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September 13, 1960

TEMPERATURE-LEVEL INDICATOR AT CONSOLE

To: Reactor Processing Managers

INTRODUCTION

Specialized instruments have been developed and installed in recent years to make information available to the reactor operators more accurate and more timely. Yet under certain emergency conditions interpretation of information from the various more specialized instruments may be more complex and thus result in slower reaction by the operator to a hazardous condition.

It is recommended that an admittedly sluggish and inexact instrument, a bulk-outlet total-level indicator, be restored to a prominent location on the control console to provide the operator and specialist with a single instrument portraying the "feel" of the entire start-up and operating process.

SUMMARY

The proposed console readout, shown in Figures 1 and 2, is not a new instrument system, but simply a single-range approximation of the original thermohm indicators. With such a device in full view of the console operator and the reactor specialist, gross errors in judgment due to misinterpretation or malfunction of the specialized instrument systems would be avoided, or at least checked in time to avoid serious consequences.

It is proposed that this dual indicator device augment rather than supplant any of the other more specialized devices such as the period meter, rate-of-rise meter, popcorn popper, zone-temperature monitor, or temperature trend recorders.

Figure I

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Movable Scale (MW) Adjusted for 0° Inlet Temp.

Figure 2

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Movable Scale (MW) Adjusted for 7.0°

DISCUSSION

1. General Background

Over the past few years, several instances have occurred during reactor startup that would indicate that the present instrumentation does not present a completely straightforward, gimmick-proof picture of the total reactor power level during this important phase of reactor operation. These instances, usually associated with a presumably "safe" period or rate-of-rise taking place too high in level, could probably have been avoided or at least satisfactorily slowed down if there had been a direct indication to the operator of the total reactor power and the bulk outlet temperature. The straightforward power level recorder used in the past has been replaced by a deviation recorder equipped with multiple scales to give the total reactor power. However, these scales must be continually adjusted (manually) to determine the total power during the rise to operating levels. An additional power level chart recorder is located some distance from the control console, out of view of the reactor operator. At most reactors the bulk outlet recorder, formerly located immediately adjacent to the control console, has been relocated in a remote section of the control room. This information should be immediately available to the reactor operator as well as easily visible to all occupants of the control room. This becomes increasingly important during reactor startup, the power rise to operating level, and during any emergency operating condition.

2. Complexity of Present System

During these same few years several new monitoring devices, innovations, and operating techniques have been acquired in an effort to provide additional control data for the increasing power levels. Consequently, the instrumentation and control facilities have pyramided to a point where the total result is a large, complicated system which is difficult to integrate or analyze. In the midst of a multitude of monitoring instruments equipped with numerous scales, shunts, switches, ranges, etc., it has been demonstrated on several occasions that a procedural breakdown can create a potentially hazardous operating condition. This is most likely to occur during a reactor startup and the following rise to operating level. During these important operating periods, a procedural breakdown with the resulting confusion can cause a situation where switches, ranges, scales, shunts, etc., can be manipulated in such a manner that the absolute value and rate of increase in power level may be masked for a period of several minutes. A large dial gauge indicating bulk outlet water temperature (with time lag as short as feasible) plus an approximation of the total reactor power should go far toward eliminating the confusion regarding approximate power level which can lead to hazardous reactor startups.

3. Benefits of Proposed Indicator

The proposed approximate indicator of bulk outlet temperature and total level would have the following advantages:

- a. Large dial easily visible from all sections of the control room; all occupants will know approximate power level and temperature rate of rise at all times during reactor startup.

- b. Will show the bulk outlet water temperature during the rise to power following reactor startup, plus an approximate power level for each degree of temperature change. A sensing point immediately upstream of the downcomer should give a time lag of less than 30 seconds.
- c. Simple manual adjustment for existing inlet temperature before startup. No adjustments or manipulations from zero power to operating levels (see Fig. 2).
- d. Will give a constant indication of bulk outlet water temperature during equilibrium operation; will detect any uncontrolled temperature increases.
- e. Will measure heat generation rate immediately following reactor shutdown.
- f. Will detect and show conspicuously premature reduction of cooling water flow to shutdown pressures, or to emergency backup pressures.
- g. Will give constant indication of reactor shutdown temperature during emergency conditions, outages, etc.

4. Recommendations

It is recommended that all reactors be provided with a large dial-type indicator (diameter: 12-18 inches) installed in a prominent location on the main control console. The device should be equipped with a single rotating pointer simultaneously indicating an accurate bulk outlet water temperature (circular scale: 0-100°C) and an equivalent approximation of the total reactor power for each degree of temperature change (see Figs. 1 and 2).

A simple temperature readout free of any encumbrances may prevent a hazardous occurrence during critical operating periods. In plain view of all control room personnel the approximate rate of temperature rise and order of magnitude of power level will be immediately apparent to all present. Under these circumstances, it should be virtually impossible to maintain an excessive rate of rise for any appreciable length of time without full knowledge of everyone on the operating team.

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Operational Physics Sub-Section
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

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Recommendations Approved By:

H C Fuller

Manager, Operational Physics

DATE

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END