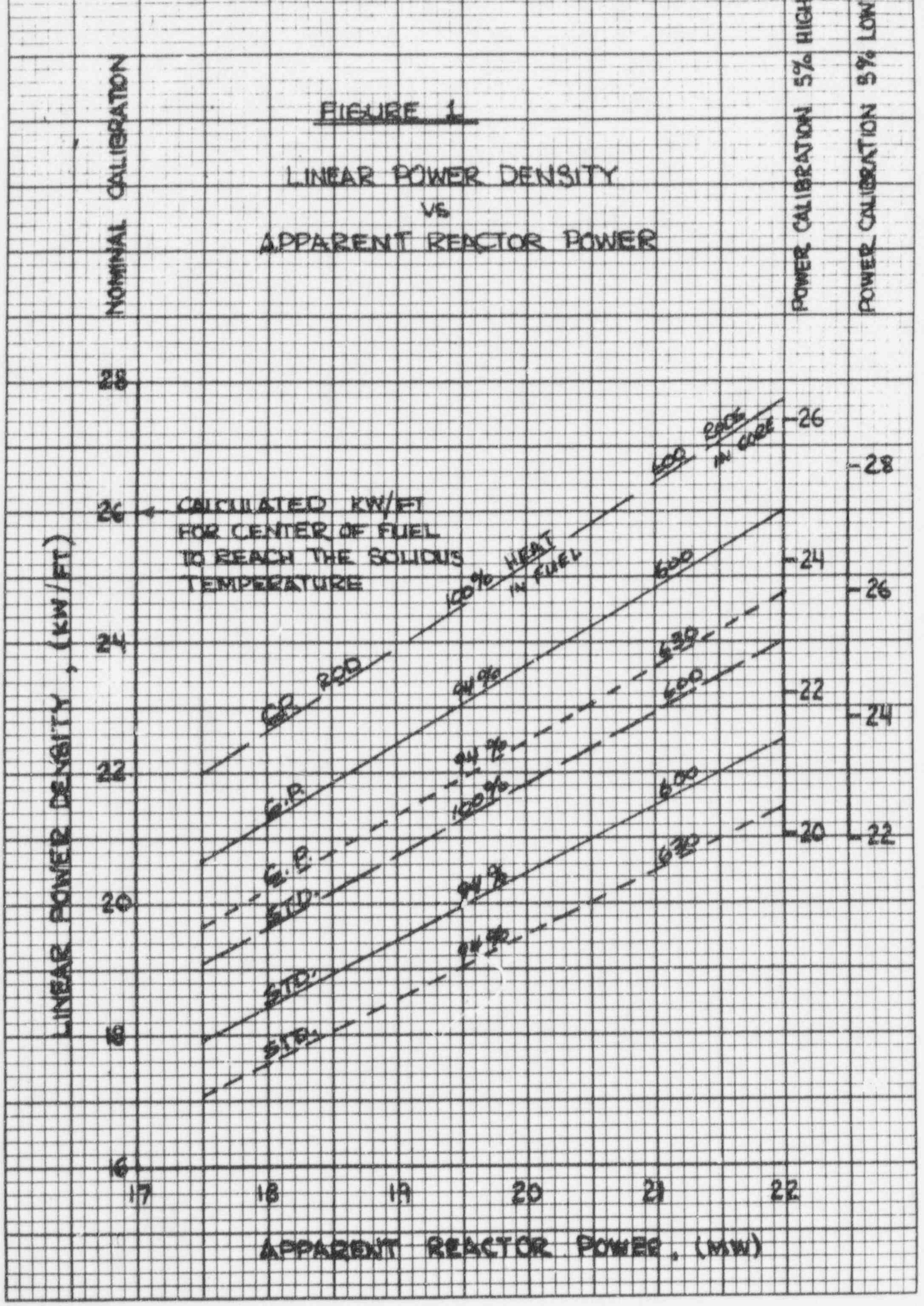
FIGURE 1
LINEAR POWER DENSITY
VS
APPARENT REACTOR POWER
NOMINAL CALIBRATION
POWER CALIBRATION 5% HIGH
POWER CALIBRATION 5% LOW
LINEAR POWER DENSITY , (KW/FT)
APPARENT REACTOR POWER , (MW)
CALCULATED KW/FT
FOR CENTER OF FUEL
TO REACH THE SOLIDUS
TEMPERATURE
600 RODS IN CORE
100% HEAT IN FUEL
G.P. ROD
600
94%
G.P.
630
94%
600
100%
G.P.
STD.
600
94%
630
STD.
94%
STD.
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