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TITLE
CHARACTERIZING W-2 SLSF EXPERIMENT TEMPERATURE OSCILLATIONS USING COMPUTER GRAPHICS
~~(All Capitals; Double Spaced; Centered)~~

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Characterizing W-2 SLSF Experiment Temperature Oscillations Using Computer Graphics

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SUMMARY

The W-2 SLSF experiment was an instrumented in-reactor test performed to characterize the failure response of full-length, preconditioned LMFBR prototypic fuel pins to slow transient overpower (TOP) conditions. Although the test results were expected to confirm analytical predictions of upper level failure and fuel expulsion, an axial midplane failure was experienced. Extensive post-test analyses were conducted to understand all of the unexpected behavior in the experiment.(1) The initial post-test effort focused on the temperature oscillations recorded by the 54 thermocouples used in the experiment. In order to synthesize the extensive data records and identify patterns of behavior in the data records, a computer-generated film was used to present the temperature data recorded during the experiment.

The temperature oscillations were quickly determined to be centered in the test section of the seven pin experiment. A review of the records for test loop thermocouple outside of the test section revealed only damped oscillations transported from the test section. This observation focused attention on 17 thermocouples on five axial levels starting at the fuel column midplane and extending to the top

of the fuel column. Since the thermocouples were distributed in 13 different radial positions in the test section, manual comparison of the data generally proved to be unwieldy.

The five degrees of freedom found in the data (3-D spatial, temperature magnitude, and time) complicated the process of interpreting in the data. The computer-generated film showed: 1) the spatial considerations by displaying together two cross sections and a side view of the test section, 2) the thermocouple temperatures by color variations, and 3) the time aspect by the natural procession of the film. A black and white simulation of a color film frame is shown in Figure 1 for illustration purposes.

The film was generated using a variety of tools. A software library called KRISPLA, developed by Boeing Computer Science, Richland (BSCR) to drive a FR-80 Microfilm Recorder was used to generate the 16 mm film. A FORTRAN-77 program was developed to provide frame, line, and color control using the KRISPLA library. The title and the basic frame outline were built into the main program. A data file of temperature variations for each thermocouple was created using the differences determined at each .1s time interval between the test data and the pretest thermal analysis temperatures. The file was used to drive a temperature-color correlation (red-yellow-white) to visually simulate the recorded temperature oscillations.

The film shown at half real time speed allowed the formation of general impressions as well as the comparison of specific thermocouple

pairs. The simulated frame shown in Figure 1 may be used as an example of the visual impact of the methodology. The hexagonal cross sections shown on the left side of Figure 1 show the thermocouples located in the midplane region (bottom) and top region (top) of the fuel column. The axial side view as seen from the bottom of the hexagonal section is shown on the right side of the frame. Temperature deviation is shown by color: black (low), grey (neutral), and white (high). The top section shows a symmetrical pattern signifying fuel pin motion outward to form hot coolant channels next to the hexagonal wall and inward to form cooler coolant channels. The opposite pattern is shown in the midplane cross section. The side view is slightly more complicated since front and back thermocouples are shown together. This view allows identification of spiral flow patterns.

The sheer volume of data recorded in the extremely well instrumented W-2 experiment strained the traditional manual method of correlating data in both raw and line graph form. The simultaneous film representation of deviations in the W-2 thermocouple data permitted discovery of previously unobserved interdependencies in temperature oscillations. One interdependency which was identified is shown in Figure 2. The W-2 temperature oscillation film proved invaluable in directing further study of thermocouple data records and in establishing that the cause of the temperature oscillations was fuel pin bowing.

References

1. D.E. Smith, A.L. Pitner, and G.E. Culley, "Posttest Analysis of the W-2 SLSF Experiment," Trans. Am. Nucl. Soc., 44, pp. 325-326, 1983.

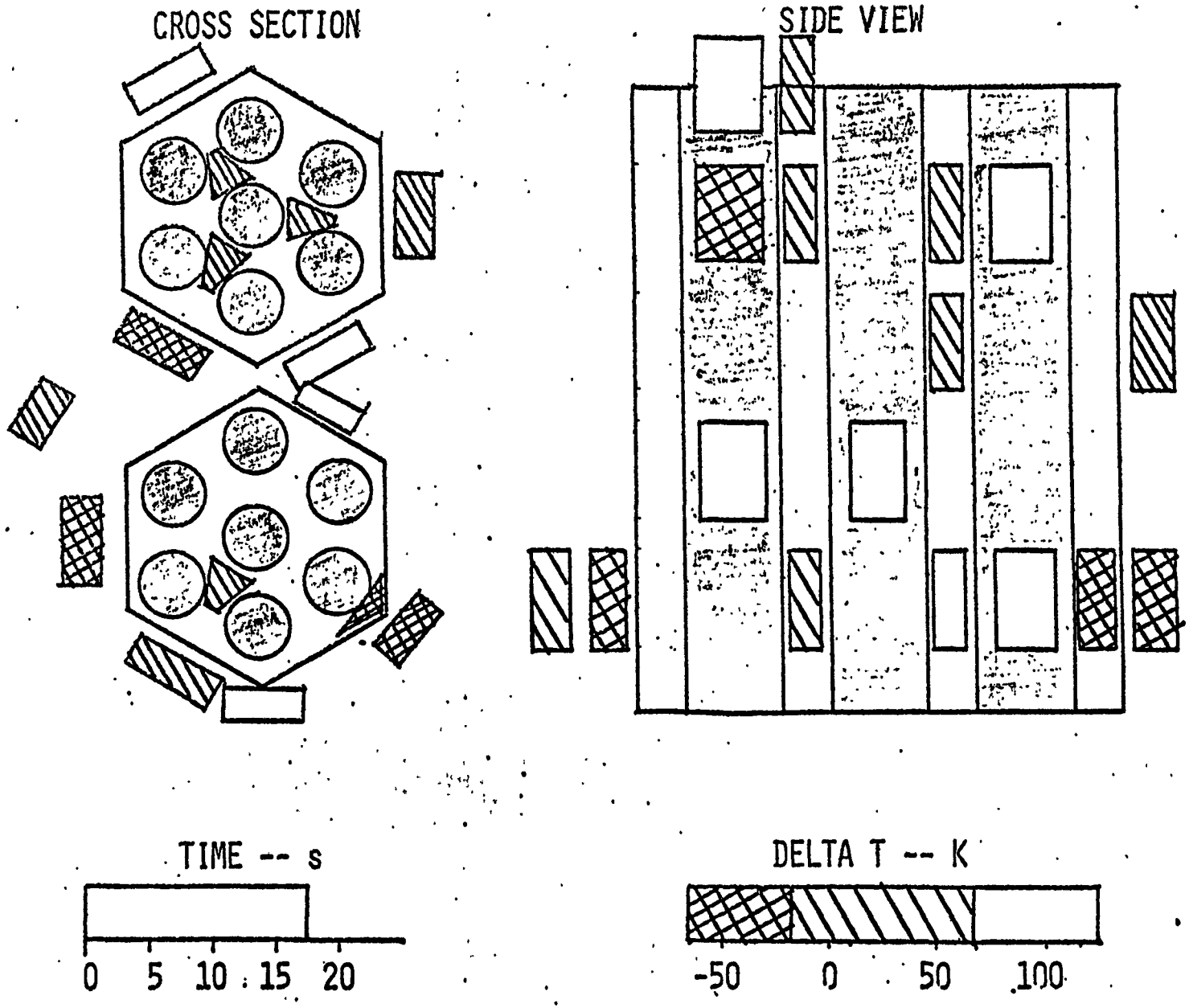

Figure 1. W-2 Temperature Oscillation Simulated Film Frame.

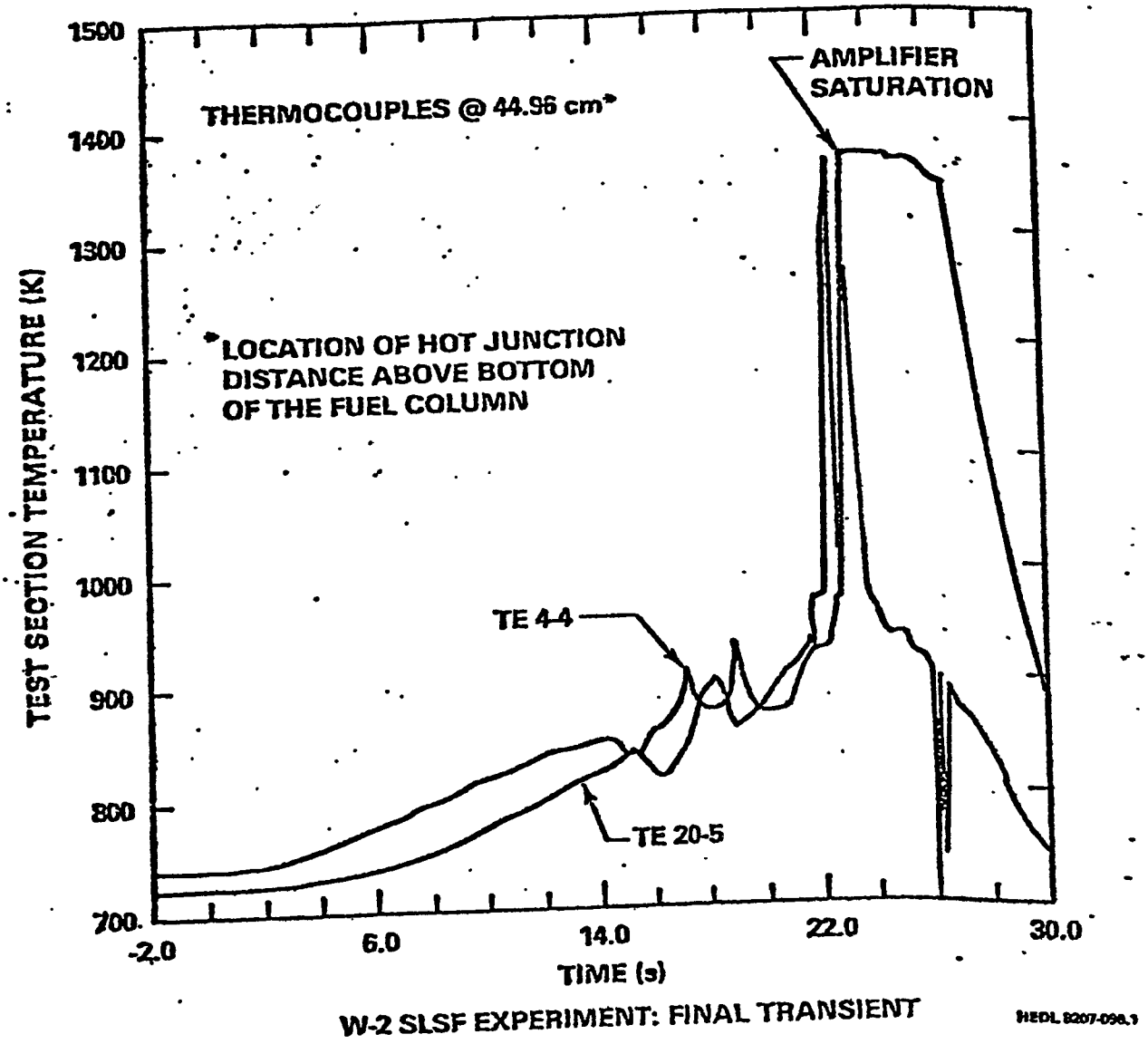

FIGURE 2. W-2 Thermocouple Data: Inner Channel (TE 4-4) vs Fluted Tube (TE 20-5) Temperatures.