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LOFT CENTER MODULE RADIATION HEAT
TRANSFER FOR L2-3 & L2-4

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LOFT TECHNICAL REPORT

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 FE&OB MLR RSB P&CSB KCS LEPD Mgr.
 Mgr. FD&AB Mgr. Mgr. PSB Mgr.

Mgr. The purpose of this study is to evaluate the potential influence of radiation heat transfer on the peak cladding temperature and the peak guide tube temperature during LOFT L2-3 and L2-4 tests.

The basic approach is to calculate and evaluate the change of fuel rod/guide tube thermal-mechanical behavior as a result of radiation heat transfer. The mechanisms of radiation heat transfer considered in this study include: (1) surface-to-surface radiation with no steam absorption of radiation, and (2) surface-to-surface radiation with steam absorption of radiation.

A simplified version of the MOXY/SCORE² computer program was used in this study. In order to minimize computer costs, the internal hydrodynamic calculations were bypassed. The convective heat transfer coefficients and fluid conditions calculated from the computer programs RELAP4/MOD5 and FLOOD4 were used as boundary conditions in the fuel rod/guide tube thermal-mechanical calculations.

The results of this study indicate that for the L2-3 test, the influence of radiation heat transfer might reduce the peak cladding temperature by 81 K and increase the peak guide tube temperature by 277 K. For the L2-4 test, the corresponding figures are 177 K and 285 K, respectively.

DISPOSITION OF RECOMMENDATIONS

No disposition required.

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ABSTRACT

A simplified version of the MOXY/SCORE computer program is used to evaluate the potential influence of radiation heat transfer on the peak cladding temperature and the peak guide tube temperature during the higher power loss-of-coolant tests in LOFT. The results of this study indicate that radiation heat transfer influences peak cladding temperature and peak guide tube temperature by as much as -177 K and +285 K, respectively.

SUMMARY

The main purpose of this study is to evaluate the potential influence of radiation heat transfer on the peak cladding temperature and the peak guide tube temperature during the LOFT L2-3 and L2-4 tests¹. The secondary purpose is to provide the histories of average surface temperature for individual guide tubes during LOCE L2-3 and L2-4 for subsequent analysis of fuel module structural behavior during core heat up.

The basic approach is to calculate and evaluate the change of fuel rod/guide tube thermal behavior as a result of radiation heat transfer. The mechanisms of radiation heat transfer considered in this study include: (1) surface-to-surface radiation with no steam absorption of radiation, and (2) surface-to-surface radiation with steam absorption of radiation.

A simplified version of the MOXY/SCORE² computer program was used in this study. In order to minimize computer costs, the internal hydrodynamic calculations were bypassed. The convective heat transfer coefficients and fluid conditions calculated by the computer programs RELAP4/MOD5 and FLOOD4 were used as boundary conditions in the fuel rod/guide tube thermal-mechanical calculations.

The results of this study indicate that for the L2-3 test, the influence of radiation heat transfer will reduce the peak cladding temperature by 81 K (from 1149 K to 1068 K) and increase the peak guide tube temperature by 277 K (from 657 K to 934 K). For the L2-4 test, the corresponding figures are 177 K (from 1423 K to 1246 K) and 285 K (from 954 K to 1239 K), respectively.

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1. INTRODUCTION

The Loss-of-Fluid Test (LOFT) program is providing unique data from an integral pressurized water nuclear reactor system during the blowdown and reflood phases of a loss-of-coolant accident (LOCA). The total LOFT core power is approximately 1/60 (50 MW Thermal) the power capability of a large PWR, and the LOFT system has been thermal-hydraulically scaled by this ratio to result in system behavior representative of a full sized PWR. The LOFT reactor core contains 1300 commercial design (15 x 15) pressurized water reactor (PWR) fuel rods with the exception of active fuel length (5.5 ft long) and initial internal prepressurization of 0.10 MPa helium. Approximately 200 thermocouples attached to the fuel rod surface measure the cladding temperatures over the axial length of the LOFT core, and extensive thermal-hydraulic measurements are made to characterize the transient fluid behavior throughout the system.

The first nuclear test series consists of double-ended cold leg break, loss-of-coolant experiments (LOCE) at maximum linear powers ranging from 26 to 52 kW/m. Best estimate predictions of the coupled thermal-hydraulic and fuel rod behavior for these tests indicate the cladding surface temperatures to range from 1000-1400 K. These predictions have been made with one-dimensional models for both thermal-hydraulic and fuel rod response and normally do not account for radiation heat transfer between fuel rods and control rod guide tubes within the fuel assembly. Accurate predictions of both peak cladding temperature and peak guide tube surface temperature are essential in assessing safety margins of current computer models to predict LOCA response and in identifying conditions which may lead to the failure of fuel rods, guide tubes or in-core measurement devices. Accordingly, a study of the potential influence of radiation heat transfer on the peak clad temperature and the peak guide tube surface temperature during planned high power LOCEs was carried out. This document describes the results of this study. The remainder of this report is organized into the following sections: Section 2 - Analysis Approach; Section 3 - Results and Analyses; and Section 4 - Conclusions and Discussion.

2. ANALYSIS APPROACH

The LOFT L2-3 and L2-4 tests¹ (200% double-ended, offset shear, cold leg break with maximum linear heat generation rates of 39.4 kW/m and 52.5 kW/m, respectively) were selected as the reference cases for this study. Based on preliminary calculations, radiation heat transfer is expected to influence the peak cladding and control rod guide tube temperatures for these tests.

2.1 Code Description

A simplified version of the MOXY/SCORE² computer program (basically, MOXY/SCORE is a 3-D thermal-hydraulic computer program suitable for the analysis of reactor core behavior during various types of transients) was used to model the fuel rods in the LOFT center fuel module. In order to minimize computer costs, the internal hydrodynamic calculations were bypassed, and the convective heat transfer coefficients and fluid conditions (temperature, pressure and void fraction) calculated from the best estimate, one-dimensional computer programs RELAP4/MOD5³ and FLOOD4⁴ were used as boundary conditions for the internal heat slab heat transfer calculations.

The fuel rod thermal model for the calculations utilizes the HEAT1 subcode and include state-of-the-art models for UO_2 fuel thermal properties, fuel-cladding gap conductance, and metal-water reaction heat addition to the cladding. The MacDonald-Broughton gap conductance model which considers the effect of fuel-to-cladding contact conductance was utilized. The model assumes partial contact between fuel and cladding as a result of fuel cracking. The code has fuel rod mechanical response models which compute axial and radial fuel and cladding displacements as a result of thermal strains and pressures internal and external to the fuel rod. The axial cladding pressure strain is elastic only; the cladding radial pressure strain is a composite of elastic and plastic effects. The fuel rod thermal and mechanical models used in the code were initially developed for the fuel rod behavior code FRAP-T4⁵.

Rod-to-rod radiation heat transfer is calculated using the network method described by Sparrow and Cess⁶. The assumptions implicit in this technique are as follows:

- (1) All surfaces are gray, diffuse, and opaque.
- (2) All surfaces emit radiation uniformly and are irradiated uniformly.
- (3) All surfaces are in thermal equilibrium during each time step.
- (4) Axial radiation interchange is negligible.
- (5) The medium between surfaces does not absorb, scatter, or emit radiation.

In order to account for the effect of steam participation, the version of the MOXY/SCORE code used for this study allows an option in which the steam absorption of radiation is considered.

2.2 Description of Heat Slab Physical Model

Figure 1 shows a cross-sectional view of the LOFT core. Since the rods of higher power density are located in the central fuel module, only the central fuel module was considered for this study.

The heat slab model for the central fuel model is shown in Figures 2 and 3. The following remarks will clarify and justify this particular model.

- (1) Because hydrodynamic calculations were bypassed, there is no coupling between calculations at different axial levels for the computer code used in this study except for the calculation of the fuel rod internal fission gas pressure. For the LOFT L2-3 and L2-4 tests, fission gas pressure is

Fig.1. LOFT core map showing position designations.

FIG. 2. FUEL ROD/GUIDE TUBE ASSEMBLY AXIAL LEVEL
ARRANGEMENT FOR MOXY/SCORE MODEL

32 GUIDE TUBE

(1) FUEL ROD

FIG. 3 LOFT CORE CENTRAL MODULE CROSS-SECTIONAL
VIEW SHOWING 37 HEAT SLABS AT FIRST
AXIAL LEVEL FOR MOXY/SCORE MODEL

low and is not an important factor in determining other thermal-mechanical properties. In other words, the only coupling left is insignificant as far as this study is concerned.

- (2) For this study, one is primarily interested in obtaining accurate thermal-mechanical properties near the hot plane. To fulfill this primary goal, only the portion of the reactor with the highest power density needs to be modeled, in view of the remarks made in (1). However, in order to fulfill a secondary goal and obtain the histories of average surface temperature for individual guide tubes (these histories are needed for the analysis of fuel module structural behavior during heat up), the reactor core was modeled with four axial levels as shown in Figure 2. Two axial levels (No. 2 and No. 3 in Figure 2) are utilized to provide detail in the neighborhood of the hot plane while other portions of the reactor core are lumped into two axial levels (No. 1 and No. 4 in Figure 2).
- (3) As shown in Figure 3, one-eighth symmetry is assumed for the central fuel module. Therefore, at one axial level, several segments of the fuel rod or guide tube are completely symmetric with respect to one another. In order to model all the fuel rod/guide tube segments in the entire central fuel module with a minimal number of heat slabs, these symmetric segments, which have identical temperature and other physical properties, will be considered as constituents of a single heat slab. For example, heat slab No. 1 consists of four symmetric segments while heat slab No. 8 consists of eight segments. Contrary to the general practice in which only fuel rods and guide tubes in an octant are modeled, this particular method of designating heat slabs models all the fuel rods and guide tubes with the same number of heat slabs and was designed to ensure a correct calculation of radiation view factors (the details of view factor calculation are given in Appendix A).

- (4) In order to satisfy a basic assumption for the radiation heat transfer calculation, i.e., any ray leaving a heat slab's surface must be intercepted by the surface of itself or another heat slab, a thin imaginary canister with insulated outside surface is introduced to surround the central module.
- (5) The numbering of heat slabs at the first axial level is shown in Figure 3. The rule of heat slab numbering for other axial levels is: if heat slab A is just above heat slab B, then the heat slab number for A will be 37 (number of heat slabs at one axial level) plus the heat slab number of B.
- (6) A guide tube will be modeled as a thin hollow cylinder. It is assumed that identical fluid conditions and convective heat transfer coefficients can be applied at both inside and outside surfaces.

2.3 Description of Transient Calculations

In order to quantify the effect of radiation heat transfer on the peak clad temperature, five different transient calculations have been carried out for both the L2-3 and L2-4 tests. Each calculation began at the start of blowdown and continued until the reflood quench front reaches the hot plane. The five cases considered are:

- Case 1: (Base Case) transient calculation with no radiation heat transfer.
- Case 2: Transient calculation with only surface-to-surface radiation considered, and steam absorption is neglected. It is also assumed that the emissivity of the inside surface of the canister heat slab is zero, i.e., radiation reaching the inside surface of the canister will be completely reflected back into the

central fuel module. The fuel rods and guide tubes are assumed to have emissivities equal to 0.6.

Case 3: A transient calculation that is identical to (2) except that steam absorption of radiant energy is modeled.

Case 4: A transient calculation that is identical to (2) except that the emissivity of the inside surface of the canister heat slab is 0.6.

Case 5: A transient calculation which is identical to (4) except that there is steam participation in the radiation heat transfer calculation.

These cases are summarized in Table 1.

TABLE 1 SUMMARY OF TRANSIENT CALCULATIONS

Case	Radiation Heat Transfer Mechanism Turned On?	Steam Participation In Radiation Heat Transfer?	Emissivity of Inside Surface of Canister Heat Slab	Surface Emissivity of Canister Heat Slab
#1	No	No	Not applicable	Not applicable
#2	Yes	No	0.6	0.
#3	Yes	Yes	0.6	0.
#4	Yes	No	0.6	0.6
#5	Yes	Yes	0.6	0.6

3. CALCULATIONAL RESULTS

By comparing the results of the cases considered, the effect of radiation heat transfer on the peak cladding temperature and peak guide tube surface temperature during a LOCE can be bounded.

Since the effect of radiation heat transfer on the peak cladding temperature is the major concern of this study, the histories for only the peak cladding temperature heat slab will be compared and evaluated. Guide tube temperatures will also be presented for the axial levels at which the peak cladding temperatures occur. (The histories of individual guide tube average surface temperature will be presented in Appendix B).

The surface temperature differences among the guide tube heat slabs located at the second and the third axial levels are less than 25 K during the entire course of the LOCE. The surface temperature of guide tube heat slabs at the first and the fourth axial levels generally are much lower and will not be presented.

The emissivity of the inside surface of the canister is not a sensitive parameter as far as fuel rod cladding temperature and guide tube surface temperature are concerned. The results of Run #2 and Run #4 are almost identical (the differences are the order of 1 K). The results of Run #3 and Run #5 are even closer. Therefore results of Run #4 and Run #5 are not presented.

3.1 Rod Cladding Temperature and Guide Tube Surface Temperature

Only the surface temperatures of heat slabs No. 84 (peak cladding surface temperature) and No. 106 (peak guide tube temperature) as calculated by Case #1, Case #2, and Case #3 will be compared and evaluated.

Figures 4 and 5 compare peak cladding temperature histories for Cases 1, 2 and 3 for L2-3 (Figure 4) and L2-4 (Figure 5).

CLADDING TEMP. FOR HEAT SLAB NO. 84 (K)

FIG. 4. COMPARISON OF CLADDING TEMPERATURES FOR L2-3 TEST

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FIG. 5. COMPARISON OF CLADDING TEMPERATURES FOR L2-4 TEST

Peak clad temperatures and the times of their occurrence as predicted by transient calculations are summarized in Table 2. For L2-3, peak clad temperatures predicted by Case #2 and Case #3 are lower than that predicted by Case #1 by 42 K (76°F) and 81 K (146°F), respectively.

For L2-4, peak clad temperatures predicted by Case #2 and Case #3 are lower than that predicted by Case #1 by 90 K (162°F) and 177 K (319°F), respectively.

Without radiation heat transfer, the peak cladding temperature occurs during reflood, whereas with radiation the peak cladding temperature occurs at the start of reflooding. Thus, radiation losses prevent the temperature from increasing during reflooding. For L2-3, the minimum effect of radiation heat transfer will reduce the peak cladding temperature by 42 K (76°F); for L2-4, the minimum effect of radiation will reduce the peak cladding temperature by 90 K.

TABLE 2 PEAK CLAD TEMPERATURES AND THE TIMES OF THEIR OCCURRENCE FOR L2-3 AND L2-4 TESTS

TEST	Transient Calculation	Peak Clad Temperature	Time At Which Peak Clad Temperature Occurs	Temperature Difference Compared to Base Case (#1) (K)
L2-3	#1	1149 K (1609°F)	43 sec.	--
	#2	1107 K (1533°F)	26 sec.	43
	#3	1068 K (1463°F)	26 sec.	81
L2-4	#1	1423 K (2102°F)	35 sec.	--
	#2	1333 K (1940°F)	34 sec.	90
	#3	1246 K (1783°F)	34 sec.	177

Figures 6 & 7 compare the surface temperature history of the hottest guide tube heat slab (No. 106) for the L2-3 and L2-4 tests. The highest guide tube surface temperatures (heat slab No. 106) and the times of their occurrences for those cases are summarized in Table 3. These results show that at all times during a LOCE, Case #2 guide tube temperatures were highest followed by Case #3 and then Case #1. The differences between these predictions are rather substantial; the best estimate temperature is expected to lie somewhere between Case #2 and Case #3 predictions.

TABLE 3 PEAK GUIDE TUBE SURFACE TEMPERATURES AND TIMES
OF OCCURRENCE FOR L2-3 AND L2-4 TESTS

TEST	Transient Calculation	Peak Guide Tube Temperature	Time At Which Peak Clad Temper- ature Occurs
L2-3	#1	657 K (723 ⁰ F)	26 sec.
	#2	934 K (1222 ⁰ F)	26 sec.
	#3	798 K (977 ⁰ F)	26 sec.
L2-4	#1	954 K (1258 ⁰ F)	34 sec.
	#2	1239 K (1771 ⁰ F)	34 sec.
	#3	1121 K (1558 ⁰ F)	32 sec.

FIG. 6. COMPARISON OF GUIDE TUBE SURFACE TEMPERATURES FOR L2-3 TEST

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FIG. 7. COMPARISON OF GUIDE TUBE SURFACE TEMPERATURES FOR L2-4 TEST

4. CONCLUSIONS AND DISCUSSION

A quantitative study of the potential influence of radiation heat transfer on the peak cladding temperature and peak guide tube temperatures during the higher power loss-of-coolant tests in LOFT has been completed. Using the heat transfer coefficients and fluid conditions calculated from the computer programs RELAP4/MOD5 and FLOOD4 as boundary conditions, this study investigates the change of fuel rod/guide tube thermal-mechanical behavior as a result of radiation heat transfer. The principle conclusions reached can be summarized as follows:

- (a) The effect of radiation heat transfer, neglecting the influence of steam absorption, reduces the peak cladding temperature for the L2-3 and L2-4 tests by 42 K and 90 K, respectively. If steam is allowed to participate in the radiative heat transfer calculation, it is estimated that the effect of radiative heat transfer will reduce the peak clad temperatures in L2-3 and L2-4 tests by 81 K and 177 K, respectively. The calculations assuming steam participation are probably more realistic than those with no steam radiation absorption.
- (b) In the central fuel module, the guide tube surface temperature at the hot plane varies only slightly (the upperbound of this variation is about 25 K) from one guide tube to another during the entire course of the LOCE.
- (c) If steam absorption is not included in the radiation heat transfer calculation, it is estimated that the highest temperature reached on the surface of the guide tube passing through the center of reactor core will increase from 657 K (723⁰F) to 934 K (1222⁰F) for the L2-3 test and from 954 K (1258⁰F) to 1239 K (1771⁰F) for the L2-4 test. If steam is included in the radiation heat transfer calculation, the highest temperature reached on the surface

of the guide tube passing through the center of reactor core will increase from 657 K (723⁰F) to 798 K (977⁰F) for the L2-3 test and from 954 K (1258⁰F) to 1121 K (1558⁰F) for the L2-4 test.

The results obtained in this study depend on the RELAP4 and FLOOD4 convective heat transfer coefficients and fluid conditions which are input as boundary conditions. A portion of the input convective heat transfer coefficient is due to radiation transfer to fluid. As a result, the effect of radiation to fluid may be duplicated somewhat by a MOXY/SCORE radiation-to-steam calculation (surface-to-surface radiation calculation is not duplicated). As explained in Appendix C of Reference 7, this duplication is not significant when radiation to steam is important (high temperature and high void fraction). Furthermore, it is noted that the differentials of the results of different transient calculations are the most important quantities in determining the effect of radiation heat transfer, and fortunately, these quantities are relatively immune from the influence of the inflated convective heat transfer coefficients because they are identically applied to every calculation.

APPENDIX A

The view factors (or configuration factors) between heat slabs at the same axial level are among the input data for MOXY/SCORE radiation heat transfer calculation. The calculation of these factors will be discussed in this appendix.

For current calculation, each axial level of the LOFT central fuel module is modeled by 31 fuel rod heat slabs, 5 guide tube heat slabs and 1 canister heat slab. Because (1) the view factors between heat slabs at one axial level are identical to those at another axial level (this is true because of the assumptions made in item (a) of this appendix), and (2) the radiation heat transfer calculation is limited to heat slabs at the same axial level, one only needs to compute view factors between heat slabs at the first axial level (from now on, it will be assumed implicitly that heat slabs mentioned are at the first axial level).

To illustrate the method of view factor calculation, the procedure used in computing view factors involving heat slabs No. 1 and No. 32 (see Figures 3 and 8) will be given. By a similar procedure, other view factors can be calculated easily.

Because heat slab No. 1 is a collection of four identical fuel rod segments (they are identified as 1A, 1B, 1C, and 1D in Figure 8), the calculation of view factors involving heat slabs No. 1 and No. 32 must begin with the calculation of view factors among segments 1A, 1B, 1C, 1D, and 32 (heat slab No. 32 consists of one guide tube segment only). The method of segments view factor calculation can be briefly described by:

- (a) The view factors among all segments at any axial level are calculated with the assumptions that (1) the diameters of all fuel rod segments are always identical, and time independent, (2) the diameters of all guide tube segments are always identical and time independent, and (3) the ratio

FIG. 8 HEAT SLABS NO. 1 & NO. 32

between the height of any segment and its diameter is so large that it can be considered as an infinite long cylinder. If one defines that

$F_{1A \rightarrow 1B}$ = view factor from segment 1A to segment 1B

$F_{1A \rightarrow 32}$ = view factor from segment 1A to heat slab No. 32
and so on,

then, by symmetric considerations, it is seen that:

$$\begin{aligned} F_{1A \rightarrow 1B} &= F_{1B \rightarrow 1A} = F_{1A \rightarrow 1D} = F_{1D \rightarrow 1A} = F_{1B \rightarrow 1C} \\ &= F_{1C \rightarrow 1B} = F_{1C \rightarrow 1D} = F_{1D \rightarrow 1C} \equiv x, \end{aligned} \quad (A-1)$$

$$F_{1A \rightarrow 32} = F_{1B \rightarrow 32} = F_{1C \rightarrow 32} = F_{1D \rightarrow 32} \equiv y, \quad (A-2)$$

and

$$F_{32 \rightarrow 1A} = F_{32 \rightarrow 1B} = F_{32 \rightarrow 1C} = F_{32 \rightarrow 1D} \equiv z \quad (A-3)$$

x, y and z, as defined in Equations (A-1), (A-2), and (A-3), can be calculated with methods given in Chapter 7 of Reference 8.

- (b) Because the diameter of the guide tube is larger than that of fuel rod, it can be seen that

$$\begin{aligned} F_{1A \rightarrow 1C} &= F_{1C \rightarrow 1A} - F_{1B \rightarrow 1D} \\ &= F_{1D \rightarrow 1B} = 0. \end{aligned}$$

The next step is to calculate heat slab view factors. One defines:

$F_{1 \rightarrow 32}$ = view factor from heat slab No. 1 to heat slab No. 32 and so on,

then $F_{1 \rightarrow 32}$ = the fraction of radiation leaving segments 1A, 1B, 1C and 1D that arrives at heat slab No. 32

$$= \frac{y + y + y + y}{4} = y \quad (\text{A-4})$$

with y defined in Equation (A-2). Similarly,

$$F_{32 \rightarrow 1} = \frac{z + z + z + z}{1} = 4z, \quad (\text{A-5})$$

$$F_{1 \rightarrow 1} = \left(F_{1A \rightarrow 1B} + F_{1A \rightarrow 1D} + F_{1B \rightarrow 1A} + F_{1B \rightarrow 1C} + F_{1C \rightarrow 1B} + F_{1C \rightarrow 1D} + F_{1D \rightarrow 1A} + F_{1D \rightarrow 1C} \right) / 4 = 8x/4 = 2x \quad (\text{A-6})$$

and

$$F_{32 \rightarrow 32} = 0. \quad (\text{A-7})$$

APPENDIX B

The histories of average surface temperature for individual guide tubes during LOCE L2-3 and L2-4 are needed for the analysis of fuel module structural behavior during core heat up. They are discussed in this appendix.

If one defines that: (See Figure 2).

L_i = length of i-th axial level (i=1, 2, 3, 4),

T_i = guide tube surface temperature at i-th axial level,

then the average surface temperature of a guide tube T_a is

$$T_a = \left(\sum_{i=1}^4 L_i T_i \right) / \sum_{i=1}^4 L_i.$$

For both L2-3 and L2-4 tests, the calculated histories of average surface temperature for guide tubes in the central fuel module are nearly identical (the deviations among them at any time are in the order of 10 K). As a result, only the histories of average surface temperature in L2-3 and L2-4 tests for the guide tube passing through the center of the reactor core will be discussed.

As shown in Figures 6 and 7, Run #2 (Radiation, No Steam Absorption) generally gives the highest guide tube surface temperatures. From the point of view of guide tube structural analysis, the results given by Run #2 are most conservative and are given in Table 4.

TABLE 4. GUIDE TUBE AVERAGE SURFACE TEMPERATURE VS. TIME FOR
L2-3 and L2-4 TESTS (RUN #2, CENTRAL GUIDE TUBE)

TIME (SECOND)	L2-3 T _a (K)	L2-4 T _a (K)	TIME (SECOND)	L2-3 T _a (K)	L2-4 T _a (K)
0	595.17	596.78	23	596.92	768.44
1	582.58	582.58	24	618.35	794.33
2	576.27	576.67	25	639.89	817.66
3	576.18	584.06	26	657.43	839.01
4	581.75	600.21	27	656.41	855.00
5	589.32	615.56	28	653.02	865.97
6	594.31	630.55	29	650.11	872.30
7	594.92	641.67	30	647.70	874.14
8	594.43	654.04	31	645.76	872.03
9	593.06	670.20	32	644.24	874.10
10	590.80	683.97	33	643.12	884.72
11	587.90	690.06	34	642.35	894.26
12	584.75	701.49	35	641.89	891.67
13	581.45	710.87	36	640.05	878.91
14	577.16	716.79	37	638.34	868.85
15	570.43	715.85	38	638.33	861.25
16	563.34	714.81	39	638.50	846.46
17	560.25	713.86	40	638.81	816.91
18	563.43	716.52	41	633.12	794.32
19	568.47	723.66	42	629.60	795.16
20	574.74	732.79	43	623.15	780.30
21	580.27	742.37	44	602.90	705.57
22	585.96	750.78	45	569.26	655.20

46	535.37	642.04	69	405.80	411.32
47	509.37	589.07	70	405.48	410.29
48	491.28	521.22	71	404.36	409.29
49	463.91	493.01	72	404.33	408.39
50	445.80	481.96	73	404.33	407.62
51	438.73	474.00	74	404.33	406.99
52	433.62	467.11	75		406.48
53	429.57	460.90	76		406.08
54	426.35	455.27	77		405.74
55	423.88	450.12	78		405.47
56	421.92	445.40	79		404.87
57	420.26	441.13	80		404.46
58	418.80	437.29	81		404.39
59	417.52	433.84	82		404.33
60	416.40	430.74	83		404.32
61	412.70	427.83	84		404.32
62	411.76	425.03	85		404.32
63	410.49	422.46	86		404.32
64	408.96	420.20	87		404.32
65	407.78	418.24	88		404.32
66	407.07	416.55	89		404.32
67	406.57	415.11	90		404.32
68	406.16	413.87			

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