50-267

PUBLIC SERVICE COMPANY OF COLORADO
P. O. BOX 840 · DENVER, COLORADO 80201

OSCAR R. LEE
VICE PRESIDENT

July 18, 1983
Fort St. Vrain
Unit No. 1
P-83239

Mr. John T. Collins, Regional Administrator
Nuclear Regulatory Commission
Region IV
Office of Inspection and Enforcement
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76012

RECEIVED
JUL 25 1983

DOCKET NO: 50-267

SUBJECT: Fort St. Vrain CRDM Temperature

REFERENCES:
1) O.R. Lee (PSC) Letter to J.T. Collins (NRC) dtd 4/15/83 (P-83132)
2) W.A. Graul, "Fort St. Vrain Control Rod Drive Mechanism - Thermal Effects"; GA Letter GP-1014, dtd 6/9/81
3) Fort St. Vrain Technical Specification SR-5.1.1
4) G.L. Madsen (NRC) Letter to O.R. Lee (PSC) dtd 5/16/83 (G-83194)

Dear Mr. Collins:

PSC has reviewed your letter of May 16, 1983 (reference 4) requesting additional information regarding testing and operation of the Fort St. Vrain (FSV) Control Rod Drive Mechanisms (CRDMs). The four commitment items requested in reference 4 are responded to in this letter, along with PSC's proposal for the long-term operation and monitoring of the CRDMs.

A005
1/1

Six of the 37 regions in the FSV reactor core are currently equipped with sensors to monitor CRDM temperatures (Regions 4, 5, 15, 31, 34, and 35). Each of the six CRDMs has three Resistance Temperature Devices (RTDs) located as follows: on the CRDM's closure plate (Sensor #1), the orifice valve motor plate (Sensor #2), and on the CRD motor (Sensor #3). These RTDs are connected to a bridge-type instrument producing a millivolt signal, which can then be converted to a temperature reading. Figure #1 shows the mounting location of the three RTDs and Figure #2 shows, in more detail, the RTD location on the shim motor of a CRD motor assembly (Sensor #3). The RTDs are installed per a PSC Request for Test Procedure (Attachment #1), which specifies that similar devices be installed on the remaining CRDMs as they become accessible. A FSV Change Notice is being prepared by PSC's Engineering staff to install equipment so that all 37 regions will be equipped with CRDMs that have temperature monitoring capabilities. Since it is only practical to install these devices during plant outages, no specific time commitment for the installation is feasible. It should be noted, however, that six more CRDMs are planned to have RTDs installed and be placed into service during the next refueling outage (Regions 3, 13, 18, 22, 29 and 33). A similar schedule is planned for subsequent refueling outages, and any CRDMs replaced between refueling outages will also be equipped with temperature monitoring devices.

The detailed analysis prepared by GA Technologies Inc. submitted to the NRC in PSC's April 15, 1983 letter (reference 1) provided information regarding the thermal expansion and tolerance buildup effects on the CRDMs at a temperature of 280°F (reference 2). This analysis evaluated all components in a CRDM assembly for worst case tolerance conditions which could inhibit a control rod scram. A temperature approximately 20° higher than the anticipated CRD motor temperature at 100% power (discussed later in this letter) was utilized for the GA analysis. Worst case tolerance combinations at 280°F resulted in probabilities of the gears jamming that were less than one in one million for one CRDM and less than one in one billion for two CRDMs failing to scram. PSC feels this evaluation provides adequate justification that the scram capability of the CRDMs will not be jeopardized by gear jamming at high ambient temperatures.

The brake assembly is an electromagnetic friction device which is spring-released when de-energized. When the brake is energized and applied, the control rods are retained in a fixed position. The d.c. brake power must be maintained if the rods are to be held steady in any position other than fully inserted; thus the system is fail safe. PSC's Engineering staff has evaluated the brake assembly and concludes that there are no components which could cause the brake to fail to release due to high ambient temperatures. Also, rod drop tests (reference 3) serve to verify that the brake assemblies are capable of releasing properly.

GA Technologies Inc. performed calculations to predict the maximum CRD motor temperature at 100% power conditions (Attachment #2). This analysis predicted a maximum CRD motor temperature of 260°F if the orifice valve is fully closed. At a 10% open orifice valve position, a maximum temperature of 250°F is predicted. A 10% orifice valve position is generally expected to be the least open position at 100% power. Tests were conducted on November 7, 1981 to determine the CRD motor temperatures with the plant operating at 100% power. The maximum CRD motor temperature recorded in the RT-485 "B" test was 218°F, which occurred in Region 5.

Presently, per FSV Technical Specification SR5.1.1 (reference 3), PSC is conducting two different "rod drop" tests. To ensure that a scram time of less than 160 seconds can be met, a yearly rod drop test is conducted (FSV Technical Specification SR5.1.1a) where all 37 control rod pairs are individually scrammed from the full out to full in positions, and the scram times are measured. To verify the operability of the position indicators, motion indicators, brake mechanisms, and cable slack indicators, a monthly rod drop test (FSV Technical Specification SR5.1.1b) is conducted. In this monthly rod drop test, (currently being run on a bi-weekly basis), the brake assemblies are de-energized, the control rods are dropped approximately 6 inches, and the time and distance are measured. The time and distance data is then extrapolated to insure that the maximum of 160 second scram time can be met. It is PSC's opinion that the rod drop tests provide adequate verification that all control rod pairs can be inserted within the specified time parameters such that safe reactivity control of the reactor is always maintained.

Regarding the temperature limit specified in the data collection surveillance, SR-RE-4-W provided with Reference 1, the 300°F temperature limit in step 5.2.2 of this surveillance was intended to encompass the upper temperature limit for all instrumented locations on a CRDM. The temperature surveillance is normally run when the Reactor Power level is 50% or greater, or the core differential pressure is 3 psid or greater. This surveillance is currently performed monthly in conjunction with the rod drop test (reference 3). The temperature surveillance will be revised so that 1) the FSV Station Manager will be advised if the CRD motor temperature reaches 250°F and/or the upper helium environment temperature reaches 300°F. 2) In the event a CRD motor temperature is found to be above 215°F during the monthly surveillance, the frequency of the temperature surveillance test on the CRDMs will be increased to weekly until the temperature returns to less than 215°F.

PSC's Engineering staff had previously determined the limiting component in a CRD motor assembly was the electrical cable, which was rated at 125°C (257°F) per drawings provided with reference 1. Subsequent discussions with the motor manufacturer, Varo Inc. Electrokinetics Division of Santa Barbara, Ca., revealed that a higher-than-specified grade of wire was used and that the lead wire insulation is, therefore, rated for continuous operation at 150°C (302°F) ambient temperature (Attachment 3). Hence, the component that limits the CRD motor temperature is the motor's Class H insulation, which is de-rated to an ambient temperature of 133.5°C (272°F). This de-rating accounts for motor temperature rise, frictional torque increase, and winding life expectancy.

After reviewing these analyses and test results, PSC concludes that Fort St. Vrain will not experience the inability of one or more control rod pairs to enter the core for automatic reactor shutdown due to CRDM temperature conditions.

Per the telephone conversation between Mr. P. Wagner (NRC) and Mr. J.R. Reesy (PSC) on July 7, 1983, the following commitments will be implemented upon receiving concurrence from the NRC:

1. Revise Technical specification SR 5.1.1 b such that the rod drop test will be required bi-weekly on each CRDM that has withdrawn control rods.

2. Continue to monitor CRDM temperatures periodically. This will be included in the "Basis" section of Technical Specification SR 5.1.1 b.

3. Revise the CRDM temperature surveillance, SR-RE-4-M to require Station Manager notification if the CRD motor temperature exceeds 250°F.

4. Install temperature monitoring devices on all CRDMs via a FSV Change Notice as described earlier.

If you have any questions, please contact Mr. J.R. Reesy at (303) 571-8406.

Very truly yours,

ORLee

O. R. Lee, Vice President
Electric Production

ORL/DYA:pa

Enclosures

List of Figures

Attachments

1. PSC-FSV Request for Test Procedure T-187.
2. W.A. Graul, "Transmittal of the Review of the Control Rod Drive Temperature Data", GA Letter GP-1283, December 22, 1981.
3. Lead Wire Drawing; Varo Inc. Electrokinetics Division, Dwg. No. 78667.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter)
)
Public Service Company of Colorado) Docket No. 50-267
Fort St. Vrain Unit No. 1)

AFFIDAVIT

O. R. Lee, being duly sworn, hereby deposes and says that he is Vice President of Public Service Company of Colorado; that he is duly authorized to sign and file with the Nuclear Regulatory Commission the attached response to the NRC Letter from G.L. Madsen to O.R. Lee dated May 16, 1983 (G-83194); that he is familiar with the content thereof; and that the matters set forth therein are true and correct to the best of his knowledge, information and belief.

ORLee
O. R. Lee
Vice President

STATE OF Colorado)
)
COUNTY OF Denver)

Subscribed and sworn to before me, a Notary Public in and for ______ ________ on this 19th day of July, 1983.

Jna LeBlanc
Notary Public
4026 E. 113th Place
Thornton, CO 80233

My commission expires August 19, 1983.

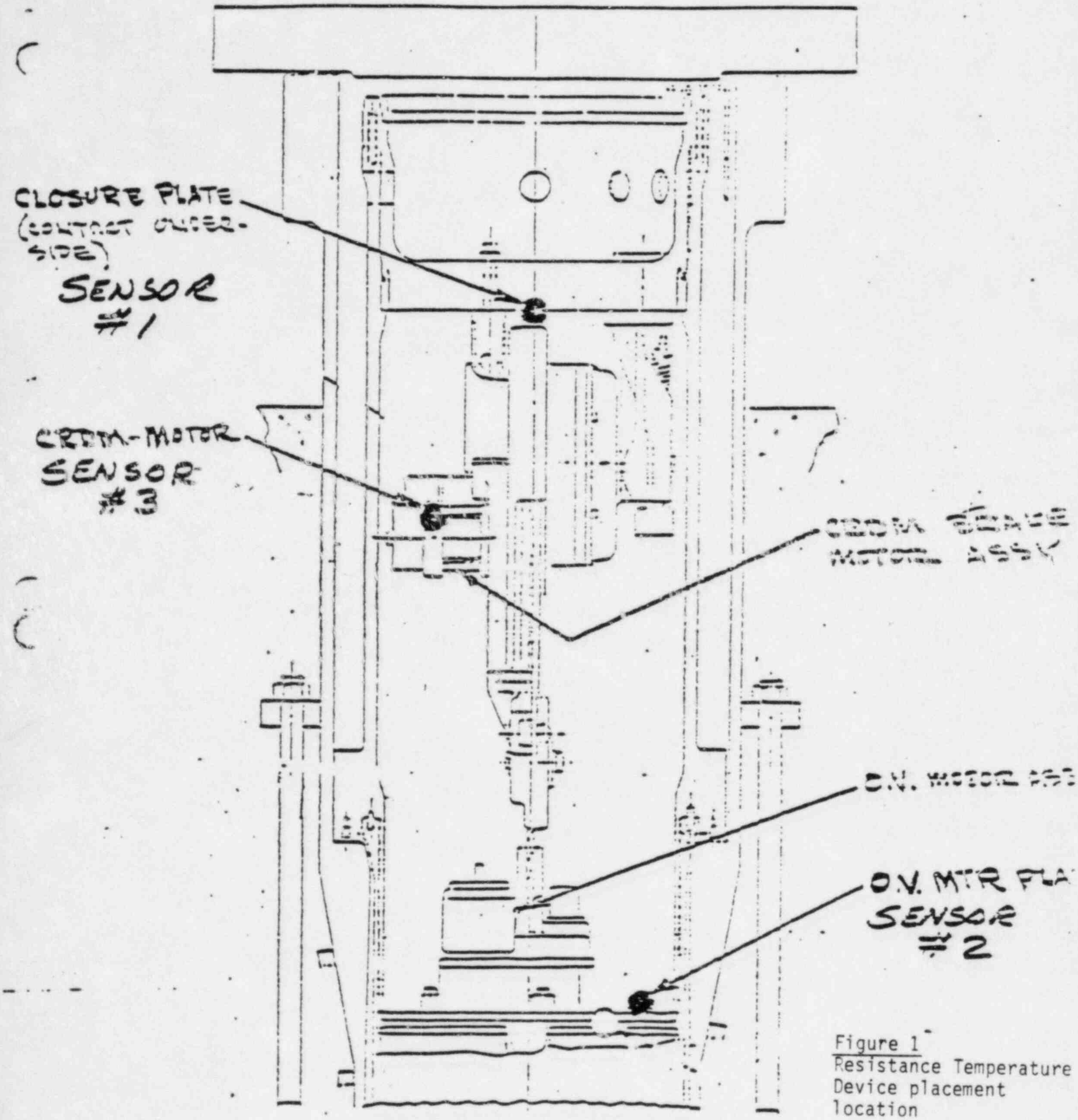


Figure 1
Resistance Temperature Device placement location

TEMP MEASUREMENT LOCATIONS
FOR CRD'S

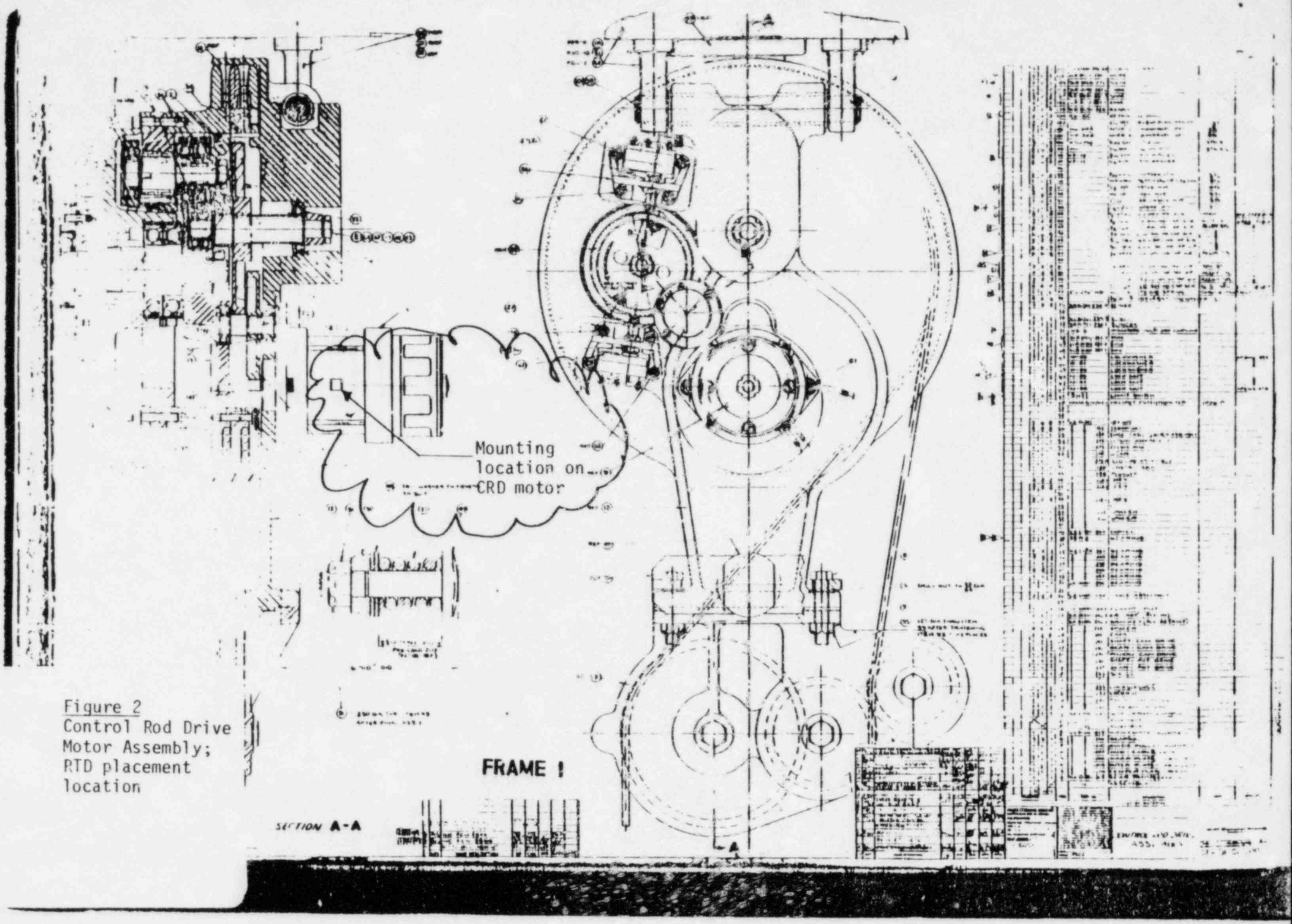


Figure 2
Control Rod Drive Motor Assembly; RTD placement location

PUBLIC SERVICE COMPANY OF COLORADC

FORT ST. VRAIN NUCLEAR GENERATING STATION

REQUEST FOR TEST

TEST REF. NO. T-187
SYST. REF. NO. 12
PAGE 1 OF 5

PREPARED BY: D. GLENN — 11/13/81 (DATE)

REVIEWED BY: E. Crown — 11-14-81 (DATE)

CONCUR WITH SAR: ☒ YES ☐ NO Per tele con with Chuck Fuller (TECHNICAL SERVICES) — 11-14-81 (DATE)

ISSUE 1 REVIEWED, PORC # 1 PORC 438 NOV 14 1981 — 11-14-81 (DATE)

APPROVED & ISSUED: Ed Hill by W. Craine (SIGNATURE) — 11-14-81 (DATE)

SAFETY SIGNIFICANT: ☐ YES ☒ NO

NFSC REVIEW: ______

RECORD AND CONTROL OF ISSUE

ISSUE NO.	PREPARED BY	PORC APPROVAL	APPROVED AND ISSUED EFFECTIVE DATE OF REVISION
2			
3			
4			
5			
6			
7			
8			

COMPLETED TEST REVIEWED: ______ (OPERATIONS MANAGER (OR DESIGNEE) SIGNATURE) ______ (DATE)

FORM 372 - 22 - 3398

ATTACHMENT 1

REQUEST FOR TEST

TEST REF. NO. T-187
SYST. REF. NO. 12
PAGE 2 OF 5

1 PURPOSE OF TEST Data Acquistion to establish temperature Profiles on Control Rod Drives.

2 TEST OBJECTIVES Record temperature (milivolt) values from temperature Sensors (RTDs) located in CRD's. THis data will be used to establish the above referenced temperature Profiles.

3 DESCRIPTION OF TEST (Use attached sheets if necessary) See Pg ×

(1) Install 3 each Temperature Sensors within each CRD as CRDs become (Accessible) available.

(2) Provide wiring between CRD MCC 1 & 2 AND THE SPECIAL BRIDGE TYPE INSTRUMENTATION LOCATED adjacent TO The MCC's

(3) Read AND Record CRD TEMPERATURES Periodically AS SPECIFIED BY THE TEST CONDUCTOR OR THE RESPONSIBLE DESIGNEE.

4 DATA REQUIRED (Include applicable data sheets and integrate with procedure if possible) - Include room for "Remarks"

DATE, TIME, CRD POSITION, CRD POSITION, CRD MOTOR TEMPERATURE, ORFICE DRIVE MOTOR MOUNTING PLATE TEMPERATURE, UNDERSIDE OF PRIMARY CLOSURE & UNDER REMARKS, ANY OTHER INFORMATION DEEMED NECESSARY BY TEST CONDUCTOR

FORT ST. VRAIN NUCLEAR GENERATING STATION

REQUEST FOR TEST

TEST REF. NO. T-187
SYST. REF. NO. 12
PAGE 3 OF 5

5 ANTICIPATED RESULTS: TEMPERATURES LESS THEN 300°F

6 ACCEPTANCE CRITERIA: No Specific Acceptance Criteria

NOTE: UPON COMPLETION OF THE TEST, DATA SHALL BE APPROPRIATELY ANALYZED AND TEST RESULTS AND RECOMME TION AND/OR EVALUATION SHALL BE SUMMARIZED AND PRESENTED TO THE SUPERINTENDENT OF OPERATIONS FINAL APPROVAL AND FURTHER REVIEW BY PORC AND THE NFSC AND/OR FURTHER REPORT AND DOCUMENTA REQUIREMENTS.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

REQUEST FOR TEST

TEST REF. NO. T-187

SYST. REF. NO. 12

PAGE 4 OF 5

7 PRECAUTIONS, LIMITATIONS, AND SPECIAL ASSISTANCE (INCLUDE PROVISIONS TO VERIFY THAT LIMITATIONS ARE NOT EXCEEDED):

Lead wires from sensors are to be gathered and routed to the existing power Cable connectors along with the normal wiring contained in this area of the Drive unit.

Calibration must be completed prior to CRD installation in order to establish a reference Temperature/millivolt value.

8 STANDARD OPERATING PROCEDURES N/A

9 SAFETY EVALUATION This Test is non-safety significant, however is Safety related due to the CRD involvement. The addition of sensors will not affect the normal function of either the control rods or the Orifice drive mechanisms. The physical installation shall be so accomplished to preclude interference with any intend operation. The installation of Sensors will not create additional or different failure modes.. nor alter the normal design intent or function

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION

REQUEST FOR TEST

TEST REF. NO. I-187
SYST. REF. NO. 12
PAGE 5 OF 5

10 TEST EQUIPMENT (IF REQUIRED)

NAME	IDENTIFICATION NUMBER	LAST CALIBRATION DATE
RTD READout Bridge	none	

11 TEST CONDUCTOR (INCLUDE ALL ASSISTANTS)
Bob Burchfield
R. D. Phelps (GA)

PERMISSION TO INITIATE TEST ______________________ (SHIFT SUPERVISOR - SIGNATURE) ______________ (DATE)

12 PROCEDURE (SEE ATTACHED PAGES 5a, 5b, etc.) Reference GA-RT 485B

Page 5A - Temperature Record
Page 5B - RTD LOCATION
Page 5C - RTD WIRING IN CRD
Page 5d - TEST WIRING FROM MCC compt.
PAGE 5E Sensor Installation Procedure

Actual sequence of temperature readings will be determined by test conductor.

FORT ST. VRAIN NUCLEAR GENERATING STATION

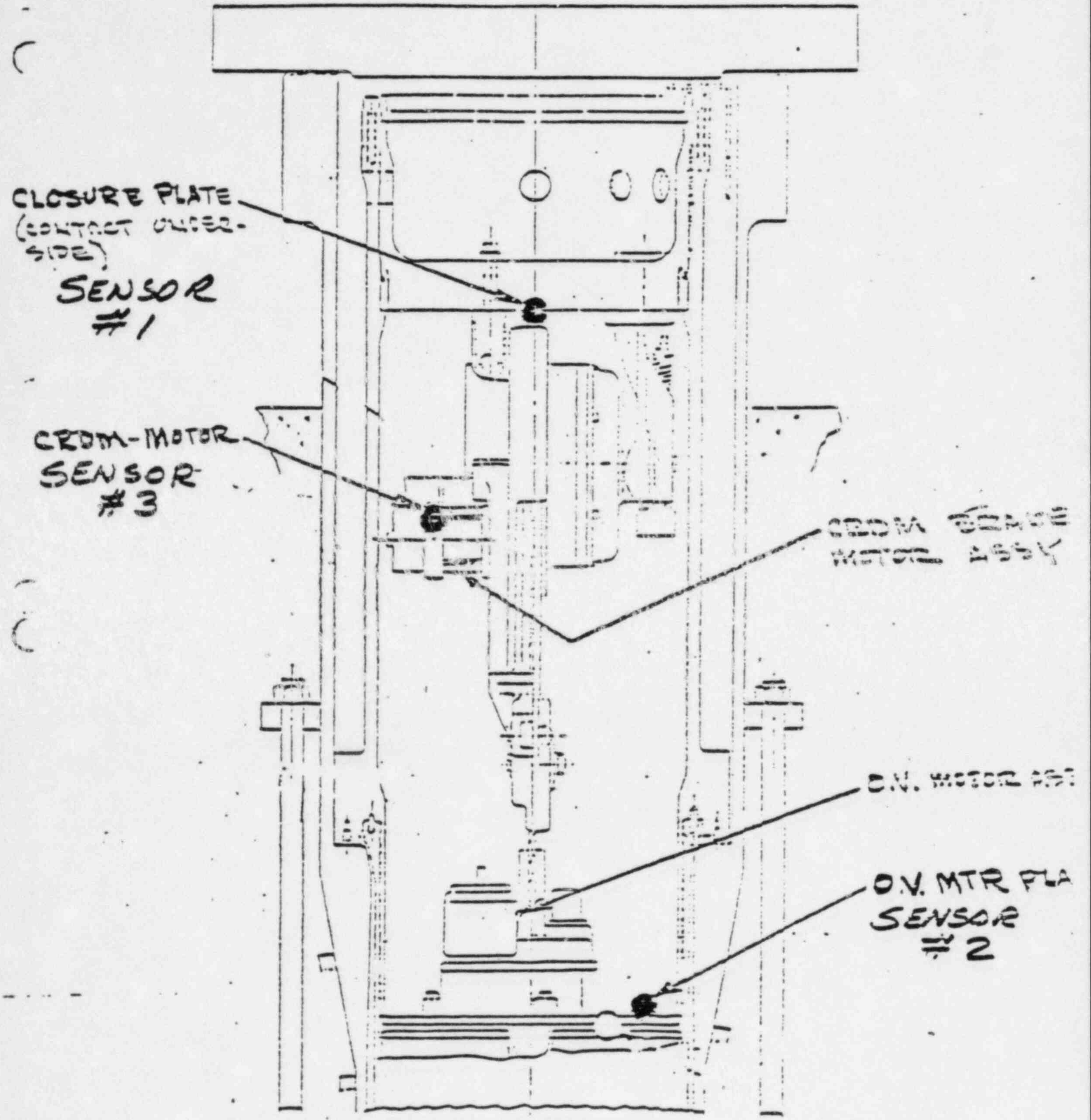
TEST REF. NO. T-187
SYST. REF. NO. 12
PAGE 5A of 5

REQUEST FOR TEST

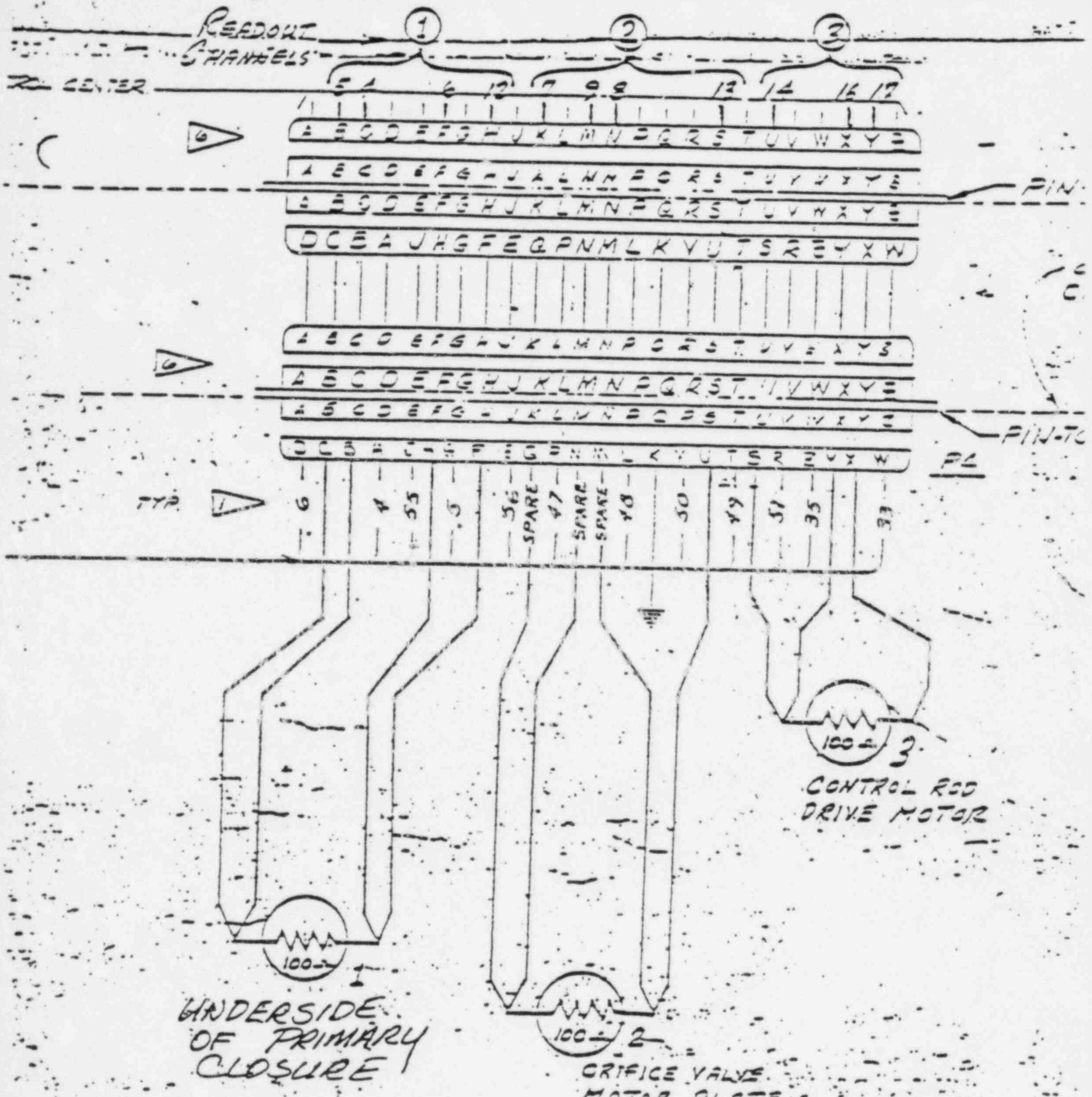
CONTROL ROD DRIVE TEMPERATURES

CRD # ________

DATE	TIME	ORIFICE POSITION % OPEN	CRD POSITION (INCHES)	CRD MOTOR TEMP: °F	ORIFICE DR. MOTOR MT. PLATE °F	UNDERSIDE OF PRIMARY CLOSURE °F	REMARKS	Initials



TEMP. MEASUREMENT LOCATIONS FOR CRD'S.

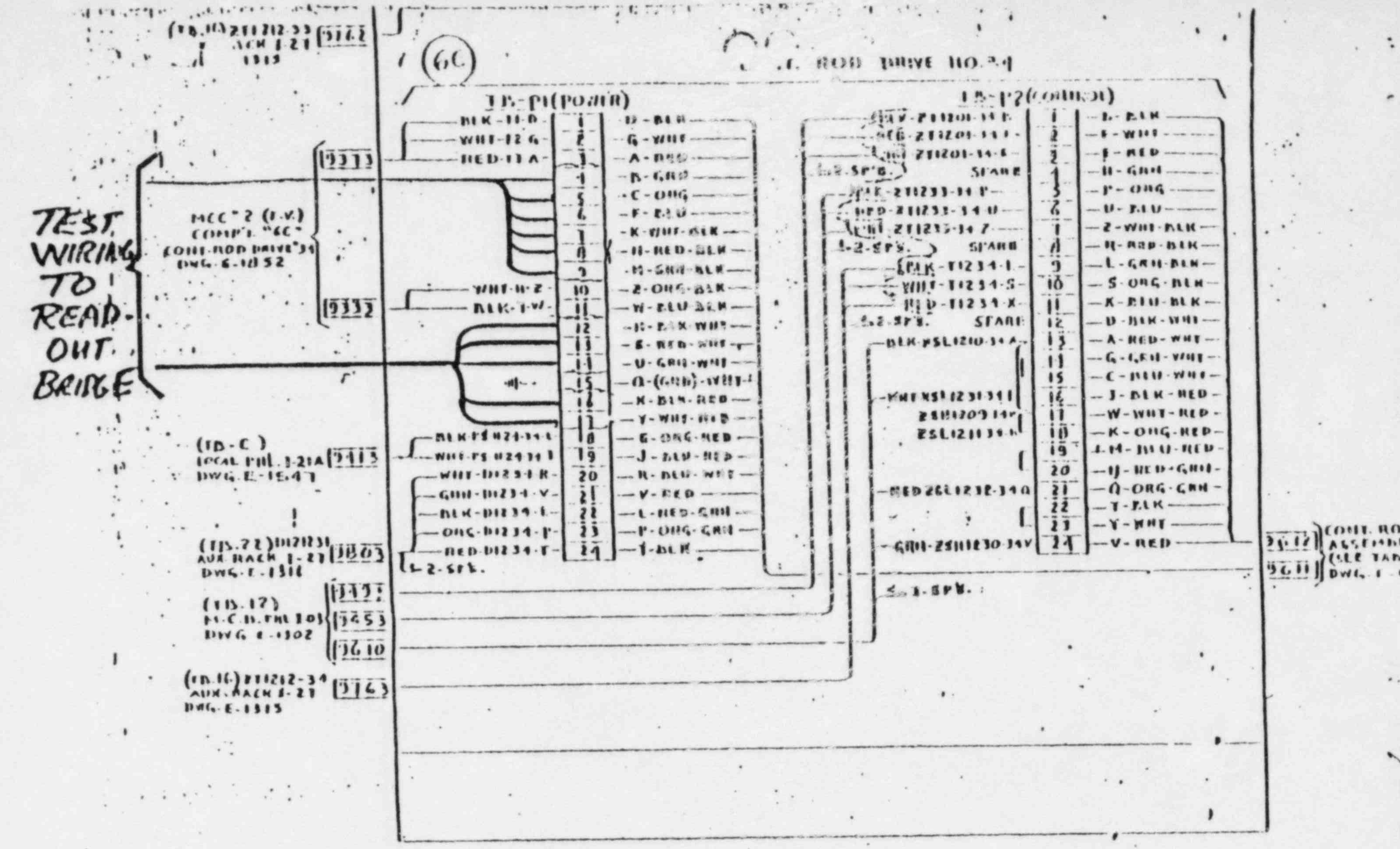


RTD WIRING IN CRD

SPARE
SPARE
SPARE

CONT

SYSTEM Ref-No 12
Page 5D of 5



Typical For CRD MCC
#1 & 2 Compts.

TEST Wiring From MCC Compt

SENSOR INSTALLATION PROCEDURE

1. Place CRD in ESW #1, and lower control rods sufficiently to reduce radiation levels in the inspection window area just below the primary seal.

2. Remove inspection windows after lifting CRD and setting on work stand.

3. Remove safety wire and bolts to allow lifting of the CRD motor and pulley assembly (-200 assy).

4. Install ambient temperature sensor per sketch, sheet 5B.

5. Install (cement in place) the surface temperature sensors per sketch sheet 5B this RT.

6. Gather the lead wires together and route them upward toward the connectors at the top of the -200 assy. Take care to insure that these wires cannot interfere with the mechanisms and equipment in this area.

7. Connect sensor wiring to spare terminals in the power cable connector. Make connections per sheet 5C.

8. Reinstall the -200 assy, install and torque bolts, and re-safety wire.

9. Replace access windows and return CRD to ESW. Pull rods to full retract in preparation for handling with the ATC.

10. The thermocouples used for secondary closure and missile plate temperature measurements are located per sheet 5B. Route leads over to handrail around top head on northwest side.

11. These T/Cs to be glued down after closure and missile plates are reinstalled. Cover all T/Cs (except ambient air) with a small piece of insulation material.

12. After all wiring is complete perform a calibration procedure on all sensors and linear bridges.

RECEIVED [illegible] 3 1981

GENERAL ATOMIC COMPANY
P.O. BOX 81608
SAN DIEGO, CALIFORNIA 92138
(714) 455-3000

December 22, 1981
GP-1283

Mr. H. L. Brey, Manager
Nuclear Engineering Division
Public Service Company of Colorado
12015 East 46th Avenue, Suite 440
Denver, CO 80239

Subject: Transmittal of the Review of the Control Rod Drive Motor Temperature Data

References: PSC P.O. N-3398
GP-1032

Dear Mr. Brey:

GAC has completed its review of the Control Rod Drive (CRD) Motor Temperature data taken during the rise-to-power/fluctuation testing. A copy of GAC memorandum SAB:144:JVDB:81, which documents this review, is enclosed.

All available data were used to predict CRD motor temperatures at 100% power conditions. This prediction, shown in Figure 1 of the enclosed memorandum, indicates that the maximum CRD motor temperature expected is 260°F. This temperature occurs only if the orifice valve is fully closed. At 10% open, as would be expected to be the least open position, a maximum CRD motor temperature of 250°F is predicted. These temperatures, while higher than those used to qualify the CRD assembly, are within the acceptable temperature ranges based on the ratings of the components in the assembly. As has been previously noted, the components are capable of operating up to 250°F to 275°F.

Other plots of these data are included using different dimensionless temperature ratios to further examine the behavior of these data. These data correlate well for each individual region. However, when data for all regions are combined, the correlation is not clear.

In addition to the various correlations, the raw data and dimensionless temperature ratios are included in the memorandum. This will allow you to perform any additional analysis you believe is needed.

Reesy - Review and respond as necessary

ATTACHMENT 2

In general, these data correlate well for a given penetration with the various ratios used in the analysis. However, these data for different penetrations do not correlate together. This lack of correlation may be indicative that a penetration other than one of the instrumented penetrations may have a higher helium leakage and higher CRD motor temperature than measured. GAC recommends PSC continue to monitor the CRD motor temperatures and instrument additional drives.

Should you have any questions, please contact Gary Hein at (714) 455-2645.

Very truly yours,

William A. Graul

William A. Graul, Manager
Fort St. Vrain Project

GA 1076

Attachment
to GP-1283

JVDB JF

FROM. J. V. Del Bene/J. F. Follin

TO G. L. Hein

SUBJECT Correlation of FSV Control Rod
Drive Motor Temperatures

IN REPLY
REFER TO
SAB:144:JVDB:81

DATE
December 10, 1981

Calculation File
SAB81002

1. Del Bene and Follin, "Correlation of FSV Control Rod Drive Motor Temperatures," GA Memo SAB:066:JVDB:81 dated June 4, 1981.

2. Young, K. A., "Orifice Calibration (SUT B-4, Part 3)," CA-D15527, July 1979.

3. Del Bene, J. V., "Additional Thermal Analysis of the FSV Control Rod Drive Penetration," GA Memo SAB:JVDB:07:78, dated February 2, 1978.

SUMMARY AND RESULTS

Control rod drive (CRD) penetrations R-4, R-5, R-34, R-35, and R-36 are instrumented with thermocouples to measure several temperatures within the penetration including the CRD motor temperature. During time periods from July 1979 to April 1981, data were taken up to 80% reactor power. The correlation of these data is reported in Ref. 1. This memo reports the correlation of several data points taken during November 1981 at reactor powers from 75% to 100% with the data of Ref. 1.

As discussed in Ref. 1, the data are correlated as:

$$\frac{T_{CRD\ \ Motor} - T_{C.W.}}{T_{Core\ Inlet} - T_{C.W.}} = f\left\{\left[\Delta P_{core}\,\frac{K_{orif}}{K_{orif} + 4fL/D}\right]^{\frac{1}{2}}\right\}$$

where

$T_{C.W.}$ is the liner cooling water temperature and is taken as 100°F,

K_{orif} is the flow control valve loss coefficient which is related to the percent of orifice valve opening (Ref. 2), and

4fL/D is the core frictional loss which is taken as 19.

The square root term on the right hand side of the above equation is proportional to the leakage flow through the control rod drive penetration (Ref. 1).

The correlation of the data in this manner is shown in Figures 2-6 for each individual region and in Figure 7 for all of the regions taken together. In general, the data correlate well for a given penetration; however, the data for different penetrations do not correlate together. An examination of the most recent data points (see Tables 1-5) fall within the scatter of the previous data.

All the data were used to predict CRD motor temperatures at 100% reactor power. This final result is shown in Figure 1 in a plot of CRD motor temperature versus fraction of orfice valve opening. The fixed variables in this plot are a core inlet temperature of 750°F and a core pressure drop of 5.0 psid (conditions representative of 100% reactor power). Curves are shown for each region based on a best fit curve through the data for that region. The curve labeled "ALL" is based on a curve that envelopes all of the data. This curve represents a conservative prediction of the CRD motor temperature at 100% reactor power at least for the given regions. It is possible that a region other than the five instrumented CRD regions has a higher helium leakage and a higher CRD motor temperature.

Other plots of the data were made with different dimensionless temperature ratios to further examine the behavior of the data. These temperature ratios included:

The CRD motor temperature with the orifice valve motor plate temperature.

The secondary cover plate temperature with the CRD motor temperature, and

The orifice valve motor plate temperature with the core inlet temperature.

Typically for these different plots the data correlate well for each individual region. However, when all the data for the five regions are plotted together, there exists considerable differences in the data from region to region.

The raw data and the reduced data are tabulated for each of the regions in Tables 1-5 for reference purposes.

ANALYSIS

As previously stated, the relation

$$\frac{T_{\text{CRD Motor}} - T_{\text{C.W.}}}{T_{\text{Core Inlet}} - T_{\text{C.W.}}} = f\left\{\left[\Delta P_{\text{Core}} \frac{K_{\text{orif}}}{K_{\text{orif}} + 4fL/D}\right]^{\frac{1}{2}}\right\}$$

is the basis for correlating the raw data since it relates the CRD motor temperature to measurable quantities. The core inlet helium temperature and the PCRV cooling water temperature represent the maximum and minimum temperatures, respectively, for the CRD motor temperature. These two limiting temperatures are therefore used to define a non-dimensional temperature ratio for the CRD motor temperature. As shown in Ref. 1, the helium leakage flow into the penetration base on a simplified analysis is proportional to the following group of measurable quantities

$$\dot{m}_{leakage} \propto \left[\Delta P_{core} \frac{K_{orif}}{K_{orif} + 19}\right]^{\frac{1}{2}}$$

where 4fL/D has been taken as 19. This square root term is called the helium flow leakage parameter.

Figures 2-6 show plots of the non-dimensional CRD motor temperature versus the helium flow leakage parameter for each of the five instrumented CRD penetrations. Figure 7 shows the same plot with the data from all regions plotted together. The straight lines through the data points for the individual region plots represent the best fit straight lines. The straight line drawn in Figure 7 envelopes all the data. The lines are replotted together in Figure 8 for comparison. All lines have approximately the same slope ($\sim$0.5 - 0.6) except for R-36 which has a slope of $\sim$0.10. No explanation is known for the steeper slope for R-36.

An equation for calculating the CRD motor temperatures at 100% reactor power (or any reactor operating condition) is obtained by utilizing the straight lines drawn in the figures. These lines relate analytically the dimensionless CRD motor temperature to the leakage flow parameter. An equation from Ref. 1 is used to express the orifice loss coefficient K_{orif} as a function of the fraction of orifice valve opened. Combining these two equations and rearranging, one can relate the CRD motor temperature to the orifice valve position, the core pressure drop and the core inlet temperature. This method was used to construct Figure 1.

Figures 9-13 attempt to correlate the orifice valve motor plate temperature with the CRD motor temperature. The data are plotted as:

$$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100} \quad \text{vs.} \quad \left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$$

From a thermal point this dimensionless temperature ratio should be constant and independent of the helium leakage parameter. In any case, the temperature ratio should be less than unity. Except for region R-36 the data correlate well for each separate region. This indicates consistency at least among the orifice valve motor plate temperatures and the CRD motor temperatures. A review of the raw data for R-36 indicates that many of the orifice valve motor plate temperatures are not consistent with other measured temperatures in R-36.

Figure 14 shows the data for all five regions plotted simultaneously with the CRD motor temperature and the orifice valve motor temperature as the dimensionless temperature. Figure 15 shows the same plot using the straight lines from the separate region plots of Figures 9-13. The reason for the separation of the data from region to region is not known. Possibly, parametric studies with the thermal model (Ref. 3) would show reasons for data separation.

Figures 16-20 attempt to correlate the CRD motor temperature with the secondary cover plate temperature as:

$$\frac{T_{\text{2nd cover}} - T_{\text{amb}}}{T_{\text{CRD Motor}} - T_{\text{amb}}} \text{ vs. } \left[\Delta P_{\text{core}} \frac{K_{\text{orif}}}{19 + K_{\text{orif}}}\right]^{\frac{1}{2}}$$

Again, heat transfer theory says that the temperature ratio should be constant. (In these plots the ambient air temperature is used for the lower reference temperature rather than the liner cooling water temperature of 100°F. At the location of the secondary cover plate the ambient air dominates more as the heat sink rather than the liner cooling. Plots were made using both T_{amb} and 100°F ($T_{C.W.}$) as the lower reference temperature. The data correlated better using T_{amb} as the lower reference temperature.)

If the above correlation were successful, the secondary cover plate temperature could be measured for each penetration and the CRD motor temperature could then be deduced from the correlation. Figures 16-20 show that the data for each region correlate reasonably well. However, when all the data for the five regions are plotted together (Figure 21), they do not correlate well as a group.

Figures 22-26 are plots correlating the orifice valve motor plate temperature to the core inlet temperature. These plots are similar to Figures 2-6 for correlating the CRD motor temperature. Again, the data for the individual regions correlate well; however, when the data for the five regions are plotted simultaneous (Figure 26), there is significant differences among the regions. Figure 13 and an examination of the measured temperatures for the orifice valve motor plate for R36 (Table 5) show that the lower grouping of data for R36 in Figures 26 and 27 are suspect.

The raw data and the calculated temperature ratios and leakage parameter for all data points are given in Tables 1-5. These tables are included for reference purposes and for checking where individual data points lie on the various data plots.

JVDB:sc

cc: FSV Data File
RCB

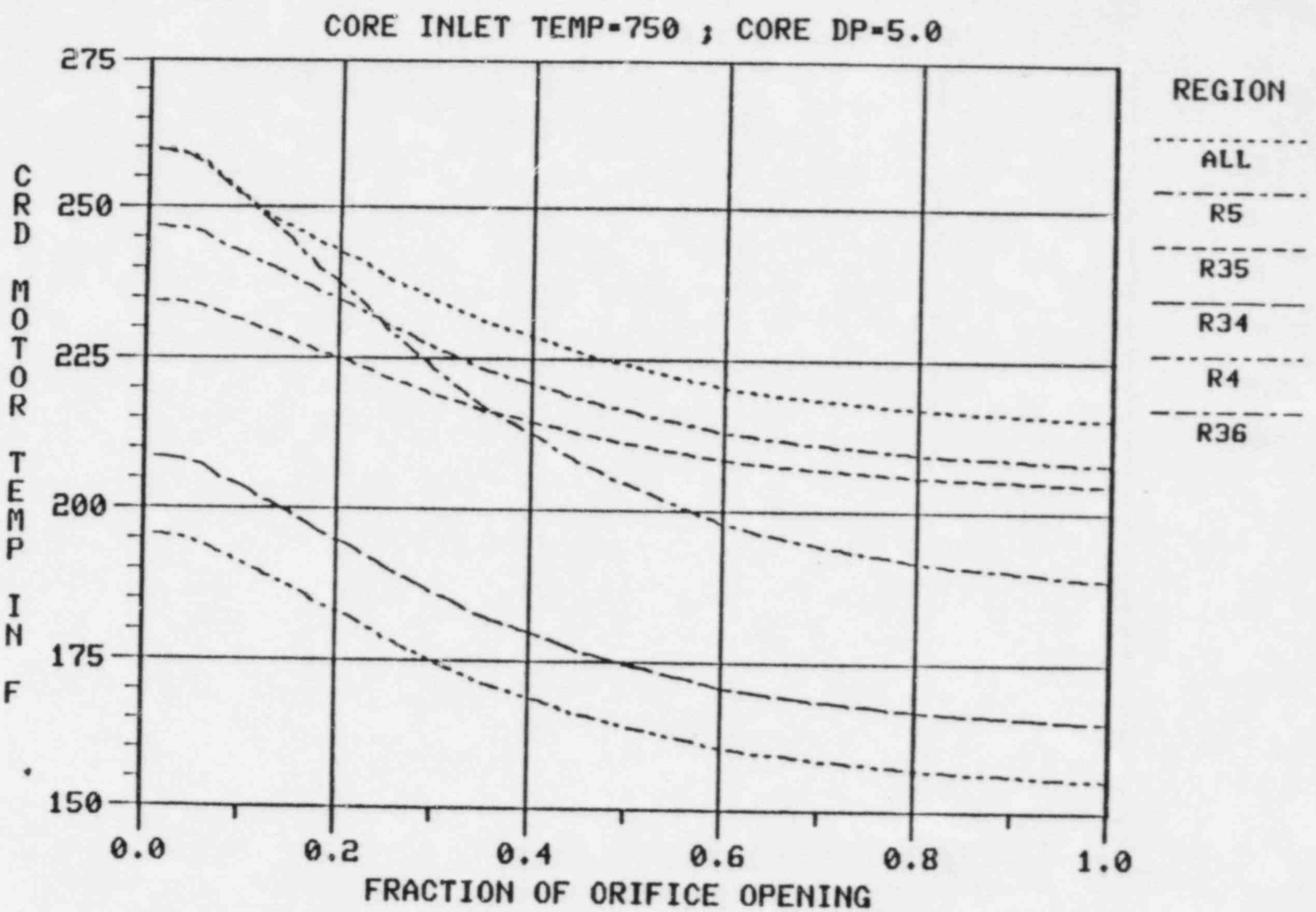
CORE INLET TEMP=750 ; CORE DP=5.0
CRD MOTOR TEMP IN F
275
250
225
200
175
150
0.0
0.2
0.4
0.6
0.8
1.0
FRACTION OF ORIFICE OPENING
REGION
ALL
R5
R35
R34
R4
R36

Figure 1.

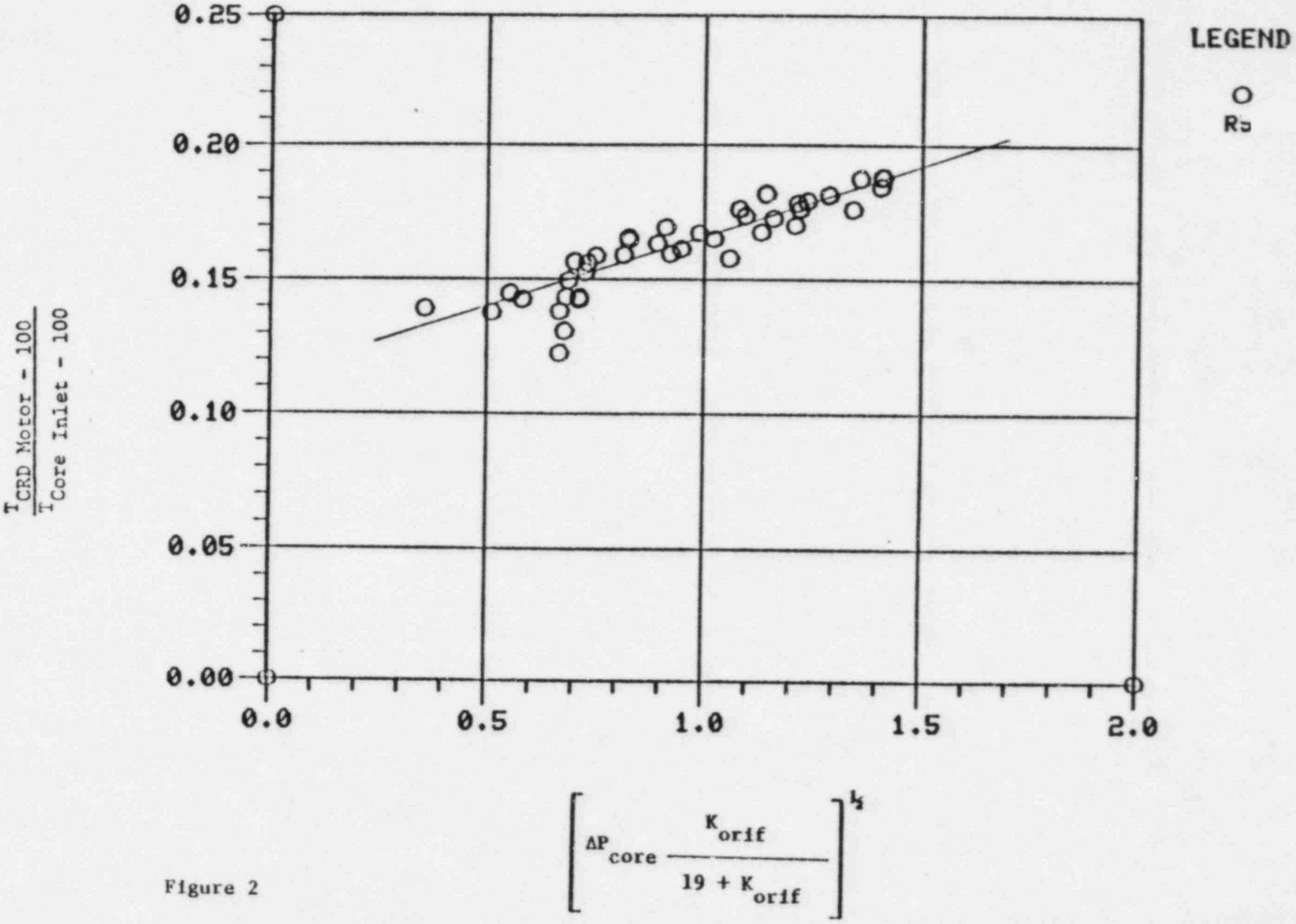

0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
$\frac{T_{CRD\ Motor} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$
LEGEND
○ R5

Figure 2

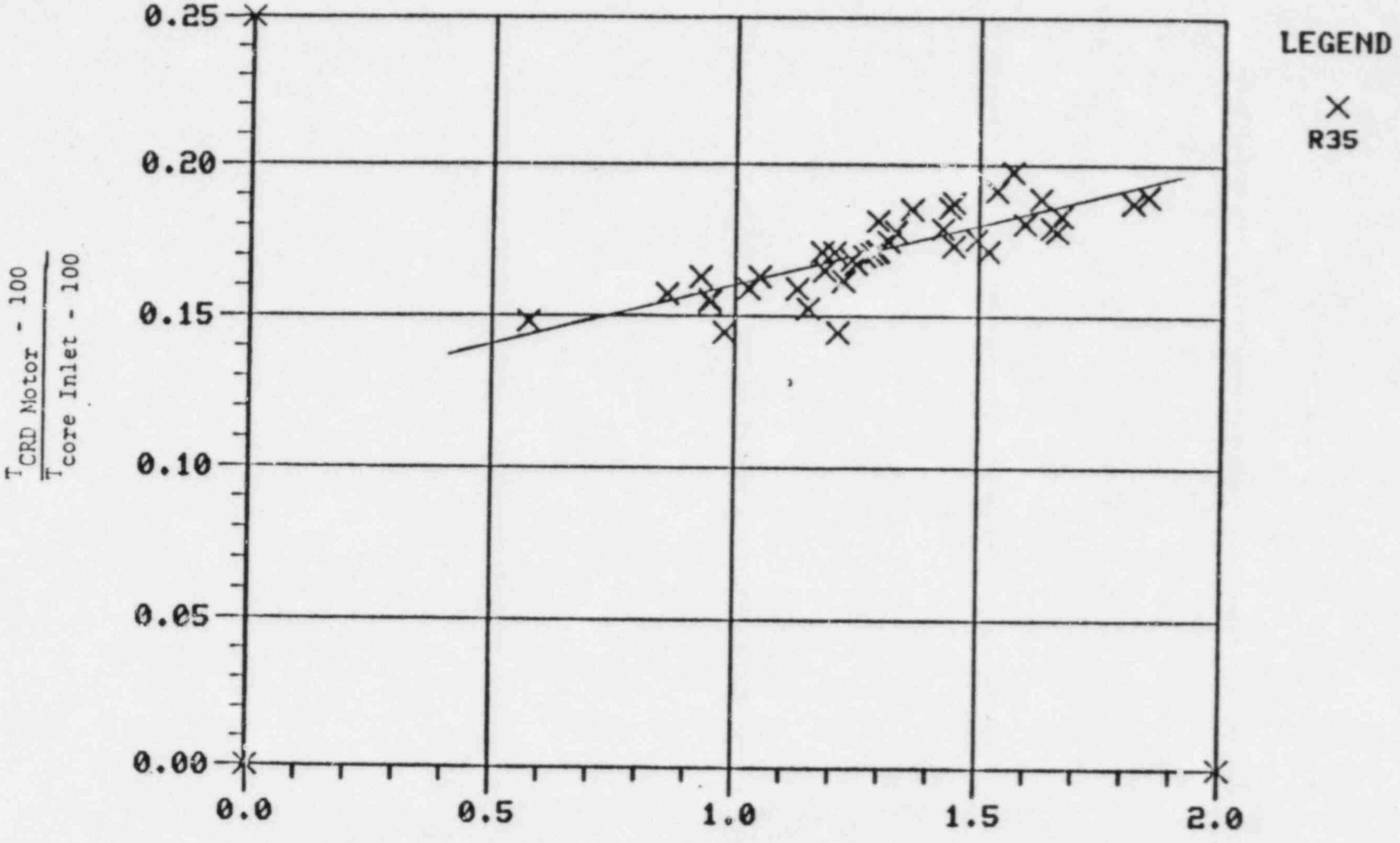


Figure 3.

$$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}} \right]^{\frac{1}{2}}$$

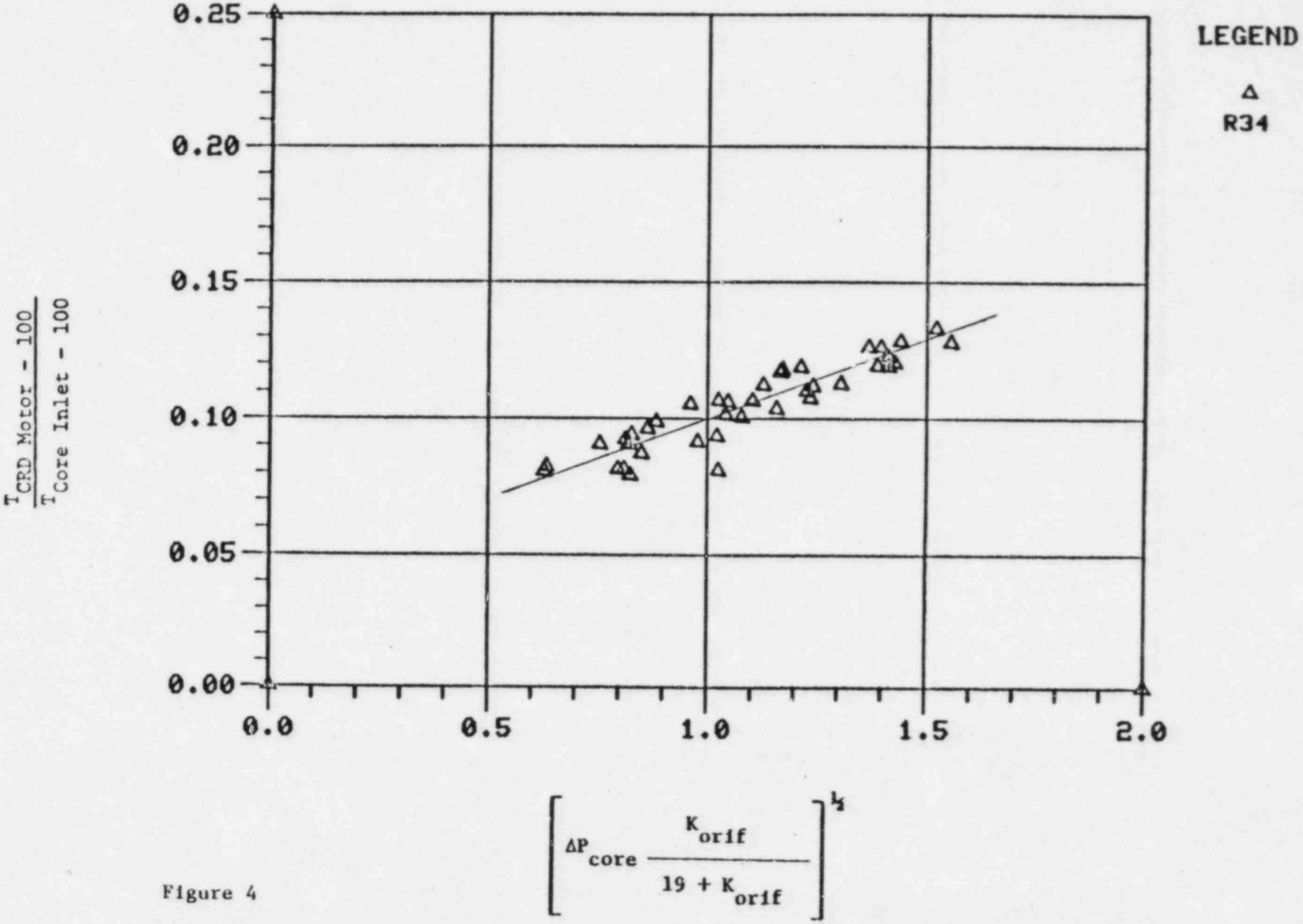
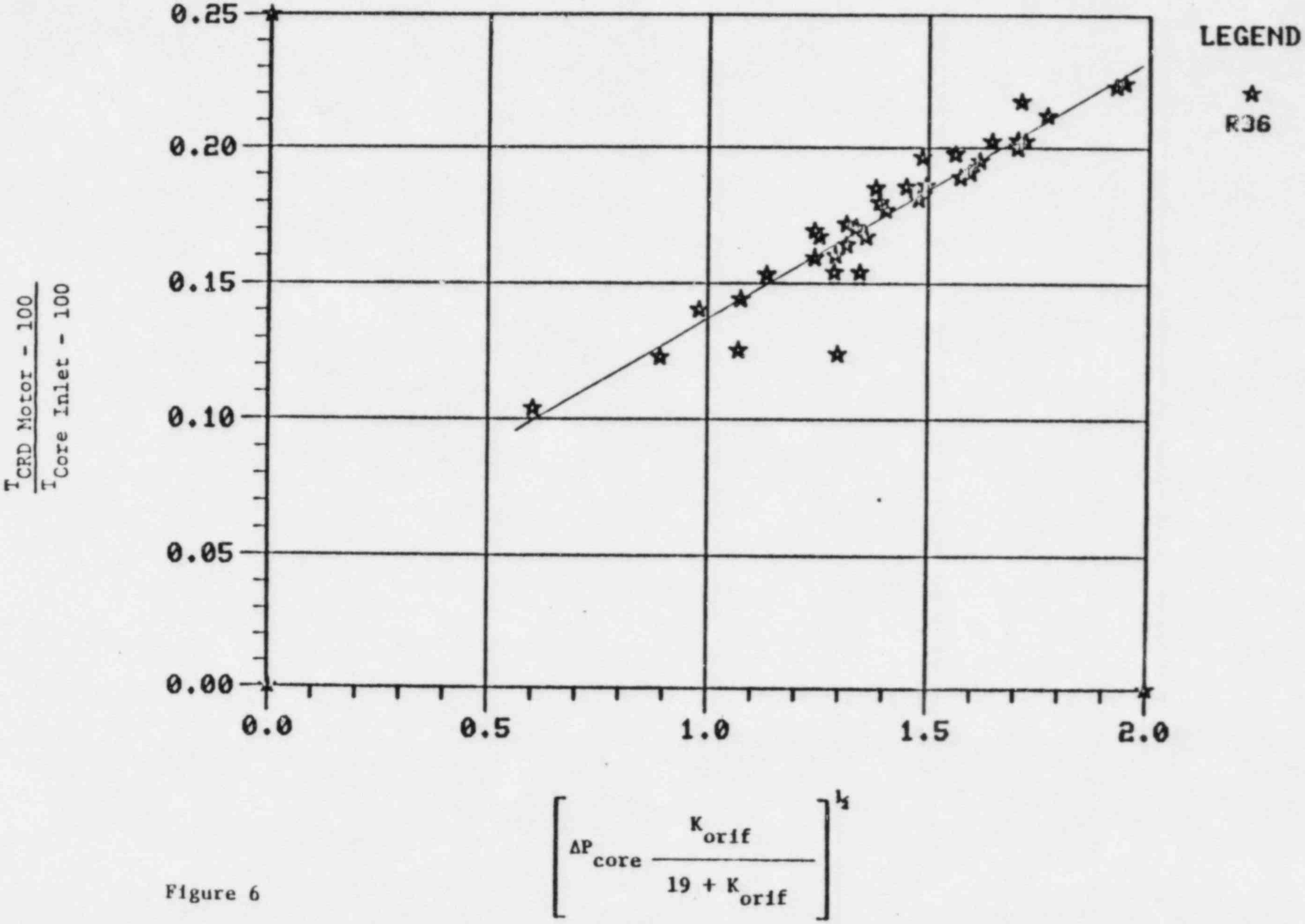

0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
LEGEND
△
R34
$\frac{T_{CRD\ Motor} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}} \right]^{\frac{1}{2}}$

Figure 4



0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
LEGEND
★ R36
$\frac{T_{CRD\ Motor} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 6

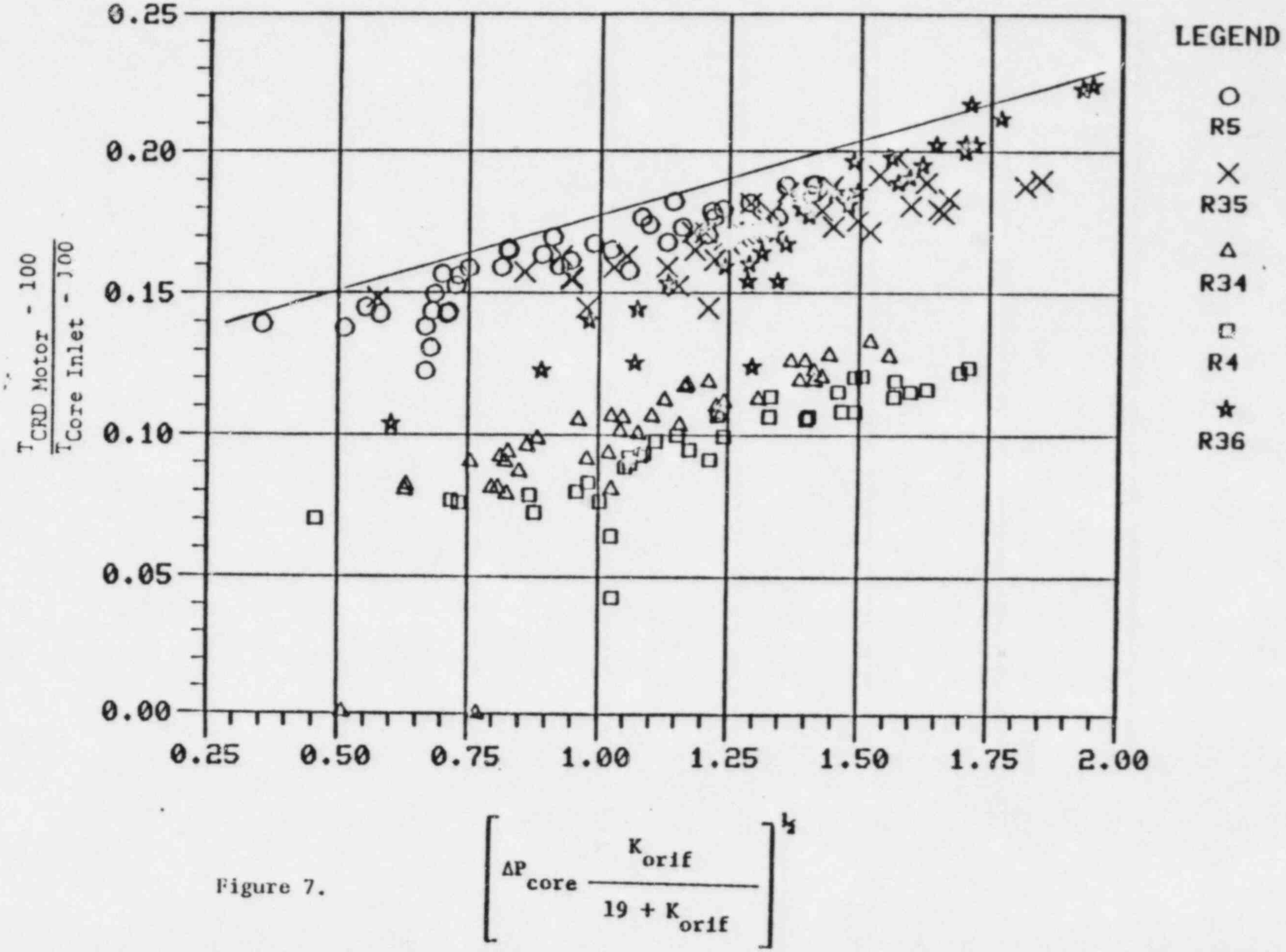

0.25
0.20
0.15
0.10
0.05
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
$\frac{T_{\text{CRD Motor}} - 100}{T_{\text{Core Inlet}} - 100}$
$\left[\Delta P_{\text{core}} \frac{K_{\text{orif}}}{19 + K_{\text{orif}}}\right]^{\frac{1}{2}}$
LEGEND
○ R5
✕ R35
△ R34
□ R4
★ R36

Figure 7.

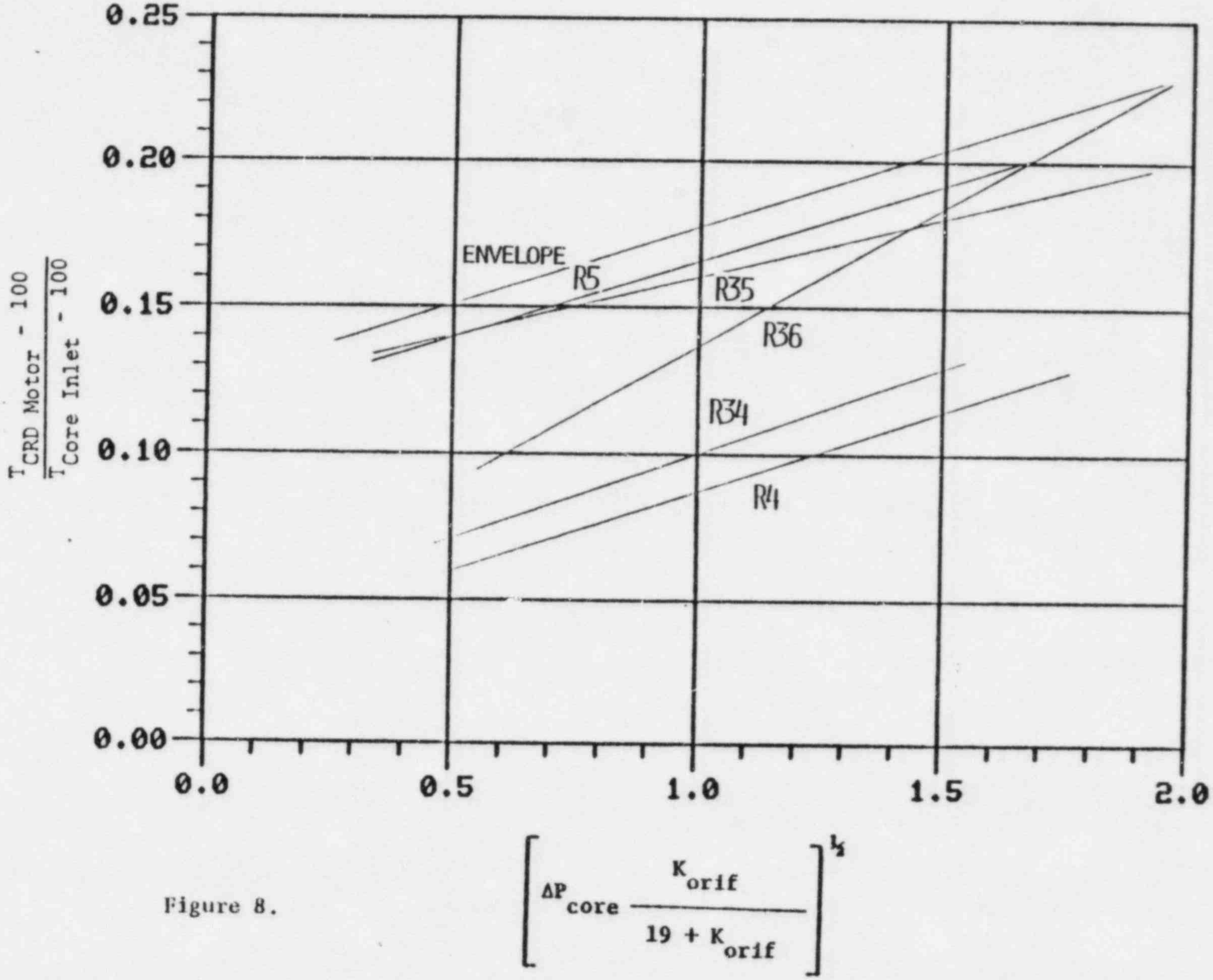

0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.5
1.0
1.5
2.0
$\frac{T_{CRD\ Motor} - 100}{T_{Core\ Inlet} - 100}$
ENVELOPE
R5
R35
R36
R34
R4
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 8.

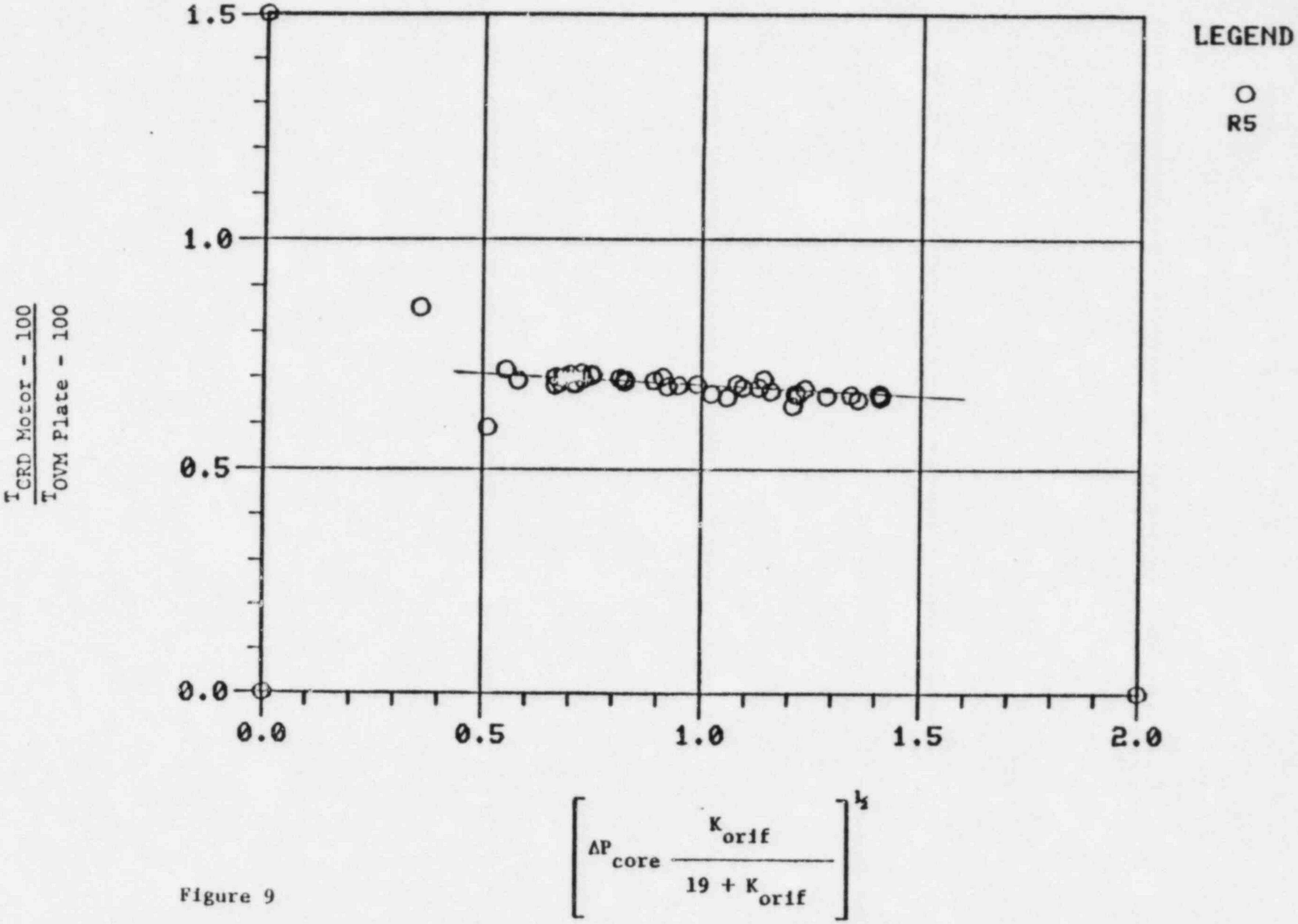

1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
LEGEND
○
R5
$\frac{T_{\text{CRD Motor}} - 100}{T_{\text{OVM Plate}} - 100}$
$\left[\Delta P_{\text{core}} \frac{K_{\text{orif}}}{19 + K_{\text{orif}}}\right]^{\frac{1}{2}}$

Figure 9

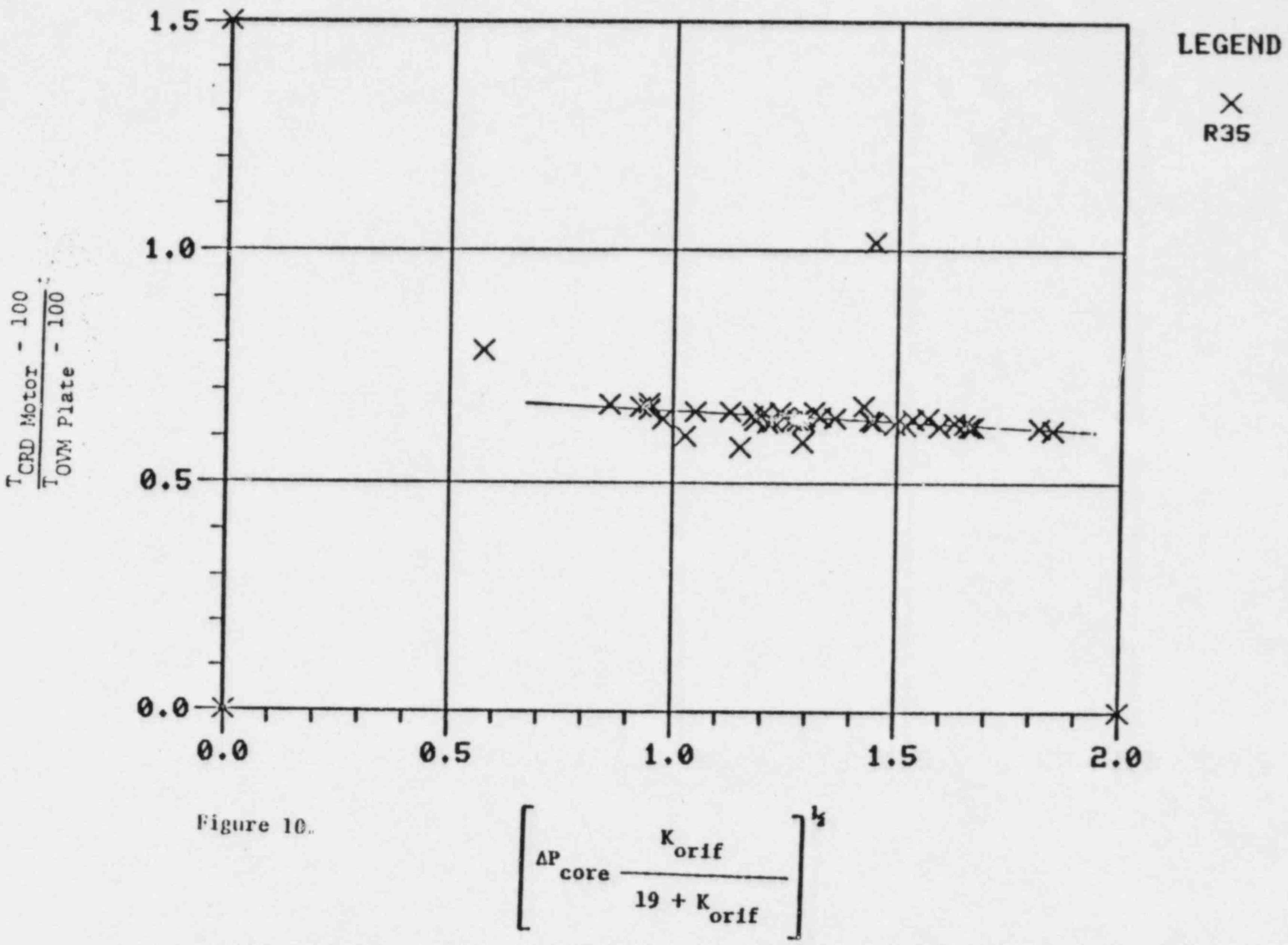

1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$
LEGEND
R35

Figure 10.

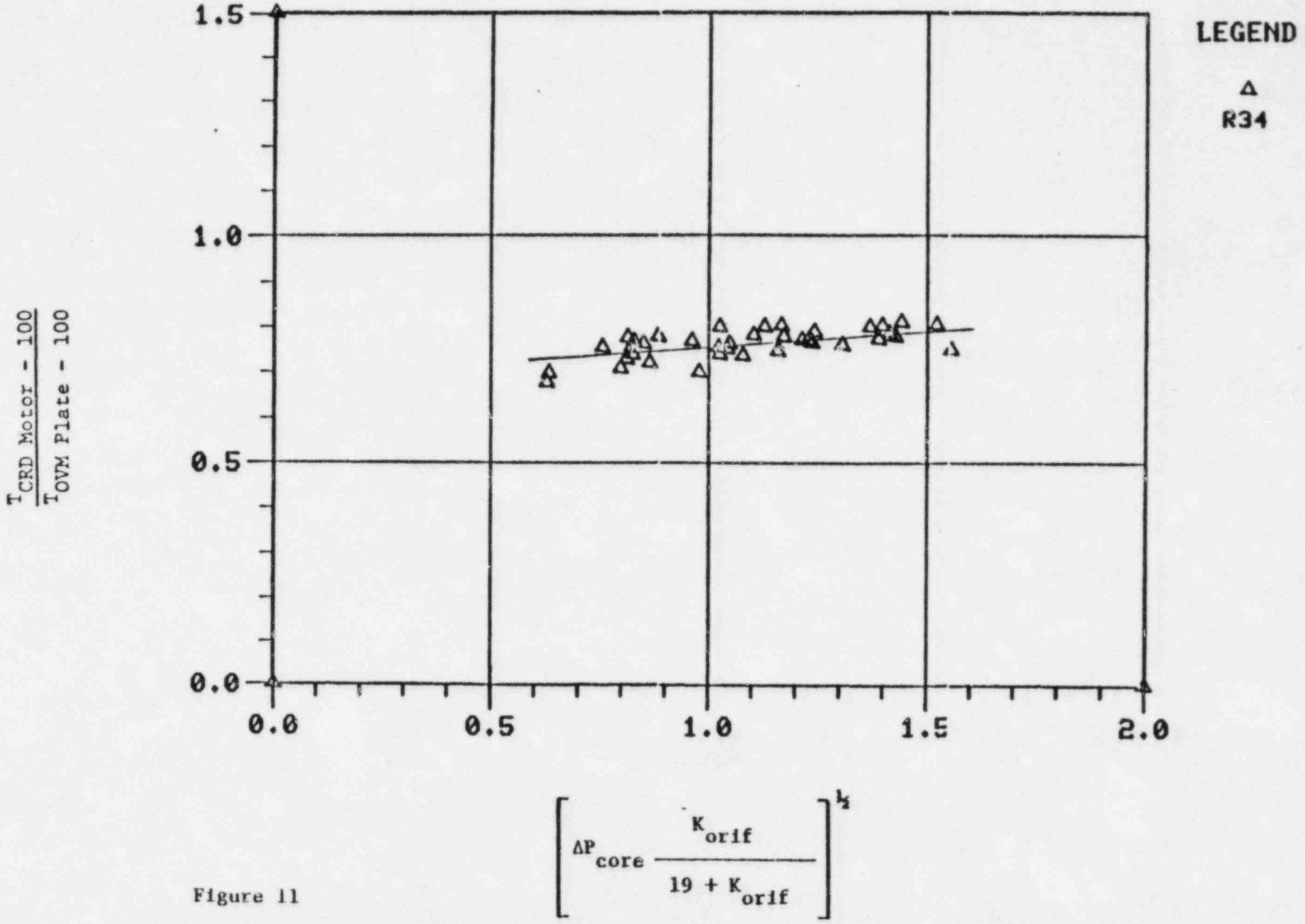

1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
LEGEND
Δ R34
$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 11

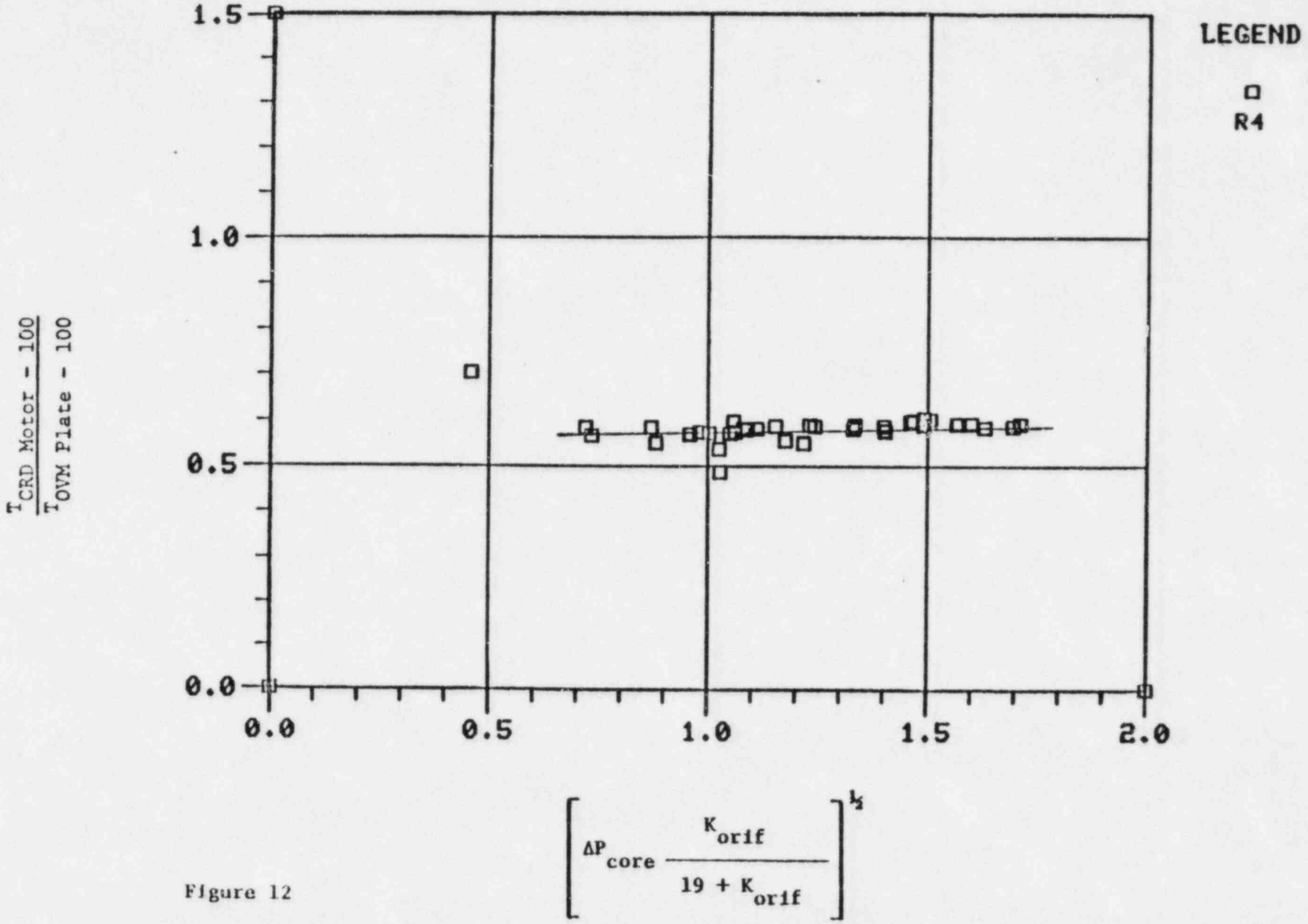

1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
LEGEND
R4
$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{1/2}$

Figure 12

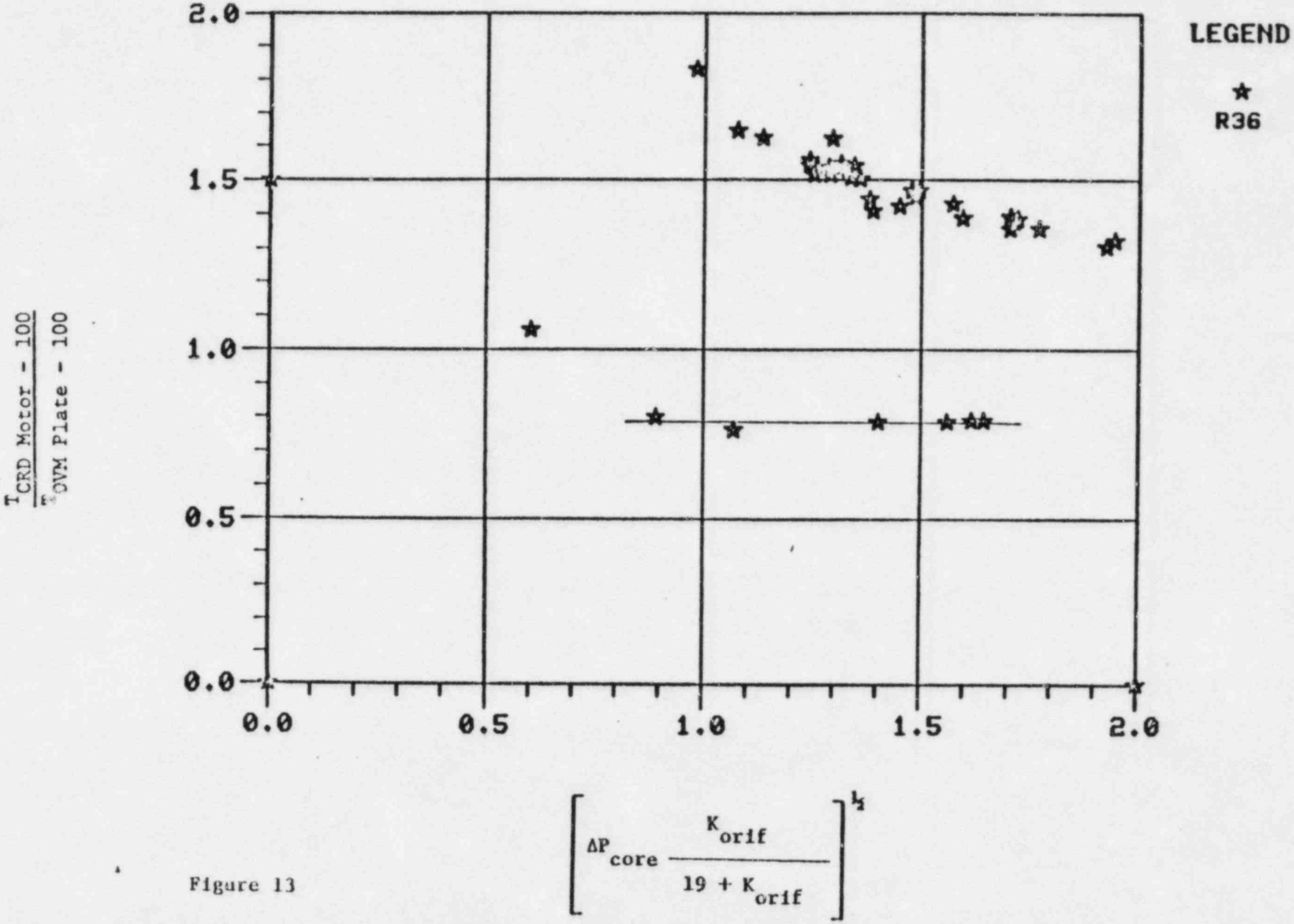

LEGEND
R36
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$

Figure 13

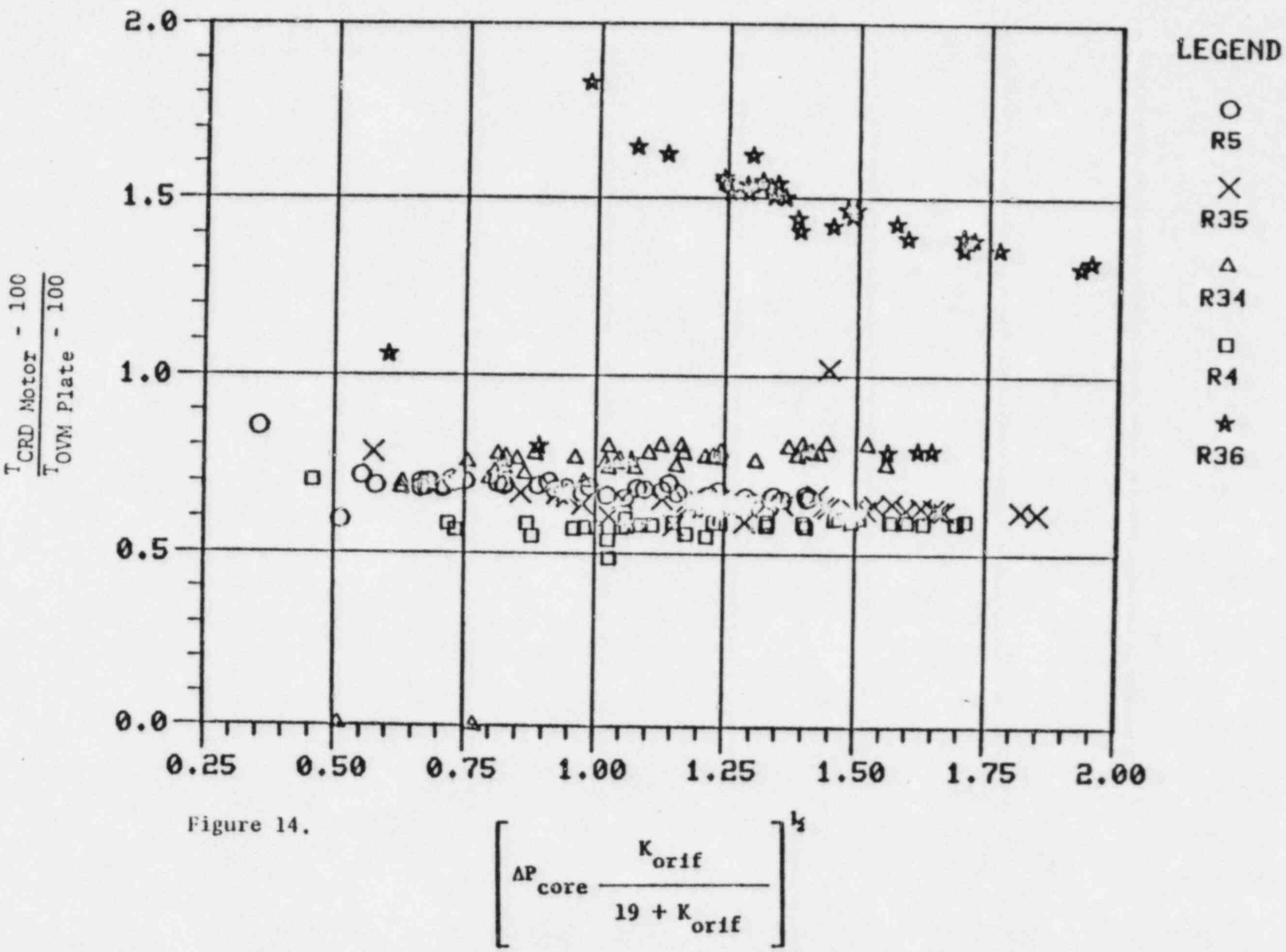

2.0
1.5
1.0
0.5
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
LEGEND
○ R5
× R35
△ R34
□ R4
★ R36
$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{1/2}$

Figure 14.

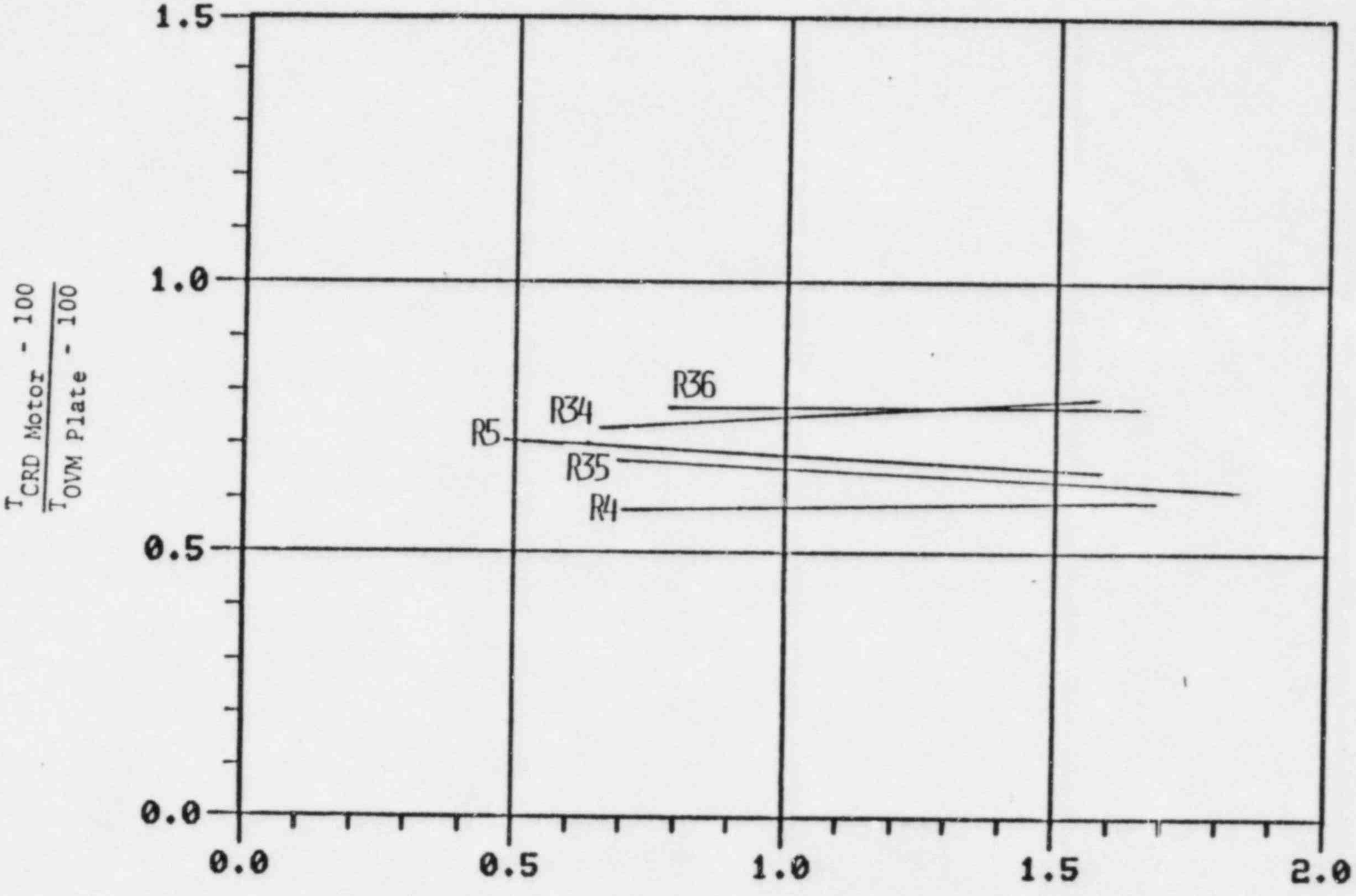

$\frac{T_{CRD\ Motor} - 100}{T_{OVM\ Plate} - 100}$
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
R36
R34
R5
R35
R4
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 15.

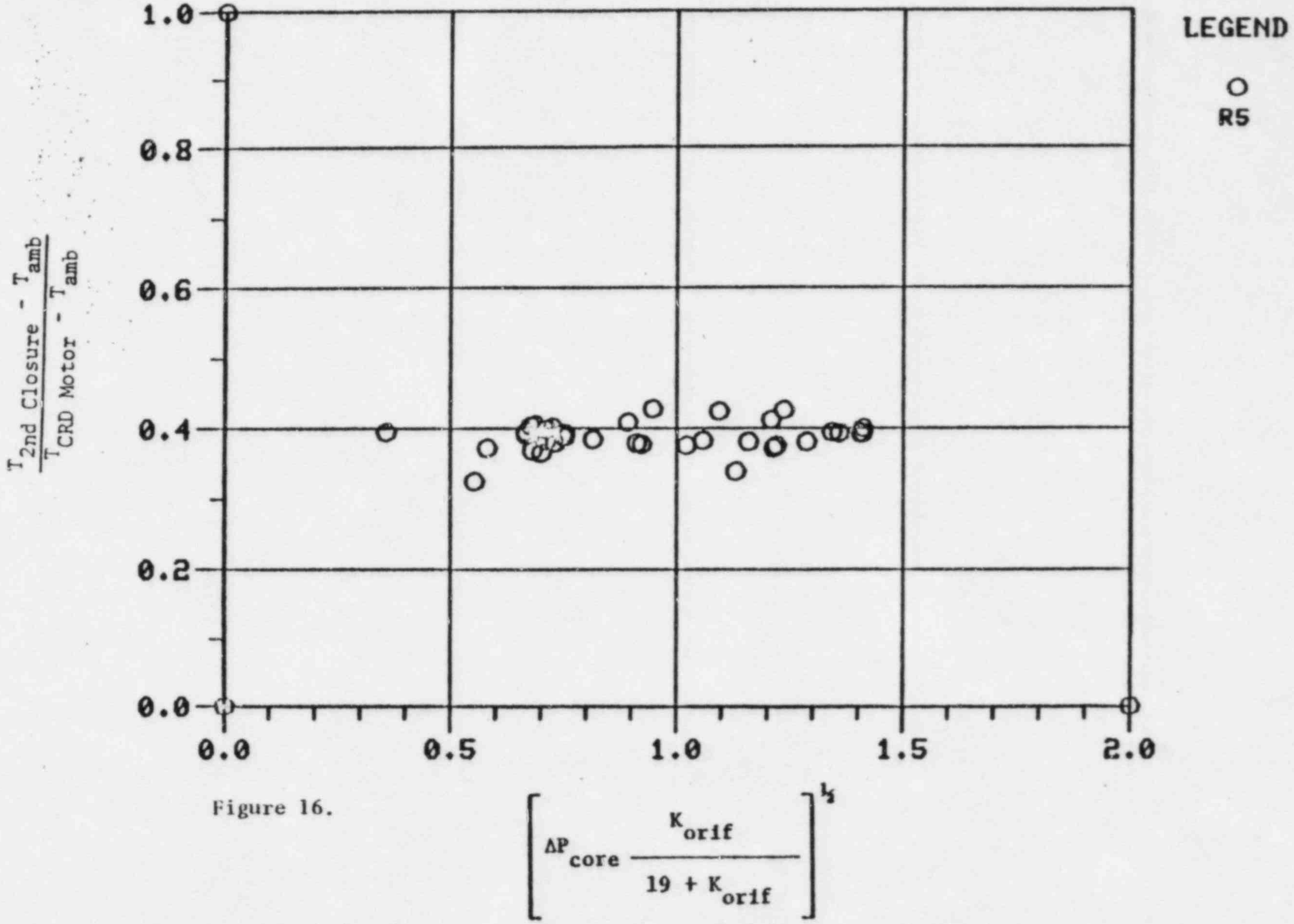
LEGEND
R5
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{2nd\ Closure} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$

Figure 16.

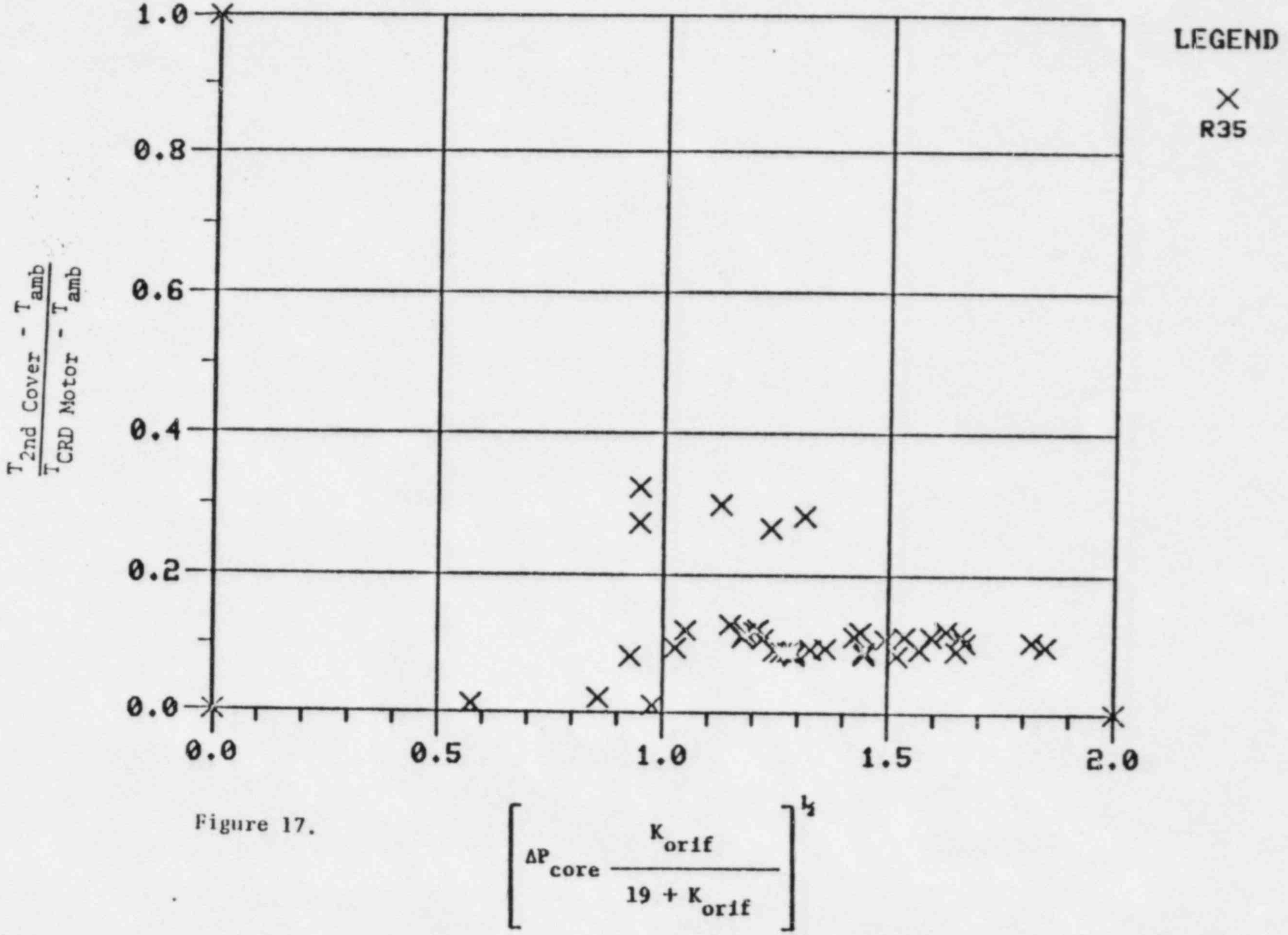

LEGEND
×
R35
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 17.

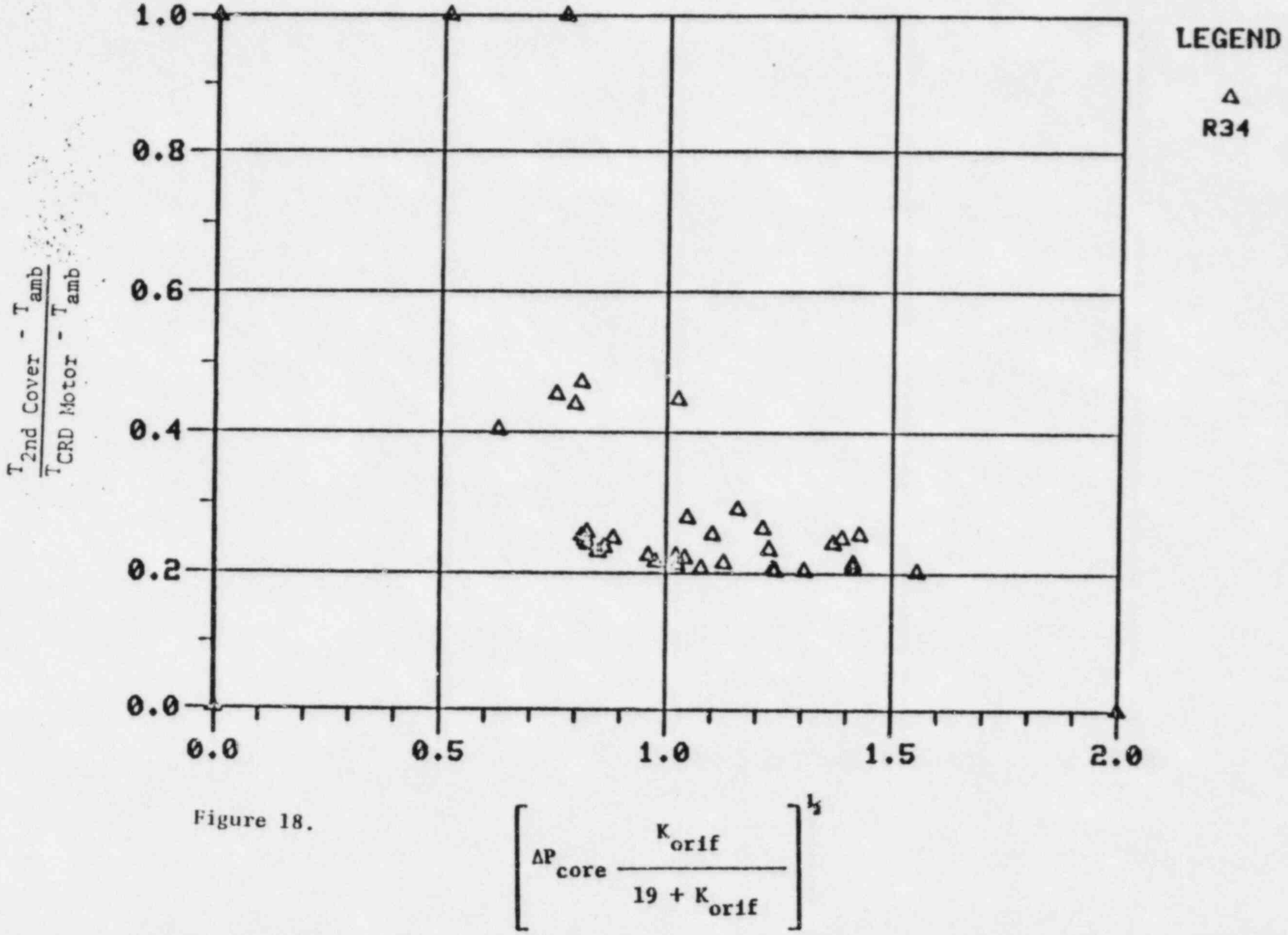

1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$
LEGEND
△
R34

Figure 18.

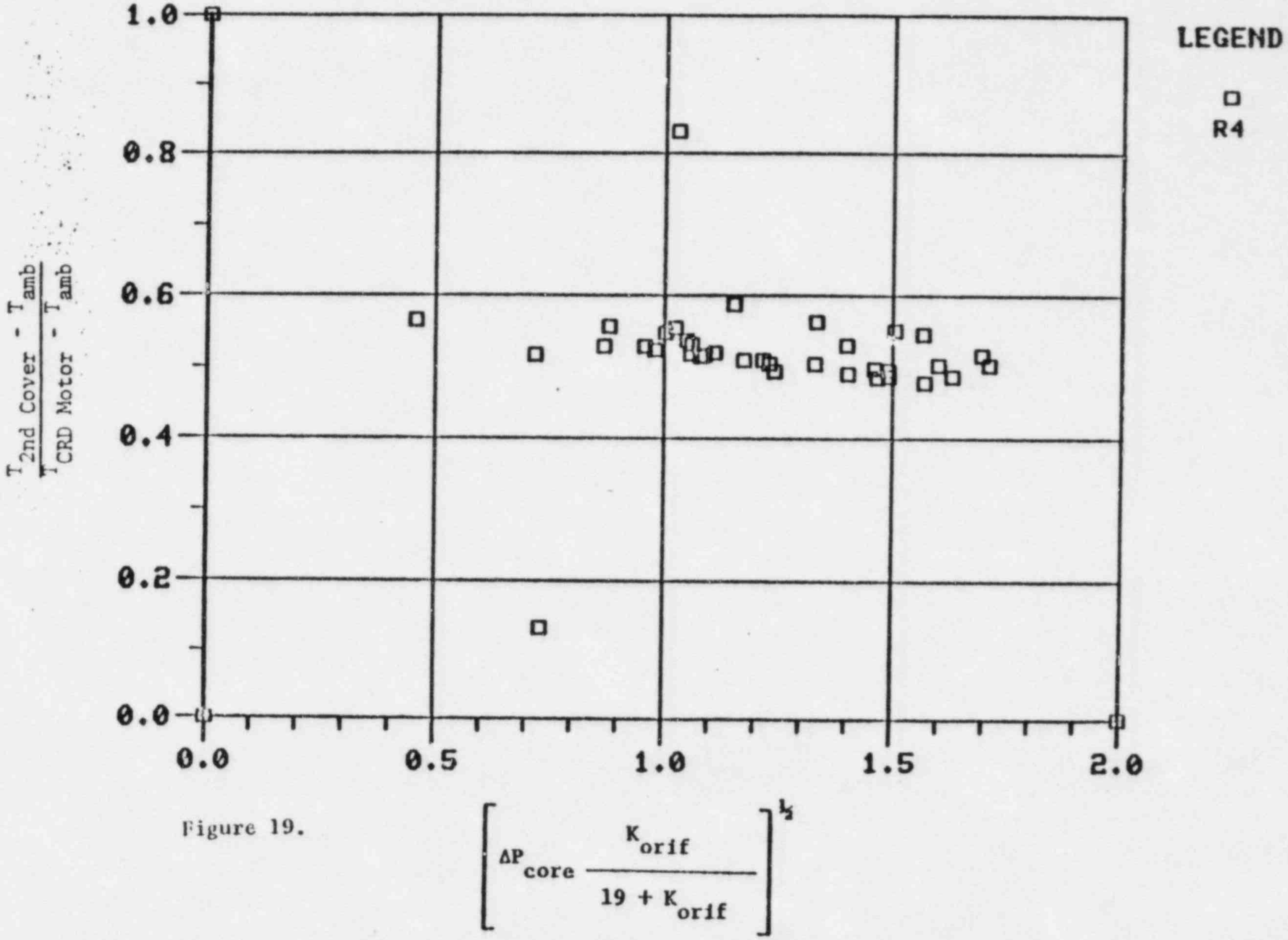
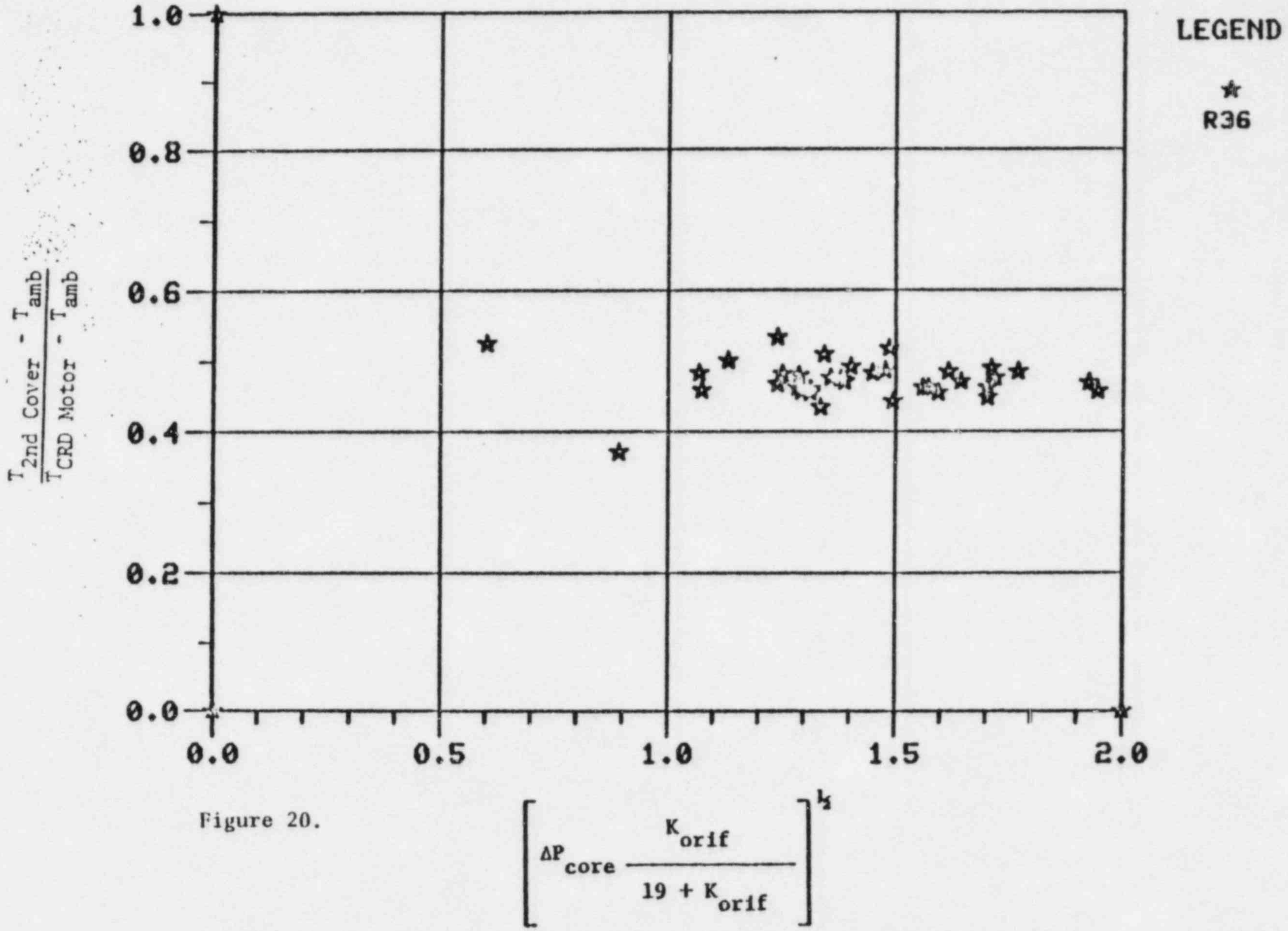

LEGEND
□ R4
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{1/2}$

Figure 19.



LEGEND
R36
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 20.

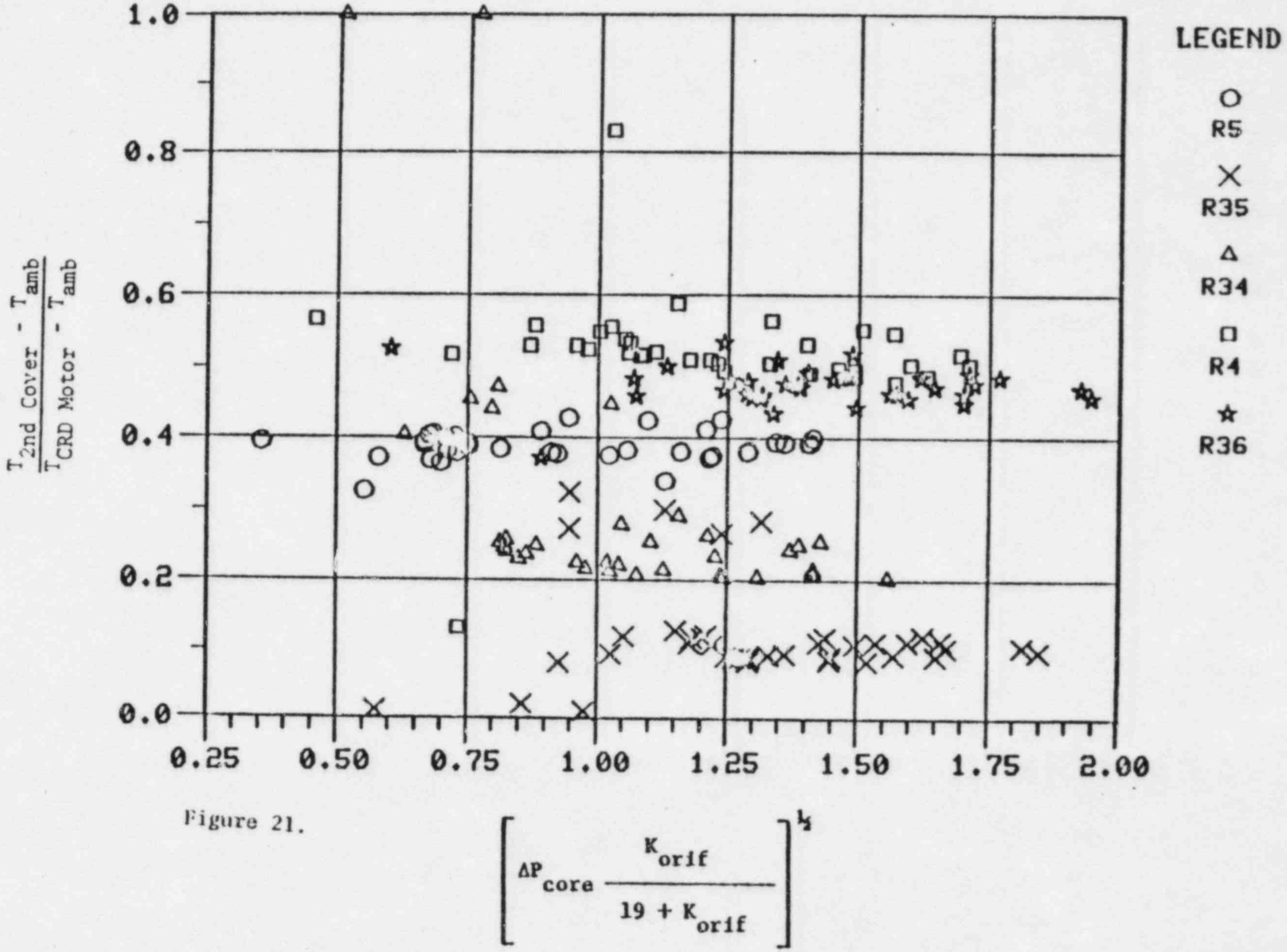

LEGEND
○ R5
× R35
△ R34
□ R4
☆ R36
$\frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ Motor} - T_{amb}}$
1.0
0.8
0.6
0.4
0.2
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 21.

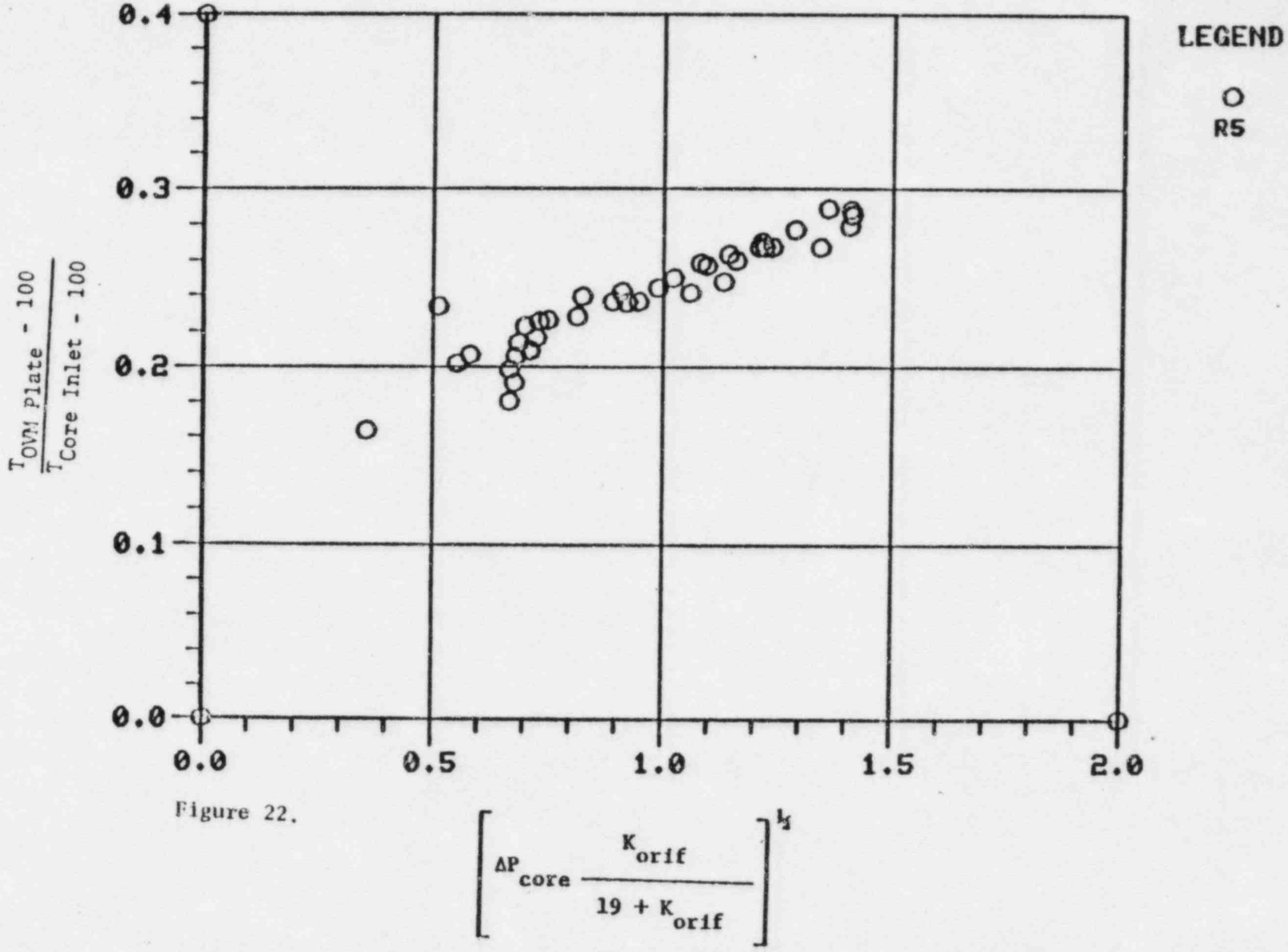

LEGEND
○ R5
0.0
0.1
0.2
0.3
0.4
0.0
0.5
1.0
1.5
2.0
$\frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$

Figure 22.

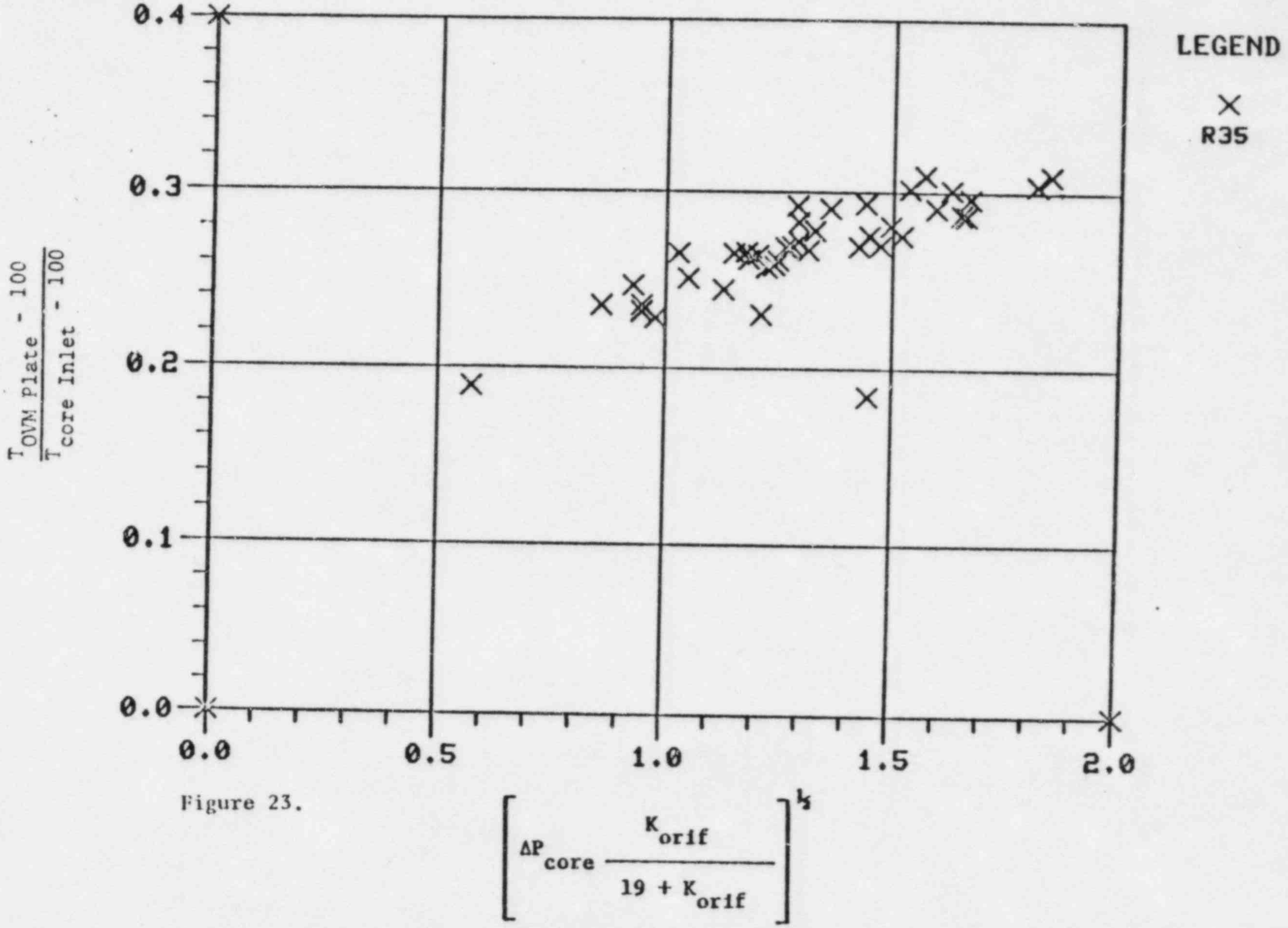

LEGEND
×
R35
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{OVM\ Plate} - 100}{T_{core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 23.

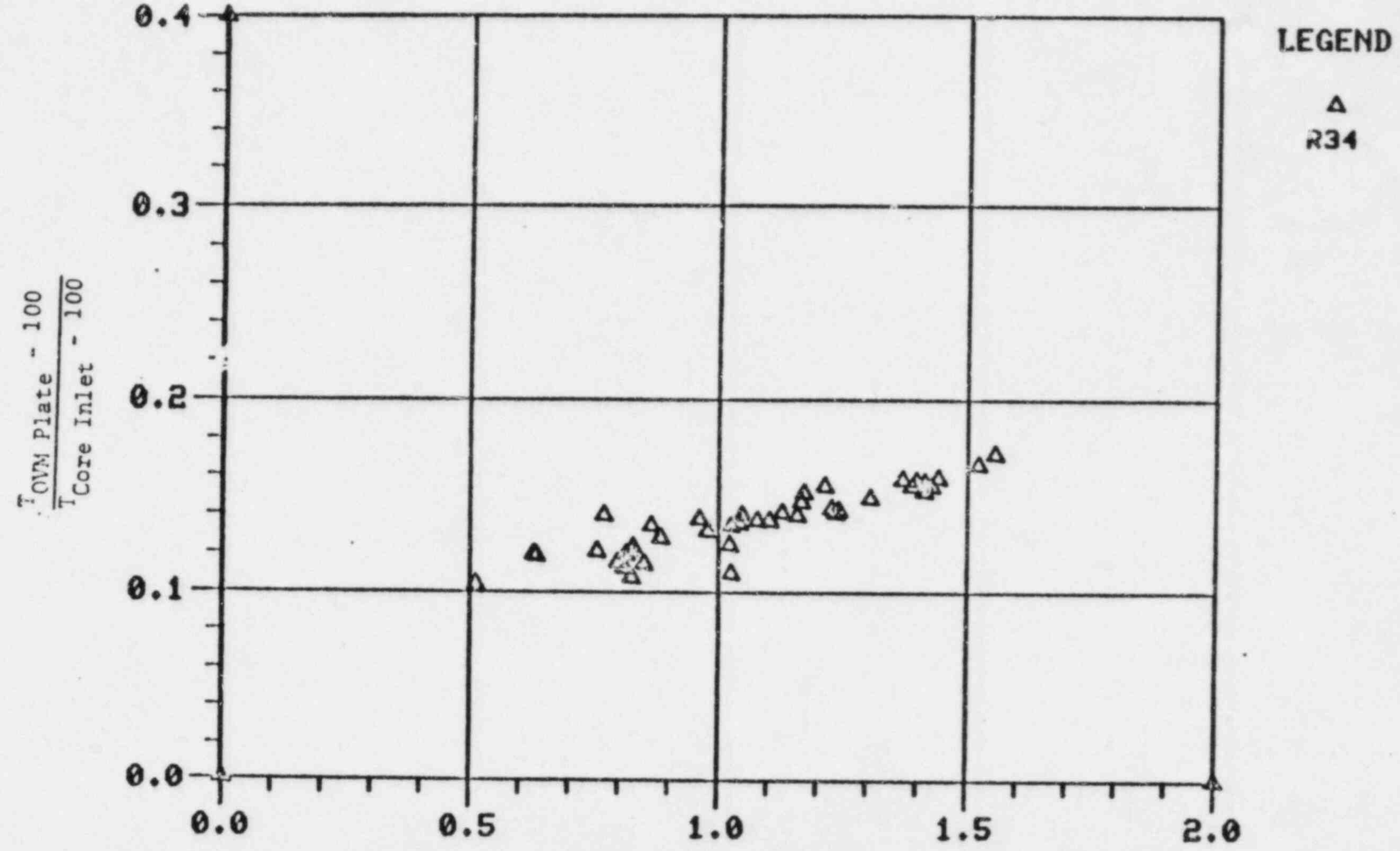
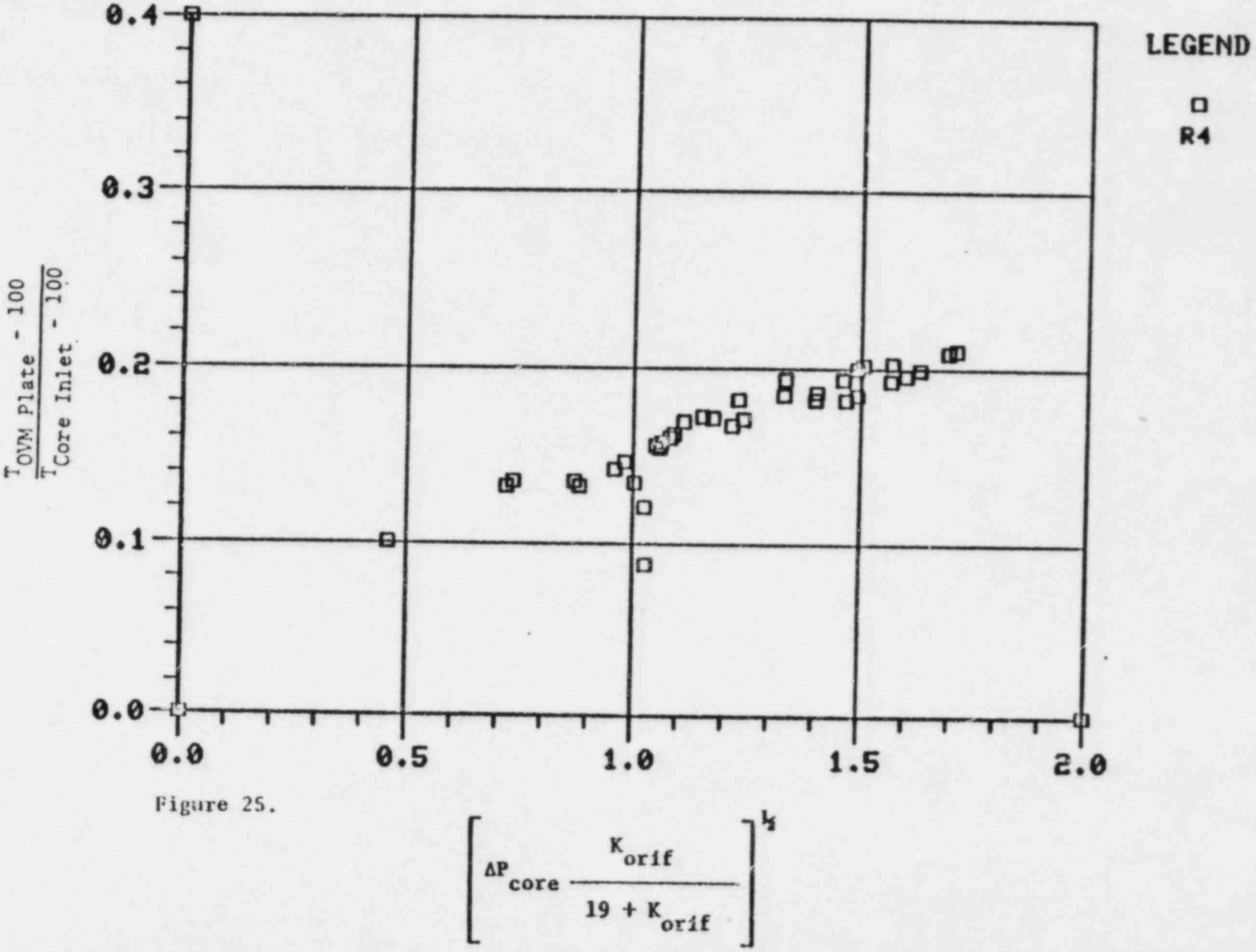

0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
LEGEND
Δ
R34
$\frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$

Figure 24.



LEGEND
□ R4
0.0
0.1
0.2
0.3
0.4
0.0
0.5
1.0
1.5
2.0
$\frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core}\frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 25.

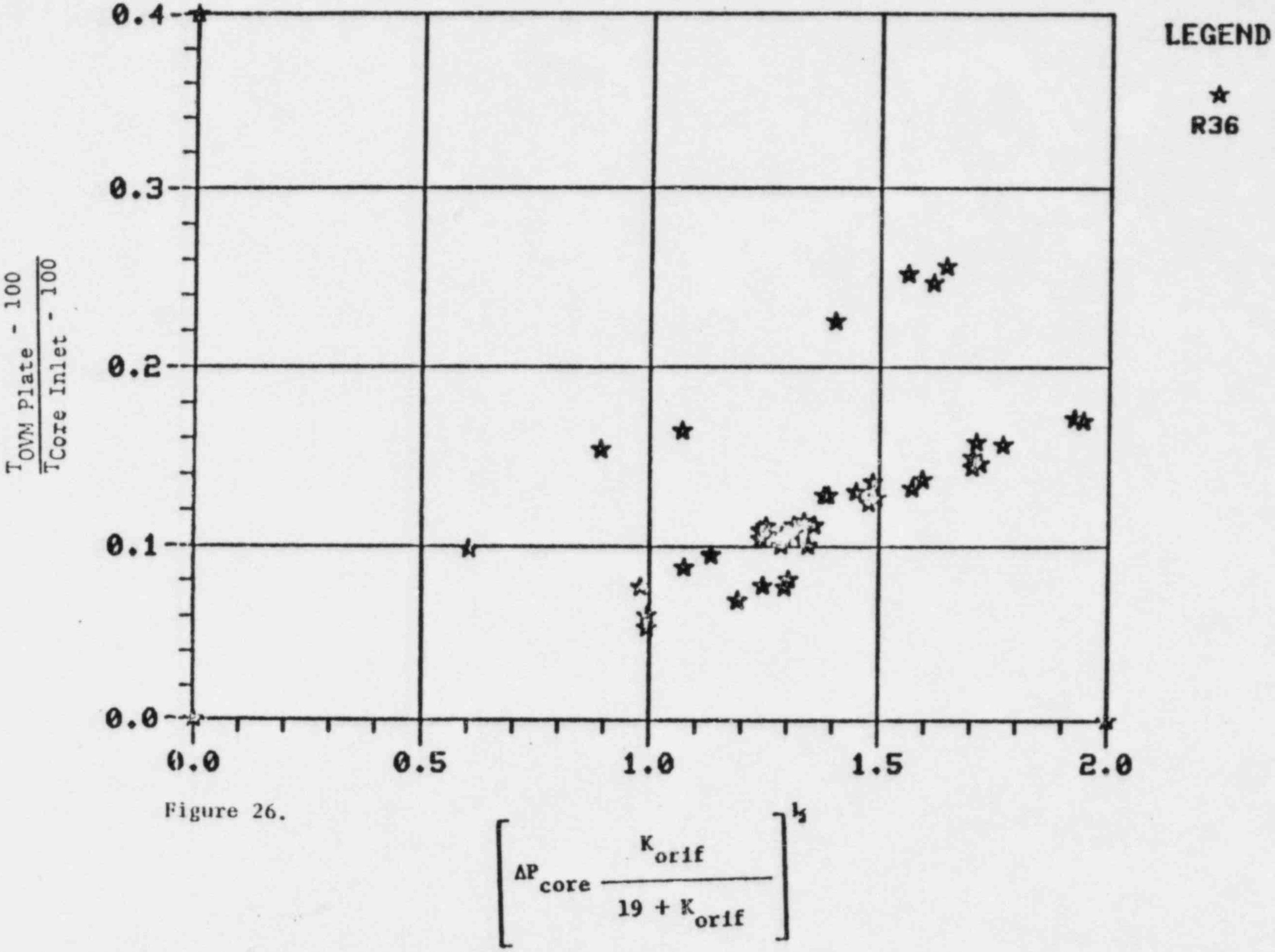

LEGEND
★ R36
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
$\frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{½}$

Figure 26.

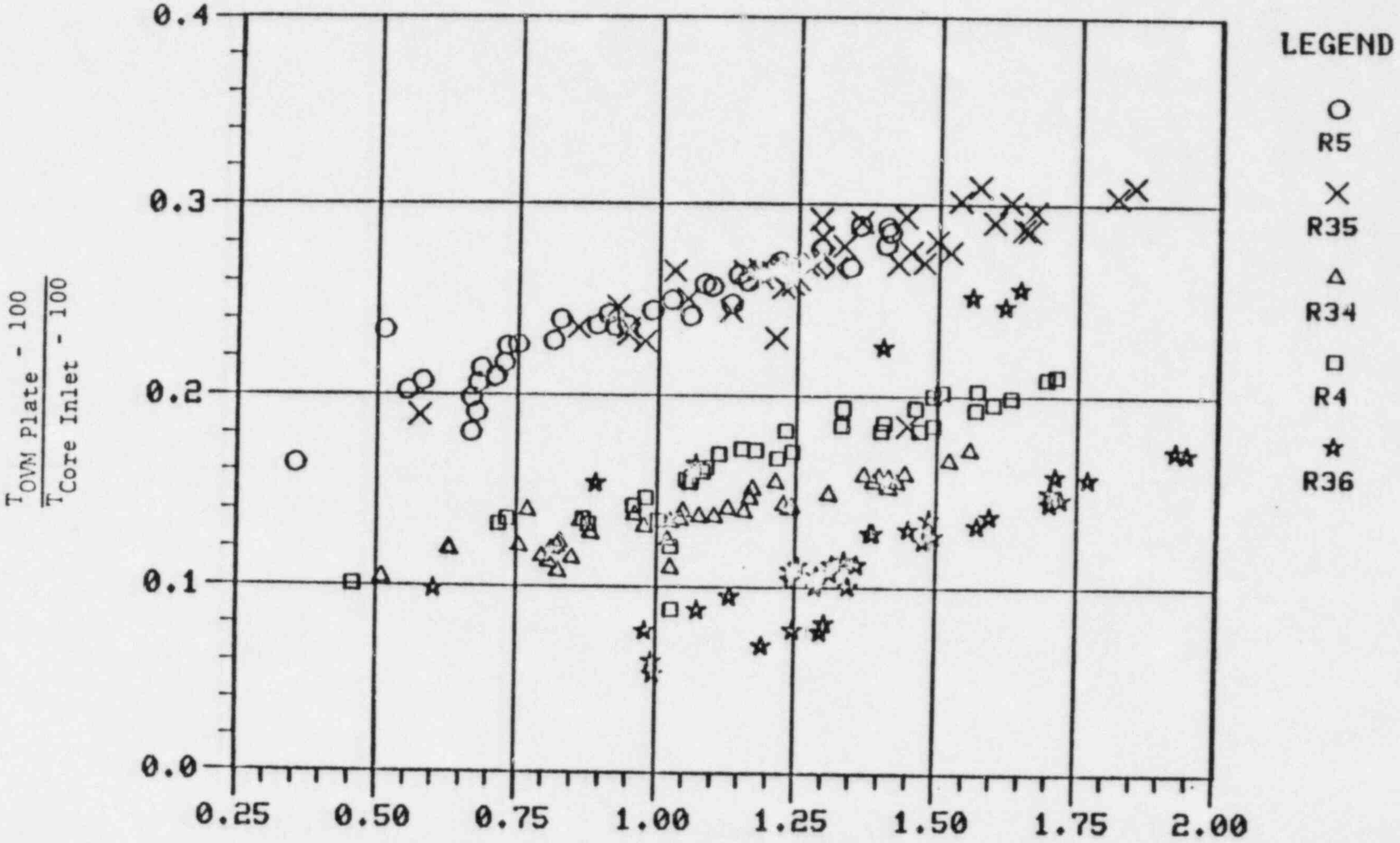

0.4
0.3
0.2
0.1
0.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
$\frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$
LEGEND
○ R5
× R35
△ R34
□ R4
☆ R36
$\left[\Delta P_{core} \frac{K_{orif}}{19 + K_{orif}}\right]^{\frac{1}{2}}$

Figure 27.

Table 1

REGION 15

Data Set	Date	Time	Reactor Power %	Primary Flow %	Core ΔP psid	Core Inlet Temp-F	Orifice Opening %	OVM Plate Temp-F	CRD Motor Temp-F	Cover Plate Temp-F	Ambient Air Temp-F	Orifice Loss Coef.	Leakage Parameter	$\hat{T}_{OVM}/T_{core}$	$\hat{T}_{CRD}/T_{core}$	$\hat{T}_{CRD}/T_{OVM}$	$\tilde{T}_{cover}/\tilde{T}_{CRD}$
10	031380	1947	9.3	20.0	.39	422.0	40.0	152.6	144.6	109.3	86.2	9.1	.36	.163	.139	.652	.394
11	031480	0425	19.5	39.5	.94	581.0	53.0	197.3	169.4	111.6	84.1	9.1	.55	.202	.145	.715	.325
12	031680	1130	28.0	66.0	1.41	665.0	56.0	208.0	174.0	116.6	60.3	9.1	.68	.191	.131	.665	.404
13	031680	1026	56.0	66.8	2.11	737.0	98.3	213.3	177.2	117.2	76.2	5.0	.67	.160	.123	.661	.394
14	031880	1030	65.1	76.7	2.39	669.0	97.3	223.0	164.0	121.9	60.9	5.1	.71	.209	.143	.663	.398
15	051580	1100	45.0	61.3	1.59	647.0	97.2	213.0	170.0	124.0	92.0	5.1	.58	.207	.143	.690	.372
16	052580	1530	67.0	73.3	2.30	675.0	95.6	228.0	193.0	131.0	97.0	5.1	.70	.223	.157	.703	.366
17	111280	0645	39.6	53.8	1.61	646.0	28.3	229.1	187.4	124.5	86.5	21.2	.92	.236	.159	.677	.377
18	111280	2153	50.0	65.4	2.28	665.0	25.7	240.1	194.7	124.5	80.4	24.0	1.13	.246	.166	.676	.340
19	111380	0755	62.5	80.7	3.19	690.0	37.0	253.9	202.2	126.2	82.7	13.8	1.16	.259	.173	.668	.381
20	111380	1425	69.5	57.9	3.64	691.0	39.0	259.5	205.5	130.2	85.4	12.9	1.21	.270	.179	.661	.373
21	111480	0639	47.0	62.8	2.61	656.0	25.8	248.7	194.7	126.3	81.9	23.9	1.21	.267	.170	.637	.411
22	111480	0630	54.0	66.9	2.96	661.0	25.7	255.3	201.9	129.3	84.6	24.0	1.29	.277	.182	.656	.381
23	111480	1810	63.0	74.8	3.54	674.0	25.1	265.1	206.1	131.7	82.3	24.0	1.41	.268	.188	.654	.393
24	111480	2025	59.6	75.8	3.46	674.0	27.7	265.7	207.7	132.4	83.6	21.6	1.36	.289	.188	.650	.393
25	111580	0700	69.7	84.4	4.10	686.0	31.0	267.2	210.2	134.2	83.6	18.0	1.41	.265	.168	.659	.400
26	112080	1200	68.0	74.9	2.40	693.0	96.0	224.0	165.2	124.7	87.1	5.0	.71	.209	.144	.687	.383
27	121180	1100	69.7	72.7	2.20	673.0	96.2	217.8	182.2	121.2	85.6	5.0	.68	.206	.143	.698	.369
28	121180	1133	68.0	72.0	2.12	686.0	99.0	216.0	181.0	123.9	87.2	5.0	.67	.198	.138	.698	.391
29	121280	0300	41.4	53.2	1.24	643.0	97.5	226.8	174.8	54.6	90.5	5.1	.51	.234	.138	.590	-.426
30	121280	1126	41.5	52.6	2.01	638.0	26.0	230.3	185.0	124.0	86.1	23.7	1.06	.242	.158	.654	.383
31	121280	1426	41.0	53.3	1.88	632.0	26.0	233.0	188.0	124.9	86.9	23.7	1.02	.250	.165	.662	.376
32	121280	2200	51.0	65.7	2.60	663.0	26.1	250.5	199.5	129.9	88.0	23.6	1.22	.267	.177	.661	.376
33	121380	1430	62.7	70.3	3.46	681.0	20.8	255.3	202.6	132.3	86.4	20.2	1.34	.267	.177	.661	.395
34	121480	0610	69.3	64.0	4.22	679.0	32.6	261.4	207.0	133.8	86.5	16.7	1.40	.279	.185	.663	.393
35	121480	0600	60.1	74.7	3.27	671.0	32.6	252.4	202.6	133.7	82.4	16.7	1.24	.267	.180	.673	.427
36	121480	1320	49.2	64.9	2.56	645.0	32.6	239.9	194.7	132.0	85.7	16.7	1.09	.257	.174	.677	.425
37	121480	1820	39.9	53.0	1.91	646.0	32.6	229.1	186.0	129.4	85.5	16.7	.94	.236	.161	.662	.428
38	012581	1100	69.3	77.6	2.50	693.0	90.1	228.1	190.5	128.6	87.1	5.0	.72	.216	.153	.706	.401
39	021781	1430	70.0	63.0	2.64	698.0	90.8	235.0	195.0	131.2	90.7	5.0	.75	.226	.159	.704	.388
40	031381	1300	70.0	61.0	2.54	695.0	97.9	234.0	193.0	136.5	92.2	5.0	.73	.225	.156	.694	.380
41	031981	1900	50.6	63.9	1.97	661.0	75.3	220.0	184.0	125.0	84.9	5.9	.68	.214	.150	.700	.405
42	032081	1700	60.9	70.4	2.37	661.0	75.4	227.0	189.0	126.7	89.6	5.9	.75	.226	.159	.701	.393
43	033181	1430	.0	7.5	.07	107.0	17.0	112.0	122.0	92.5	75.2	******	****	*****	*****	*****	*****
44	041581	2033	69.7	73.6	2.90	691.0	80.2	235.0	194.0	130.4	90.8	5.6	.81	.228	.159	.696	.384
45	041781	0800	77.3	67.9	3.35	709.0	75.7	242.0	198.0	131.5	85.7	5.9	.89	.237	.163	.690	.408
46	041681	1030	80.1	90.9	3.53	704.0	75.7	246.4	202.3	133.0	90.7	5.9	.91	.242	.169	.699	.379
47	110581	1030	68.4	75.5	2.53	677.0	61.6	238.4	196.6	133.3	88.5	7.0	.82	.239	.166	.694	.417
48	110581	1110	77.7	65.4	2.53	695.0	61.6	242.4	198.0	121.5	91.8	7.0	.82	.239	.165	.688	.280
49	110581	1260	65.7	92.7	3.63	710.0	61.6	249.0	202.0	124.7	86.8	7.0	.99	.244	.167	.685	.329
50	110681	1445	96.1	104.2	4.34	723.0	61.6	261.0	210.0	128.7	93.2	7.0	1.08	.258	.177	.683	.304
51	110781	1500	101.7	112.2	4.88	747.0	62.4	270.0	218.0	134.3	95.6	6.9	1.14	.263	.182	.694	.316

$$\frac{\hat{T}_{OVM}}{\hat{T}_{Core}} = \frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$$

$$\frac{\tilde{T}_{Cover}}{\tilde{T}_{CRD}} = \frac{T_{2nd\ Cover} - T_{amb}}{T - T}$$

Table 2

REGION R35

Data Set	Date	Time	Reactor Power %	Primary Flow %	Core ΔP psid	Core Inlet Temp-F	Orifice Opening %	OVM Plate Temp-F	CRD Motor Temp-F	Cover Plate Temp-F	Ambient Air Temp-F	Orifice Loss Coef.	Leakage Parameter	$\frac{\hat{T}_{OVM}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{OVM}}$	$\frac{\tilde{T}_{cover}}{\tilde{T}_{CRD}}$
10	03[illegible]	1047	9.8	28.9	.39	422.0	9.5	161.0	147.0	87.0	80.2	161.4	.57	.169	.148	.764	.013
11	030480	0425	18.5	39.5	.54	583.0	13.0	213.0	175.6	86.0	84.1	66.7	.86	.235	.158	.669	.021
12	030680	1136	28.0	60.0	1.41	666.0	16.0	229.0	182.0	81.0	80.0	39.7	.98	.228	.145	.636	.010
13	031[illegible]80	0926	56.0	60.9	2.11	730.0	17.0	245.0	191.3	92.0	76.2	42.9	1.21	.230	.145	.630	.122
14	031880	1030	65.1	76.7	2.39	669.0	26.1	256.0	190.0	95.0	80.9	23.6	1.15	.265	.153	.577	.129
15	051[illegible]80	1100	45.0	61.0	1.59	647.0	19.5	245.0	167.0	101.0	92.0	37.4	1.03	.265	.159	.600	.095
16	05[illegible]980	1500	67.0	76.0	2.30	675.0	19.5	255.0	201.0	100.1	97.0	37.4	1.23	.270	.176	.652	.030
17	111280	0845	58.6	53.8	1.61	643.0	18.0	237.2	189.3	96.6	86.5	41.2	1.05	.250	.163	.651	.120
18	111280	2150	59.6	65.4	2.28	665.0	17.3	251.8	190.1	98.0	80.4	44.1	1.26	.269	.170	.633	.089
19	111380	0755	62.5	80.7	3.19	690.0	17.3	265.8	203.6	95.7	82.7	44.1	1.49	.261	.176	.625	.106
20	111380	1425	69.5	87.9	3.64	691.0	17.3	271.9	200.9	98.9	85.4	44.1	1.59	.291	.161	.622	.111
21	111480	0639	47.6	62.8	2.61	656.0	13.0	249.8	199.6	95.0	81.9	66.7	1.43	.269	.179	.665	.111
22	111480	0800	54.0	60.9	2.96	661.0	13.0	254.5	196.3	94.0	84.6	66.7	1.52	.275	.172	.623	.084
23	111480	1810	60.0	74.8	3.54	674.0	13.0	264.7	202.2	95.8	82.3	66.7	1.66	.287	.176	.621	.113
24	111480	2025	59.6	75.6	3.46	674.0	11.6	270.1	205.4	96.2	83.6	78.2	1.67	.296	.164	.620	.103
25	111580	0700	68.7	64.4	4.10	686.0	11.6	278.1	210.0	96.7	83.6	78.2	1.82	.304	.188	.618	.104
26	112[illegible]80	1200	68.0	74.9	2.49	693.0	17.5	261.4	201.6	97.2	87.1	43.3	1.29	.272	.172	.631	.088
27	12[illegible]480	1100	69.7	72.7	2.20	673.0	15.1	254.3	190.0	95.6	85.6	54.0	1.28	.269	.171	.635	.089
28	121180	1130	68.0	72.0	2.12	666.0	15.4	253.0	190.0	97.2	87.2	52.4	1.25	.261	.167	.641	.090
29	121280	0300	41.4	53.2	1.24	643.0	11.6	233.7	188.6	96.5	90.5	42.9	.93	.246	.163	.663	.082
30	121280	1120	41.5	5[illegible].8	2.01	638.0	14.9	238.0	187.0	97.0	86.1	55.0	1.22	.257	.162	.630	.108
31	121280	1426	41.0	53.3	1.98	632.0	14.9	239.0	186.0	96.7	86.9	55.0	1.16	.261	.165	.633	.117
32	121280	2200	51.0	65.7	2.66	663.0	12.8	255.0	197.7	98.0	84.0	68.2	1.45	.275	.174	.630	.091
33	121380	1430	62.7	76.3	3.48	681.0	12.8	267.0	204.4	97.0	86.4	68.2	1.65	.287	.180	.625	.090
34	121480	0610	69.3	84.0	4.22	679.0	11.4	279.4	210.0	98.6	86.5	80.3	1.85	.310	.190	.613	.098
35	121480	1900	60.1	74.7	3.27	671.0	11.4	272.0	206.0	97.5	82.4	80.3	1.63	.301	.189	.628	.120
36	121480	1320	49.2	64.9	2.56	645.0	11.4	260.1	201.4	99.3	85.7	80.3	1.44	.294	.186	.633	.118
37	121480	1620	39.9	56.0	1.91	646.0	14.2	244.2	193.5	98.2	85.5	58.6	1.20	.264	.171	.648	.118
38	012981	1100	69.3	77.6	2.50	693.0	17.0	265.0	205.7	96.0	87.1	45.3	1.33	.278	.178	.641	.092
39	021781	1400	70.0	63.0	2.68	698.0	17.7	274.0	211.0	102.0	90.7	42.4	1.36	.291	.186	.638	.094
40	031381	1300	70.0	81.0	2.54	695.0	20.2	274.0	202.0	102.0	9[illegible].2	35.7	1.29	.292	.171	.586	.089
41	031981	1000	50.0	63.9	1.97	661.0	17.1	249.0	196.0	97.0	84.9	44.9	1.18	.266	.171	.644	.109
42	032081	1700	60.9	76.4	2.37	661.0	17.1	259.0	20[illegible].0	99.0	89.6	44.9	1.29	.263	.182	.642	.084
43	033181	1430	.0	7.5	.07	167.0	10.1	111.0	171.0	90.0	75.2	*******	****	*****	*****	*****	*****
44	041581	2030	69.7	76.6	2.90	691.0	16.1	209.0	211.0	101.0	90.8	49.0	1.45	.164	.168	1.018	.085
45	041781	0800	77.3	87.9	3.35	700.0	17.1	261.0	215.0	100.1	85.7	44.9	1.53	.302	.192	.635	.111
46	041881	1000	80.1	90.9	3.50	704.0	17.1	287.0	219.5	102.5	90.7	44.9	1.57	.310	.198	.639	.092
47	110581	1630	68.4	75.5	2.53	679.0	45.1	234.0	190.0	121.3	88.5	10.4	.95	.231	.155	.672	.323
48	110581	1110	77.7	85.4	2.53	695.0	45.1	240.0	192.0	119.2	91.4	10.4	.95	.235	.155	.657	.273
49	110581	2200	85.7	92.7	3.63	713.0	45.6	249.0	197.0	119.8	80.8	10.2	1.13	.244	.159	.651	.299
50	11[illegible]681	1445	96.1	104.2	4.34	723.0	45.1	261.0	205.0	123.0	93.2	10.4	1.24	.258	.169	.652	.267
51	110781	1530	101.7	112.2	4.08	747.0	45.0	273.0	211.0	120.9	95.6	10.4	1.31	.267	.175	.653	.284

$$\frac{\hat{T}_{OVM}}{\hat{T}_{Core}} = \frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$$

$$\frac{\tilde{T}_{Cover}}{\tilde{T}_{CRD}} = \frac{T_{2nd\ Cover} - T_{amb}}{T_{CRD\ ..} - T_{.}}$$

Table 3

REGION R34

Data Set	Date	Time	Reactor Power %	Primary Flow %	Core ΔP psid	Core Inlet Temp-F	Orifice Opening %	OVM Plate Temp-F	CRD Motor Temp-F	Cover Plate Temp-F	Ambient Air Temp-F	Orifice Loss Coef.	Leakage Parameter	$\frac{\hat{T}_{OVM}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{OVM}}$	$\frac{\tilde{T}_{cover}}{\tilde{T}_{CRD}}$
10	030380	1847	9.8	26.0	.39	422.0	19.0	131.3	100.1	104.1	86.2	37.1	.51	.103	.000	.003	1.288
11	032880	1422	18.5	59.5	.94	587.0	21.9	166.7	100.1	111.8	64.1	31.9	.77	.139	.000	.001	1.731
12	031680	1133	29.0	60.0	1.41	666.0	34.0	165.0	140.0	109.0	80.0	15.5	.80	.115	.081	.708	.439
13	041980	0826	36.0	66.8	2.11	735.0	30.0	169.0	151.0	110.7	76.2	16.8	1.02	.110	.081	.739	.446
14	031880	1600	65.1	76.7	2.33	689.0	60.0	166.0	145.0	112.5	80.9	7.1	.81	.112	.081	.727	.471
15	051580	1130	45.0	61.0	1.59	647.0	70.1	165.0	144.0	113.0	92.0	6.2	.63	.119	.080	.677	.404
16	052980	1533	67.0	76.0	2.30	675.0	70.2	169.0	152.0	122.0	97.0	6.2	.75	.120	.090	.754	.455
17	111280	0845	36.8	53.8	1.61	648.0	37.2	165.8	149.6	102.0	80.5	13.7	.82	.126	.091	.754	.246
18	111280	2150	59.8	65.4	2.28	665.0	37.2	173.7	151.6	102.0	88.4	13.7	.98	.130	.091	.700	.215
19	111380	0755	62.5	80.7	3.19	690.0	37.2	161.9	161.0	105.4	82.7	13.7	1.16	.139	.103	.745	.290
20	111380	1425	69.5	67.9	3.64	691.0	37.2	163.1	163.5	101.4	85.4	13.7	1.24	.141	.107	.764	.205
21	111480	0639	47.0	62.8	2.61	656.0	24.6	179.3	161.1	100.4	61.9	25.8	1.23	.143	.110	.770	.234
22	111480	0830	54.0	66.9	2.96	661.0	24.6	183.2	163.2	100.6	84.6	25.8	1.31	.146	.113	.760	.204
23	111480	1610	60.0	74.8	3.54	674.0	24.6	188.8	169.1	104.4	82.3	25.6	1.43	.155	.120	.778	.255
24	111480	2025	59.6	75.8	3.46	674.0	24.5	189.7	173.5	102.2	81.6	26.0	1.41	.156	.123	.786	.214
25	111580	0700	68.7	64.4	4.16	686.0	32.4	190.5	169.9	105.0	83.6	16.8	1.39	.154	.119	.772	.248
26	111780	1200	66.0	74.9	2.40	693.0	35.4	173.6	155.4	102.4	87.1	14.5	1.02	.124	.093	.753	.224
27	120680	1103	69.7	72.7	2.23	673.0	49.5	165.5	149.9	100.4	85.6	9.2	.85	.114	.087	.762	.230
28	121180	1130	68.0	72.0	2.12	686.0	50.7	162.7	146.3	102.4	87.2	6.9	.82	.107	.079	.738	.257
29	121280	0303	41.4	53.2	1.24	643.0	50.6	164.1	144.7	76.6	90.5	9.0	.63	.118	.082	.697	-.256
30	121280	1120	41.5	52.8	2.31	638.0	24.6	173.4	154.0	100.1	86.1	25.8	1.08	.136	.100	.736	.206
31	121280	1426	41.0	53.3	1.68	632.0	24.6	171.9	154.0	101.7	86.9	25.8	1.04	.135	.102	.751	.221
32	121280	2233	51.0	65.7	2.68	663.0	24.7	180.0	163.0	103.2	80.0	25.6	1.24	.142	.112	.767	.203
33	121380	1430	62.7	76.3	3.48	681.0	24.7	188.3	169.1	103.6	86.4	25.6	1.41	.152	.119	.763	.208
34	121480	0610	69.3	84.0	4.22	679.0	24.7	199.0	174.1	104.1	86.5	25.6	1.56	.171	.128	.748	.201
35	121480	0830	60.1	74.7	3.27	671.0	24.7	190.2	171.9	104.0	82.4	25.6	1.37	.158	.126	.797	.241
36	121480	1320	49.2	64.9	2.56	645.0	24.7	184.2	164.7	106.5	85.7	25.6	1.21	.154	.119	.768	.263
37	121480	1623	39.9	50.6	1.91	646.0	24.7	176.1	157.9	105.7	85.5	25.6	1.05	.139	.106	.761	.279
38	012781	1100	69.3	77.8	2.53	693.0	63.5	170.4	154.6	104.1	87.1	6.8	.81	.119	.092	.776	.252
39	021781	1400	70.0	63.0	2.68	692.0	56.5	176.0	159.0	107.7	90.7	7.8	.88	.127	.099	.776	.249
40	031381	1300	70.0	61.3	2.54	695.0	61.6	173.0	156.0	107.5	92.2	7.0	.83	.123	.094	.767	.240
41	031981	1600	50.0	63.9	1.97	661.0	42.2	175.0	154.0	101.3	84.9	11.6	.86	.134	.096	.720	.237
42	032681	1730	60.9	70.4	2.37	661.0	40.8	177.0	159.0	105.2	89.6	12.1	.96	.137	.105	.766	.225
43	033181	1430	.0	7.5	.07	107.0	17.3	102.0	100.0	83.0	75.2	*******	****	*****	*****	*****	*****
44	041581	2030	69.7	78.6	2.93	691.0	44.1	179.0	163.0	106.1	90.8	10.8	1.02	.134	.107	.797	.212
45	041781	0800	77.3	67.9	3.35	700.0	44.1	182.0	164.0	105.6	95.7	10.8	1.10	.137	.107	.780	.254
46	041981	1030	80.1	90.9	3.50	704.0	44.1	164.7	167.7	107.2	90.7	10.8	1.13	.140	.112	.799	.214
47	110581	1030	68.4	75.5	2.53	679.0	27.3	164.7	167.8	118.6	60.5	22.1	1.17	.146	.117	.800	.360
48	110581	1110	77.7	85.4	2.53	695.0	27.0	190.0	170.0	112.2	91.8	22.4	1.17	.151	.118	.778	.261
49	110581	2203	65.7	92.7	3.63	710.0	27.3	196.0	177.0	118.6	86.8	22.1	1.40	.157	.126	.802	.353
50	110681	1445	96.1	104.2	4.34	723.0	31.6	199.0	180.0	120.4	93.2	17.5	1.44	.159	.128	.808	.313
51	110781	1500	103.7	112.2	4.88	747.0	32.0	207.0	186.0	126.1	95.6	17.1	1.52	.165	.133	.804	.337

$$\frac{\hat{T}_{OVM}}{\hat{T}_{Core}} = \frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$$

$$\frac{\tilde{T}_{Cover}}{\tilde{T}} = \frac{T_{2nd\ Cover} - T_{amb}}{T \qquad - T}$$

Table 4

REGION R4

Data Set	Date	Time	Reactor Power %	Primary Flow %	Core ΔP psid	Core Inlet Temp-F	Orifice Opening %	OVM Plate Temp-F	CRD Motor Temp-F	Cover Plate Temp-F	Ambient Air Temp-F	Orifice Loss Coef.	Leakage Parameter	$\hat{T}_{OVM}/\hat{T}_{core}$	$\hat{T}_{CRD}/\hat{T}_{core}$	$\hat{T}_{CRD}/\hat{T}_{OVM}$	$\tilde{T}_{cover}/\tilde{T}_{CRD}$
10	030380	1047	9.6	20.0	.19	422.0	27.4	157.1	172.7	166.8	86.2	22.0	.46	.106	.070	.763	.564
11	032480	0425	18.5	37.2	.94	560.0	26.0	163.5	130.9	111.4	84.1	22.9	.72	.132	.077	.581	.517
12	[illegible]	1130	45.2	60.3	1.41	666.0	26.0	175.0	141.0	114.0	80.0	22.9	.88	.133	.072	.547	.557
13	[illegible]	0020	56.0	60.8	2.11	733.0	30.0	175.6	140.5	112.8	76.2	18.8	1.02	.120	.064	.536	.555
14	031880	1000	65.1	70.7	2.39	687.0	32.0	179.0	145.0	116.0	80.9	15.6	1.00	.134	.076	.570	.548
15	051580	1100	45.0	61.0	1.59	647.0	32.0	174.0	143.0	119.0	[illegible]	17.1	.87	.135	.079	.581	.529
16	052980	1530	67.0	70.0	2.30	675.0	30.9	169.0	153.0	126.0	97.0	16.0	1.06	.155	.092	.596	.518
17	111280	0845	36.8	53.0	1.61	648.0	16.0	155.3	140.6	119.9	86.5	41.2	1.05	.156	.069	.570	.530
18	111280	2150	50.6	65.4	2.25	665.0	15.7	176.2	150.3	121.9	88.4	39.4	1.24	.170	.100	.565	.493
19	111380	0755	62.5	80.7	3.19	690.0	16.7	207.0	164.0	122.2	82.7	39.4	1.47	.161	.108	.598	.486
20	111380	1425	69.5	87.9	3.04	691.0	16.7	213.7	167.0	129.9	85.4	39.4	1.57	.192	.113	.589	.545
21	111480	0639	47.0	62.0	2.61	656.0	16.7	200.8	150.8	122.7	81.9	57.0	1.40	.161	.106	.563	.531
22	111480	1800	54.0	56.9	2.96	661.0	14.5	203.4	160.6	122.4	84.6	57.0	1.49	.164	.108	.568	.496
23	111480	1810	60.9	74.3	3.54	674.0	14.5	214.4	160.7	123.4	82.3	57.0	1.63	.159	.116	.563	.487
24	111480	2025	59.6	75.0	3.46	674.0	14.5	216.2	163.4	124.2	83.6	46.9	1.57	.262	.119	.589	.479
25	111580	0730	68.7	84.4	4.10	686.0	16.6	222.5	171.7	129.1	83.6	44.1	1.69	.209	.122	.585	.516
26	112080	1200	66.0	74.9	2.40	693.0	17.3	152.0	125.2	116.8	87.1	14.9	1.03	.068	.042	.465	.032
27	120580	1100	69.7	72.1	2.20	673.0	34.8	163.6	147.7	118.1	85.6	14.7	.98	.146	.083	.571	.523
28	121180	1130	68.0	72.0	2.12	666.0	35.0	163.0	147.0	116.8	87.2	14.5	.96	.142	.080	.566	.528
29	121280	0300	41.4	53.2	1.24	643.0	35.5	173.4	141.4	97.2	90.5	14.5	.73	.135	.076	.564	.132
30	121280	1126	41.5	54.0	2.01	636.0	35.5	189.9	149.2	118.3	86.1	52.4	1.23	.167	.091	.547	.510
31	121280	1426	41.0	53.3	1.88	632.0	15.4	191.0	150.4	119.3	86.9	52.4	1.17	.171	.095	.554	.510
32	121280	2200	51.0	65.7	2.66	663.0	15.4	204.5	159.9	123.3	80.0	52.4	1.40	.186	.106	.573	.491
33	121380	1433	62.7	76.3	3.48	661.0	15.4	213.5	166.9	126.8	86.4	52.4	1.60	.195	.115	.569	.502
34	121480	0610	69.3	84.6	4.22	679.0	15.4	221.5	171.7	129.3	86.5	42.9	1.71	.210	.124	.590	.502
35	121480	0800	60.1	74.7	3.27	671.0	17.6	215.2	169.0	130.1	82.4	42.9	1.51	.202	.121	.599	.551
36	121480	1320	49.2	64.9	2.56	645.0	17.6	205.5	161.9	128.7	85.7	42.9	1.33	.194	.114	.567	.564
37	121480	1820	39.9	50.0	1.91	646.0	17.6	193.7	154.7	126.2	85.5	42.9	1.15	.172	.100	.564	.588
38	012[illegible]81	1100	69.3	77.8	2.50	693.0	17.6	191.3	153.4	122.4	87.1	15.5	1.06	.157	.096	.572	.532
39	021781	1400	79.0	83.0	2.68	696.0	34.0	197.0	156.0	124.4	90.7	15.0	1.09	.162	.098	.577	.516
40	031381	1333	70.9	61.0	2.54	695.0	34.6	195.0	155.0	124.5	92.2	16.2	1.08	.160	.092	.579	.514
41	031981	1000	50.0	63.9	1.97	661.0	33.2	195.0	155.0	121.4	84.9	31.6	1.11	.169	.098	.579	.521
42	032081	1700	60.9	70.4	2.37	661.0	22.0	202.0	160.0	125.1	89.6	33.4	1.23	.162	.107	.588	.504
43	033181	1433	.0	7.5	.07	107.0	21.2	114.0	111.0	94.1	75.2	******	****	*****	*****	*****	*****
44	041581	2130	69.7	73.6	2.43	691.0	17.0	209.0	163.0	127.2	90.6	29.6	1.33	.184	.107	.578	.504
45	041781	0300	77.3	67.9	3.35	703.0	22.9	216.0	169.0	127.2	85.7	33.2	1.46	.193	.115	.595	.498
46	041981	1000	85.1	90.9	3.53	704.0	21.3	[illegible]	[illegible]	130.7	90.7	33.0	1.49	.200	.120	.603	.488
47	111581	1033	69.4	75.5	2.53	679.0	21.4	*****	*****	113.5	86.5	1000.0	1.58	*****	*****	*****	*****
48	111581	1110	77.7	85.4	2.53	695.0	*****	*****	*****	112.1	91.8	1000.0	1.58	*****	*****	*****	*****
49	111581	2200	85.7	92.7	3.63	710.0	*****	*****	*****	111.2	86.6	1000.0	1.89	*****	*****	*****	*****
50	111681	1445	96.1	104.2	4.34	723.0	*****	*****	*****	114.4	93.2	1000.0	2.06	*****	*****	*****	*****
51	111781	1530	101.7	112.2	4.83	747.0	*****	*****	*****	120.3	95.6	1000.0	2.19	*****	*****	*****	*****

$$\frac{\hat{T}_{OVM}}{\hat{T}_{Core}} = \frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$$

$$\frac{\tilde{T}_{Cover}}{\tilde{T}} = \frac{T_{2nd\ Cover} - T_{amb}}{T \qquad T}$$

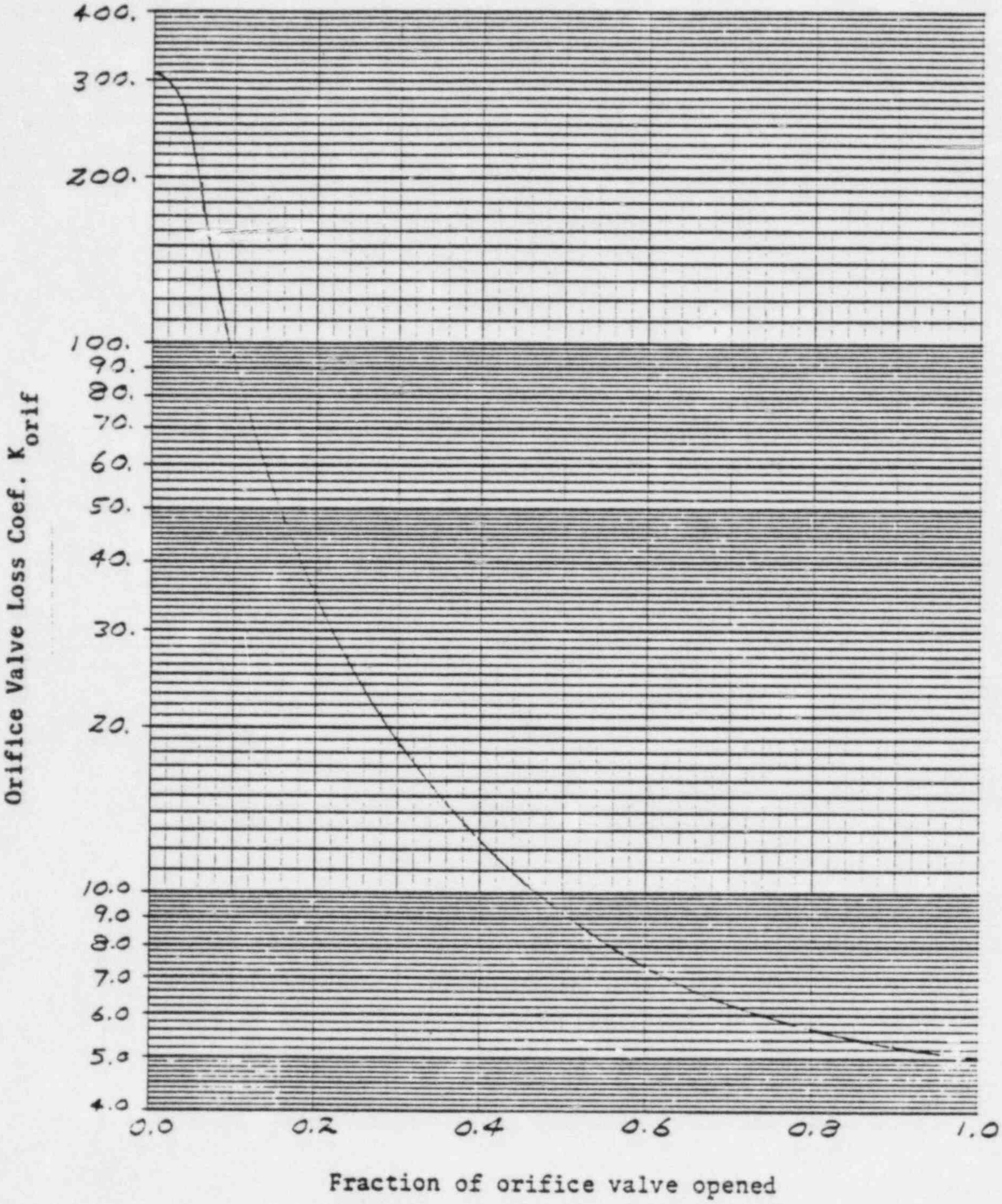
Table 5

REGION R36

Data Set	Date	Time	Reactor Power %	Primary Flow %	Core ΔP psid	Core Inlet Temp-F	Orifice Opening %	OVM Plate Temp-F	CRD Motor Temp-F	Cover Plate Temp-F	Ambient Air Temp-F	Orifice Loss Coef.	Leakage Parameter	$\frac{\hat{T}_{OVM}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{core}}$	$\frac{\hat{T}_{CRD}}{\hat{T}_{OVM}}$	$\frac{\tilde{T}_{cover}}{\tilde{T}_{CRD}}$
10	030380	1047	9.3	29.0	.39	422.0	4.7	131.6	133.9	111.0	80.2	237.1	.60	.048	.104	1.057	.525
11	030480	0425	18.5	39.5	.94	563.0	7.4	173.7	159.6	112.6	54.1	102.7	.89	.154	.123	.801	.372
12	031080	1130	28.5	60.0	1.41	666.6	11.4	193.0	171.0	124.6	80.0	80.3	1.07	.164	.125	.763	.484
13	031580	0026	56.0	66.8	2.11	730.0	12.1	144.4	178.4	124.0	76.2	73.2	1.29	.077	.124	1.620	.457
14	031680	1000	65.1	73.7	2.39	667.0	14.2	159.0	191.0	137.0	80.9	58.6	1.34	.100	.154	1.542	.510
15	051580	1100	45.0	61.0	1.59	647.0	15.9	148.0	179.0	132.0	92.0	49.9	1.07	.068	.144	1.646	.460
16	052980	1500	67.5	76.3	2.35	675.0	14.5	164.0	199.0	144.6	97.0	57.0	1.31	.111	.172	1.547	.461
17	111280	1845	38.8	53.6	1.61	645.0	12.3	151.8	184.2	135.4	86.5	73.9	1.13	.095	.154	1.625	.501
18	111280	2150	59.8	65.4	2.28	665.0	12.3	164.1	190.5	135.4	66.4	68.2	1.34	.113	.171	1.505	.435
19	111380	0755	62.5	63.7	3.19	690.0	12.0	161.0	212.5	141.8	82.7	73.9	1.59	.137	.191	1.389	.455
20	111380	1425	69.5	67.9	3.64	691.0	12.0	168.5	219.9	145.8	85.4	73.9	1.70	.150	.203	1.355	.449
21	111480	0639	47.0	62.8	2.61	656.0	9.9	168.7	200.9	139.8	81.9	96.5	1.48	.124	.181	1.469	.487
22	111480	0603	54.0	60.9	2.96	661.0	9.8	174.2	206.0	140.7	84.6	96.5	1.57	.132	.169	1.429	.462
23	111480	1810	60.0	74.8	3.54	674.0	9.9	164.0	216.3	146.1	82.3	96.5	1.72	.146	.203	1.365	.476
24	111480	2025	59.6	75.8	3.46	674.0	6.4	169.7	221.7	150.5	83.6	176.0	1.77	.156	.212	1.357	.484
25	111580	0700	68.7	64.4	4.10	665.0	6.4	200.2	230.6	152.8	83.6	176.0	1.92	.171	.223	1.305	.470
26	112480	1200	68.0	74.9	2.40	693.0	13.6	166.1	199.3	146.5	87.1	62.4	1.36	.111	.167	1.502	.476
27	120580	1100	69.7	72.7	2.23	673.0	12.8	161.2	194.1	135.0	85.6	68.2	1.31	.107	.164	1.538	.455
28	121180	1130	68.0	72.0	2.12	686.0	12.8	162.0	194.0	136.4	87.2	68.2	1.29	.106	.160	1.516	.479
29	121280	0300	41.4	53.2	1.24	643.0	13.2	141.7	176.3	42.8	90.3	65.3	.98	.077	.141	1.830	-.556
30	121280	1120	41.5	52.6	2.01	638.0	16.6	154.0	183.0	130.9	80.1	86.7	1.28	.100	.154	1.537	.462
31	121280	1426	41.0	53.3	1.88	632.0	10.8	155.0	185.0	132.8	80.9	86.7	1.24	.103	.160	1.545	.468
32	121280	2200	51.0	65.7	2.66	663.0	10.1	171.4	204.6	139.8	86.0	94.2	1.49	.127	.166	1.468	.443
33	121380	1430	62.7	76.3	3.48	681.0	10.1	163.5	210.2	146.4	86.4	94.2	1.70	.144	.260	1.392	.462
34	121480	0610	69.3	84.0	4.22	675.0	6.8	198.2	229.9	152.1	86.5	161.6	1.94	.170	.224	1.323	.457
35	121480	0803	60.1	74.7	3.27	671.0	6.8	190.1	224.1	152.0	82.4	161.6	1.71	.158	.217	1.377	.491
36	121480	1320	49.2	64.9	2.56	645.0	6.2	173.9	207.1	148.7	85.7	119.8	1.49	.136	.197	1.449	.519
37	121480	1820	39.9	50.0	1.91	646.0	11.6	159.3	192.5	142.6	85.5	78.2	1.24	.109	.169	1.560	.534
38	012981	1100	69.3	77.8	2.53	693.0	12.6	233.6	205.1	145.1	87.1	69.6	1.40	.225	.177	.787	.492
39	021781	1400	70.0	83.0	2.66	698.0	12.7	178.0	211.0	146.8	90.7	68.9	1.45	.130	.186	1.423	.483
40	031281	1300	70.0	61.0	2.54	695.0	14.0	176.0	207.0	146.3	92.2	59.6	1.39	.128	.180	1.408	.471
41	031981	1000	50.0	63.9	1.97	661.0	12.0	162.0	194.0	137.4	84.9	73.9	1.25	.111	.168	1.516	.481
42	032081	1700	60.9	70.4	2.37	661.0	11.6	172.0	204.0	143.9	89.6	78.2	1.38	.128	.185	1.444	.475
43	033181	1430	.0	7.5	.07	107.0	17.2	162.0	113.0	95.6	75.2	******	****	*****	*****	*****	*****
44	041581	2030	69.7	76.6	2.90	691.0	9.7	249.0	217.0	149.1	90.8	99.0	1.56	.252	.198	.785	.462
45	041781	0600	77.3	67.9	3.35	700.0	12.9	248.0	217.0	149.4	85.7	67.4	1.62	.247	.195	.791	.485
46	041881	1030	80.1	90.9	3.53	704.0	13.3	254.8	222.3	152.8	90.7	64.6	1.64	.256	.202	.790	.472
47	110581	1030	68.4	75.5	2.53	679.0	40.7	131.0	*****	*****	88.5	12.2	.99	.054	*****	*****	*****
48	110581	1110	77.7	85.4	2.53	695.0	40.8	136.0	*****	*****	91.6	12.1	.99	.061	*****	*****	*****
49	110581	2200	85.7	92.7	3.63	710.0	40.7	142.0	*****	*****	86.8	12.2	1.19	.069	*****	*****	*****
50	110681	1445	96.1	104.2	4.34	723.0	44.6	148.0	*****	*****	93.2	10.6	1.25	.077	*****	*****	*****
51	110781	1500	101.7	112.2	4.88	747.0	46.2	152.0	*****	*****	95.6	10.1	1.30	.080	*****	*****	*****

$$\frac{\hat{T}_{OVM}}{\hat{T}_{Core}} = \frac{T_{OVM\ Plate} - 100}{T_{Core\ Inlet} - 100}$$

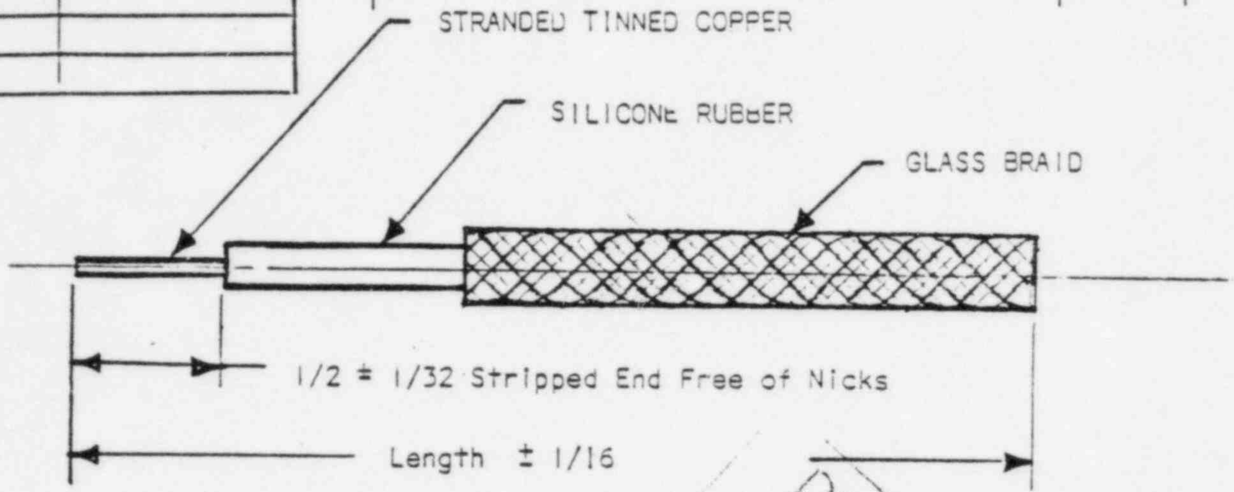
$$\frac{\tilde{T}_{Cover}}{\tilde{T}} = \frac{T_{2nd\ Cover} - T_{amb}}{T - T}$$



Orifice Valve Loss Coefficient Versus Fraction Opened.

APPLICATION	
NEXT ASSY	USED ON

REVISION			
LTR	DESCRIPTION	DATE	APPROVED
A	ADDED "OR U.L. APPROVED" DCN 10150	2/25/70	



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CONTROLLED COPY
DATE JUL 07 1983

COLOR CODE:

01 - Black	06 - Green
02 - Brown	07 - Blue
03 - Red	08 - Violet
04 - Orange	09 - Grey
05 - Yellow	10 - White

MATERIAL:

Wire, Copper Stranded; Silicone rubber insulation; Glass braid jacket, 600 V., 150°C., per MIL-W-16878D, OR U.L. APPROVED GRADE

Example of Callout:

78667 - XX XX XXX
- XXX — Length in 1/16" increments
- XX — Color Code
- XX — AWG.

SUGGESTED SOURCES:

See 2nd Sheet.

ATTACHMENT 3

UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND SHARP EDGES
SURFACE FINISH √
DIMENSIONS APPLY AFTER HT. TR. AND FINISH
ALL DIAMETERS TO BE CONCENTRIC WITHIN .005TIR
TOLERANCES:
DECIMAL XXX ±
FRAC. ±
ANGLES ±
MATL △ HT. TR. △ FIN △

	NAME	DATE
DRN	P. Moore	11-26-9
CHK	[illegible]	11/26/69
APPR	[illegible]	11/26/69

VARO INC
ELECTROKINETICS DIV.
SANTA BARBARA, CALIFORNIA

WIRE, LEAD

SIZE A
CODE IDENT NO 02101
78667
SCALE NONE
WT
SHEET 1 of 2

APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED

SUGGESTED SOURCES:

General Electric	FSCN 24457
Belden Manufacturing Co.	FSCN 70903
Frank Markel & Sons	
Rockbestos Wire & Cable Co.	FSCN 77872
Alpha Wire Corporation	FSCN 23172

RELEASED FOR CUSTOMER REFERENCE

CONTROLLED COPY DATE JUL 07 1983

UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND SHARP EDGES
SURFACE FINISH √
DIMENSIONS APPLY AFTER HT. TR. AND FINISH
ALL DIAMETERS TO BE CONCENTRIC WITHIN .005TIR

TOLERANCES:

DECIMAL	FRAC.	ANGLES
XXX ±	±	±

MATL △ HT. TR. △ FIN △

	NAME	DATE
DRN		
CHK		
APPR		

VARO INC
ELECTROKINETICS DIV.
SANTA BARBARA, CALIFORNIA

WIRE, LEAD

SIZE	CODE IDENT NO	
A	02101	78667

SCALE WT SHEET 2 of 2

MIL-STD-2C