TID-13104

REPORT RD-0011

PRESSURE DROP EXPERIMENTS OF UPPER AND LOWER DUMMY ASSEMBLIES FOR THE EXPERIMENTAL GAS COOLED REACTOR

SECTION V OF

THE FUEL ASSEMBLY HEAT TRANSFER AND CHANNEL PRESSURE DROP EXPERIMENTS FOR THE EGCR RESEARCH AND DEVELOPMENT PROGRAM

November 30, 1960

Contract No. AT(10-1)-925

Mod. IX

Prepared by

ALLIS-CHALMERS MANUFACTURING COMPANY
Atomic Energy Division
Nuclear Power Department
Washington, D. C.

DISCLAIMER

REPORT RD-0011

PRESSURE DROP EXPERIMENTS OF UPPER AND LOWER DUMMY ASSEMBLIES FOR THE EXPERIMENTAL GAS COOLED REACTOR

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FOREWORD

The test results herein reported were obtained from tests conducted by Allis-Chalmers between August and November 15, 1960, as a part of Modification IX of Contract Number AT-(10-1) - 925.

ABSTRACT

The design arrangement of the Experimental Gas Cooled Reactor contains six fuel assemblies stacked vertically, above one another, in each of two-hundred and thirty-two vertical fuel channels in the graphite core. Each stack of six fuel assemblies is preceded and followed by a dummy assembly. The upper dummy assembly contains a reflector plug and a latch mechanism. The lower dummy assembly contains an orifice with an adjustable plunger capable of varying reactor coolant flow through the orifice. The pressure drop characteristics of the dummy assemblies for eight different throttling positions were obtained in the test program at near atmospheric pressure using an air flow corresponding to Reynolds Numbers of 12,000 to 60,000 in the fuel element assemblies. The previous pressure drop tests used the Title I dummy design concept of constant 3.000 in. bore cylinders.

The data of the tests are presented in the form of the usual velocity head coefficients expressed in terms of the highest velocity head of the two test locations involved for each coefficient.

I. INTRODUCTION

The added features of a variable, externally adjustable throttling orifice in the lower dummy assembly to control reactor coolant flow and the neutron streaming reflector in the top dummy have resulted in the extension of the pressure drop program to include tests of the final designs. During reactor operation the variable orifice feature is used to obtain uniform coolant outlet temperatures from the reactor fuel channels by adjustment of coolant flow. This flow can also be regulated to meet the changing demands of any given fuel channel as the neutron flux pattern changes with fuel burnup and refueling cycling.

II. OBJECTIVE

The objective of these tests was to determine reasonably accurate pressure loss characteristics of the upper and lower dummy assemblies for at least six throttle positions of the lower dummy variable orifice.

III. SCOPE

The tests were limited to the range of Reynolds Number available in the existing pressure drop air loop at Allis-Chalmers Manufacturing Company, Washington 11, D. C. The orifice plunger was set at each of eight throttling positions and flow was regulated from wide open valve position to a minimum flow of 300 lb/hr. At the zero or open orifice position the maximum flow was about 1850 lb/hr. and at the maximum throttling position of the orifice maximum flow was approximately 700 lb/hr.

IV. RESULTS AND CONCLUSIONS

1. The tests results are plotted in the form of pressure loss coefficients vs Reynolds Number in Figures 1 through 8 of Appendix B.
2. It is recommended that the coefficients C_c (3/L-2) and C_c (L-2/1-6) be used for guide purposes only since the geometry of the test specimen did not permit a streamline flow section to be used for Station L-2, corresponding to the downstream end of the lower dummy. The use of coefficient C_c (3/1-6), which combines the two coefficients and includes the loss of entry into the first fuel assembly, is recommended for better accuracy.
3. The location of Station U-1 in the upper dummy is in a region of turbulence and C_e (3-10/U-1) and C_e (U-1/22) are similarly recommended to be used only for guide purposes. The use of coefficient C_e (3-10/22), which combines the two coefficients and includes the exit loss from the last fuel assembly, is recommended for better accuracy.
4. If full range throttling of helium from 800 lb/hr. is desired, the adjustable orifice plug diameter should be increased at the 5" and 4" locations.
5. It was observed that a high intensity whistle appeared to originate in the upper dummy at air flows at or above 1190 lb/hr. This corresponds to a Reynolds Number within a reactor fuel channel of approximately 43,500. No conclusions were reached as to the exact origin of this phenomenon.

V. TEST RIG

The test rig used for this series of tests was the same as that previously described in Report RD-0009, which constitutes Section III of this series of reports. The only changes were in the use of the dummy test specimens and the associated plenums.

Three full scale fuel assemblies as assembled in set up No. 8 of Report RD-0009(2) were placed in series. The lower dummy test assembly with an adjustable orifice throttling plug was assembled upstream of the three fuel assemblies and the upper dummy assembly was placed downstream. A centrifugal compressor delivered air at approximately 170° F to the test sections. The compressor inlet and the test section exit were open to the atmosphere. An orifice meter, installed between the compressor discharge and test section inlet, permitted measurement of air flow.

The blower and flow control system was capable of varying the flow over the previously described range. Pressure drop over the test assemblies was measured by means of U-tube glass manometers. Various density manometer fluids were used, dependent upon the magnitude of the differential pressure to be measured. Two inclined water manometers were available to accurately measure low differential pressures.

Air temperature measurements in the test rig were made at the air flow measurement orifice, the inlet of the test section, and outlet of the test section. Temperature measurements were taken with mercury-in-glass thermometers. Flow measurement through the rig was made by means of a concentric orifice plate mounted between standard orifice flanges.

V. TEST RIG (Continued)

Both the differential and static pressure downstream of the orifice were measured by means of manometers. Flow control was achieved by means of two butterfly-type valves with one valve located in the take-off from main flow to act as a by-pass vent to atmosphere, and the other valve located just upstream of pressure drop test section to act as a throttle valve.

Static pressure measurements were made at selected stations along the fuel assembly test section. Each static pressure tap was connected to a manometer leg to enable manometer readings of the differential pressure between stations. The location of static pressure taps along the test section is shown schematically on Flowsheet SK-D-170. A more detailed description of the test equipment is contained in Appendix C of the Title I report (1).

VI. TEST SPECIMENS

The two major test specimens used in the test set up were the upper and lower dummy assemblies located downstream and upstream of three fuel assemblies, respectively. The three fuel assemblies were those used in the previous test arrangement No. 8 reported in RD-0009 (2).

The fuel assemblies each consisted of a full size 5-in. O.D. x 3.00-in. I.D. x 29-in. long graphite sleeve in which seven empty fuel element 0.75-in O.D. tubes were supported by spiders at each end of the sleeve, The Mod. I spiders were as shown on Drawing SK-D-163. Mod. II spacers, with straight vanes and a 60 deg arc outer pad as shown on Drawing SK-D-161, were installed at the mid-length of the seven tubes of each fuel assembly.

The upper dummy test specimens were manufactured as shown on Drawings D-127-RD and D-130-RD and duplicated the full size flow geometry of the internals of design drawing 5927-EGCR-MS-284-00 which was certified for construction 3-19-60. This consisted, essentially, of a two step bore with a simulated neutron reflector plug centered in the larger diameter bore.

Design drawings of the lower dummy assembly were not released in time to meet the test schedule due to anticipated changes in the external parts mating with the core structure; however, the internal and flow geometry design was frozen as of the June 15 status and a sepia of the drawing, labeled SK-61560-285-00 (see Appendix B), was released to use as reference for the lower dummy test specimen.

The test specimen drawings D-124-RD, D-125-RD, and D-126-RD were used to manufacture the full scale test dummy and duplicated the flow geometry. A simpler method of moving and

VI. TEST SPECIMENS (Continued)

locking the adjustable orifice throttling plug, item 5, D-126-RD, was used which permitted the plug to be shifted to the desired position and locked with a set screw. A removable cover was designed for the housing to permit access to the plug and locking set screw.

VII. DISCUSSION

The technique in presenting the pressure loss across the dummy assemblies has followed the methods given in previous pressure drop reports (1 and 2), and the results are presented in the form of velocity head coefficients of unrecoverable losses expressed in terms of the highest average velocity head of the two test stations involved for each coefficient. Compressibility of the air was factored into the coefficients presented in Figures 1 through 8 by using the form loss equations previously established for an assumed adiabatic process between test points.

The major coefficients are as follows with all subscripts referring to test stations as located on SK-D-170 in Appendix B.

(1) $C_{3/1-6}$ = Coefficient between inlet plenums and upstream end of the first fuel assembly. The full length of the lower dummy is included.

(2) $C_{1-6/1-10}$ = Coefficient between a 14" axial length in the center portion of the first fuel assembly.

(3) $C_{1-10/2-10}$ = Coefficient for one fuel length of assembly. This length includes the open space between spiders of two adjacent assemblies.

(4) $C_{3\text{-}10/22}$ = Coefficient between the downstream end of the 3rd and last fuel assembly and the exit plenum. The full length of the upper dummy is included.

In addition, the 1st and 4th of the above listed coefficients were broken down into two separate coefficients to separate fuel assembly losses from the dummy losses as follows:

(5) $C_{3/L\text{-}2}$ = Coefficient between inlet plenum and the downstream end of the lower dummy.

(6) $C_{L\text{-}2/1\text{-}6}$ = Coefficient between downstream end of the lower dummy and the upstream end of the first fuel assembly.

(7) $C_{3\text{-}10/U\text{-}1}$ = Coefficient between downstream end of the last (3rd) fuel assembly and the upstream end of the upper dummy.

(8) $C_{U\text{-}1/22}$ = Coefficient between the upstream end of the upper dummy and the exit plenum.

Form loss equations used to obtain the loss coefficients were as follows:

$$(9)\quad C_c = 2g_c \frac{\rho_1 P_1}{G_2^2}\left(\frac{P_2}{P_1}\right)^{2/K}\left(\frac{K}{K-1}\right)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}\right] + \left(\frac{A_2}{A_1}\right)^2\left(\frac{P_2}{P_1}\right)^{2/K} - 1$$

(used for contraction coefficients listed as 1, 5 and 6 above)

$$(10)\quad C_E = 2g_c \frac{\rho_2 P_2}{G_1^2}\left(\frac{P_1}{P_2}\right)^{2/K}\left(\frac{K}{K-1}\right)\left[-1+\left(\frac{P_1}{P_2}\right)^{\frac{K-1}{K}}\right] - \left(\frac{A_1}{A_2}\right)^2\left(\frac{P_1}{P_2}\right)^{2/K} + 1$$

(used for expansion coefficients listed as 4, 7 and 8 above)

$$(11)\quad C_s = 2g_c \frac{\rho_1 P_1}{G_1^2}\left(\frac{P_2}{P_1}\right)^{2/K}\left(\frac{K}{K-1}\right)\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}\right] + \left(\frac{P_2}{P_1}\right)^{2/K} - 1$$

(used for coefficients 2 and 3 above)

Subscripts 1 and 2 refer to upstream and downstream stations, respectively.

The resulting coefficients obtained in analysing the data are presented in Figures 1 through 9. The coefficient $C_{3/1\text{-}6}$ is presented for each of 8 positions of the adjustable orifice plug of the lower dummy.

The coefficients $C_{3/L\text{-}2}$ and $C_{L\text{-}2/1\text{-}6}$ have been presented for the zero plug position to serve as a guide to isolate the two dummy losses as a separate item. It was found, that the location of the L-2 station tap is in a region of

turbulence and is effected by the plug position. Actually, $C_{L-2/1-6}$ should remain constant regardless of plug position. In reality this coefficient tended to decrease with each increase of throttling position of the adjustable orifice plug. This effect is not considered unusual, since the geometries are closely coupled and the effects of the first geometry are carried over into and influence the second geometry; therefore, any attempt to isolate such losses is not predictable without some margin of error.

The characteristics of the dummy are fully expressed in terms of the loss coefficients in Figures 1 through 9; however, additional curves were added.

Curve Number 10 presents the lower dummy unrecoverable loss in terms of psi for stations 3/1-6 and 3/L-2 versus flow of 510 F - 313.5 psia helium gas. Curve Number 11 presents the upper dummy unrecoverable loss in terms of psi for stations 6-10/22 and U-1/22 versus flow of 1075 F - 304 psia helium gas.

The plot (Figure Number 12) of plug positions versus helium flow compares the plug positions based on test data with required plug positions listed in EGCR Specification RC-6(3). The trend compares favorably; however, at the maximum insertion position (5 in.) of the adjustable plug, it is estimated that the flow would be throttled to 1080 lb/hr which is 280 lb/hr above the 800 lb/hr limit listed in the specification. If the 800 lb/hr limit is to be equalled or lowered, it is suggested

that this could be accomplished by increasing the plug dimension at the 4 and 5 inch positions. It is anticipated that this change will create very little difference in the flow characteristics for plug positions below 3 inches.

The basic data accuracy of the curves presented are predicted to be close to the 4% value predicted for Section III except for the coefficients in which stations L-2 (the downstream end of the lower dummy) and U-1 (the upstream end of the top dummy) are involved. For the coefficients involving the latter two stations, accuracy is considerably lower and it is recommended that these coefficients be used only as a guide. It should be noted that the tests have tended to prove the need to evaluate the separate coefficients for a given length as being accurate only when installed with the same preceding and following geometry. Attempts to isolate and then reassemble with other geometry will result in some error.

For the majority of the basic data, including the zero plug position data, the difference between answers quoted herein for incompressible formulae and that which would be obtained using compressible formulae is about-5%. This factor represents the effect of the square of the compressibility factor, Y. At the more fully throttled positions, the compressibility factor for stations3/1-6 decreases to approximately 0.90 at the 5-in.. plug position. It must be conceded that there is some doubt concerning the precision of the compressible formulae; however, the

incompressible formulae are recognized as the upper limit. Assuming an accuracy of 80% in the determination of the effect of the expansion factor, an additional inaccuracy of 1% at the low plug position to 4% at the 5 in. plug position is predicted. Thus, the overall accuracy is predicted to be 5% at the zero plug position and 8% at the 5 in. position.

VIII. REFERENCES

1. Allis-Chalmers Report RD-0007, Section 1 of Fuel Assembly Heat Transfer and Channel Pressure Drop Experiments for the EGCR Research and Development Program, by R. M. Higgins and C. L. Beaudoin, Washington, D. C. January 20, 1960.

2. Allis-Chalmers Report RD-0009, Section III of Fuel Assembly Heat Transfer and Channel Pressure Drop Experiments for the EGCR Research and Development Program, by W. Crandall and R. M. Higgins, Washington, D. C., October 3, 1960.

3. Allis-Chalmers Specification RC-6, Bottom Dummy Fuel Assembly - Reactor Core, Experimental Gas Cooled Reactor, by L. H. Devlin, Washington, D. C., Certified for Construction, May 19, 1960.

4. Principles and Practice of Flow Meter Engineering, 8th Ed., by L. C. Spink, Foxboro Company, Foxboro, Mass., 1958.

5. Fluid Meters - Their Theory and Application, 5th Ed., ASME, New York, 1959.

6. Allis-Chalmers EGCR Title I Study 115, Thermal Performance, Experimental Gas Cooled Reactor, by L. H. Devlin and L. L. Kintner, Washington, D. C., July 17, 1959.

7. Allis-Chalmers Study II-176, Design and Analysis of Dummy Fuel Assemblies, Experimental Gas Cooled Reactor, by L. H. Devlin, Washington, D. C., Approved May 16, 1960.

IX. NOMENCLATURE

A = coolant cross-sectional flow area, ft^2

c_v = specific heat of coolant (air) at constant volume, Btu/lb-^{o} F

c_p = specific heat of coolant (air) at constant pressure, Btu/lb-^{o} F

C_c = entrance contraction pressure loss coefficient, dimensionless

C_e = exit expansion pressure loss coefficients, dimensionless

C_s = pressure loss coefficient of 14" axial length of center of fuel assembly, dimensionless

C_s' = pressure loss coefficient of full length of one fuel assembly, dimensionless

Re = Reynolds Number = $\frac{D\ e\ G}{\mu}$

De = 4x hydraulic radius = equivalent diameter, ft

G = mass flow, lb/hr - ft^2

P = static pressure, lb/ft^2

k = ratio of specific heat cp/cv, dimensionless

ρ = density of coolant, lb/ft^3

T = coolant temperature, ^oF

R = gas constant, ft/^{o} F

gc = conversion factor, ft-lb/lb-hr^2 = 4.17×10^8

μ = viscosity of the fluid, lb/hr - ft

Subscripts 1 and 2 refer to upstream and downstream stations in general equations.

Subscripts 3, 1-6, L-2, 1-10, 3-10, U-1 and 22 refer to actual test stations referred to in SK-D-170.

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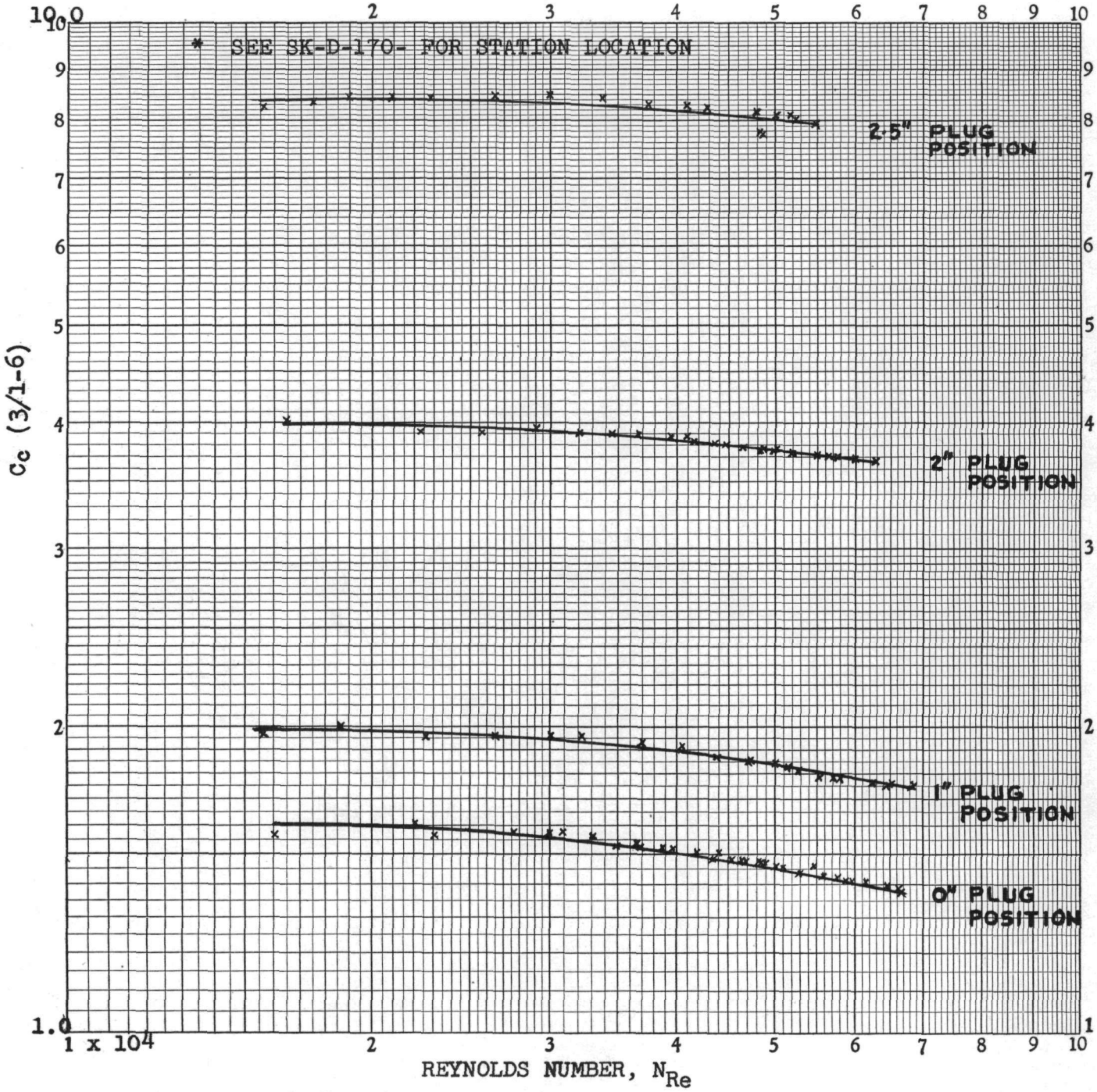
APPENDIX A

Pressure Drop Curves

INDEX TO CURVES

FIGURE 1

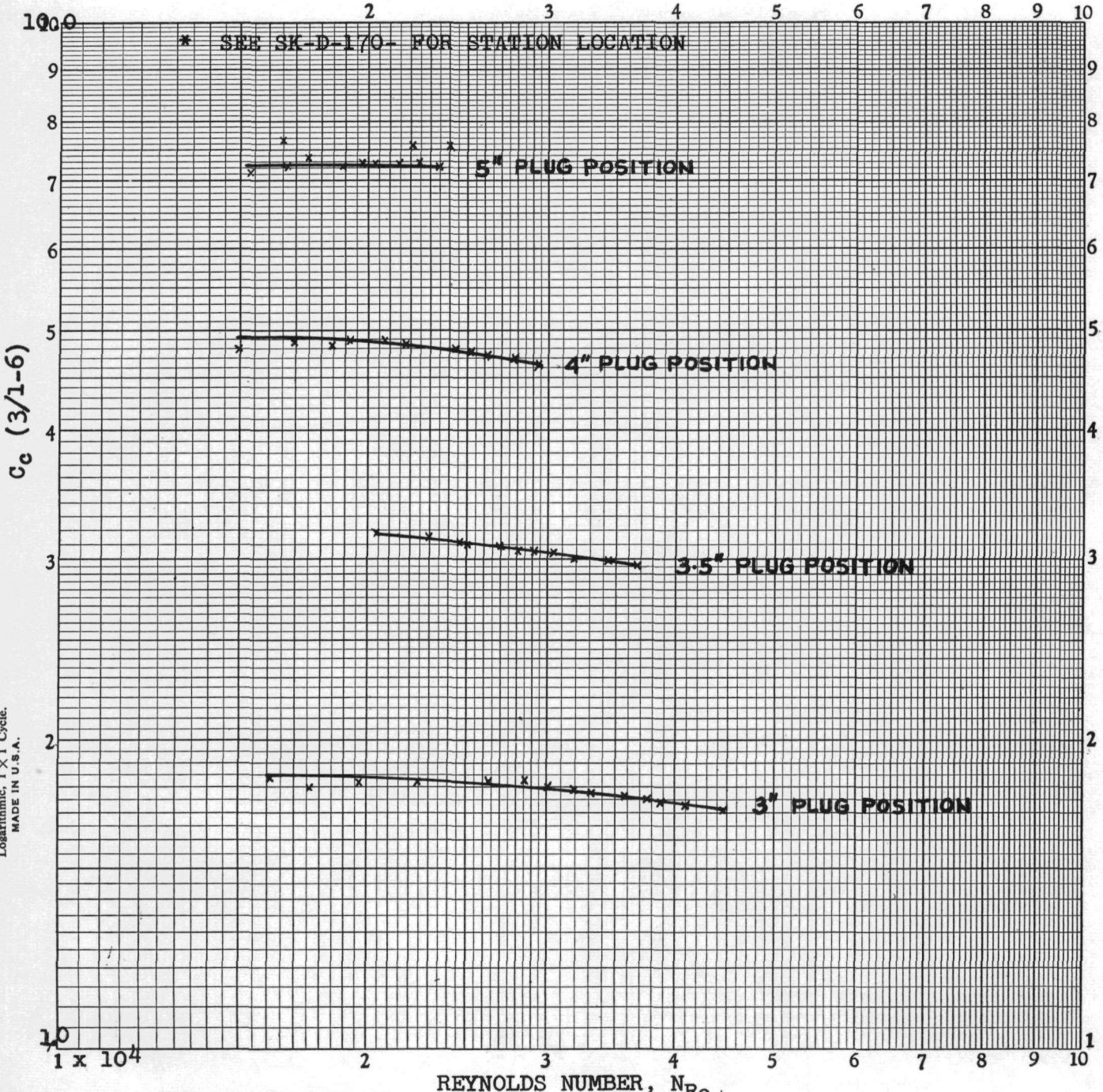
CONTRACTION COEFFICIENT, C_c (STATIONS * 3/1-6), VS REYNOLDS NUMBER (Inlet Plenum to Upstream of First Fuel Assembly)



TEST ASSEMBLY NO. 10
ADJUSTABLE ORIFICE PLUG POSITIONS- 0", 1", 2", & 2.5"
(AT ZERO POSITION PLUG NOSE IS FLUSH WITH ORIFICE FACE)
RUN NUMBERS - STARTING WITH 449

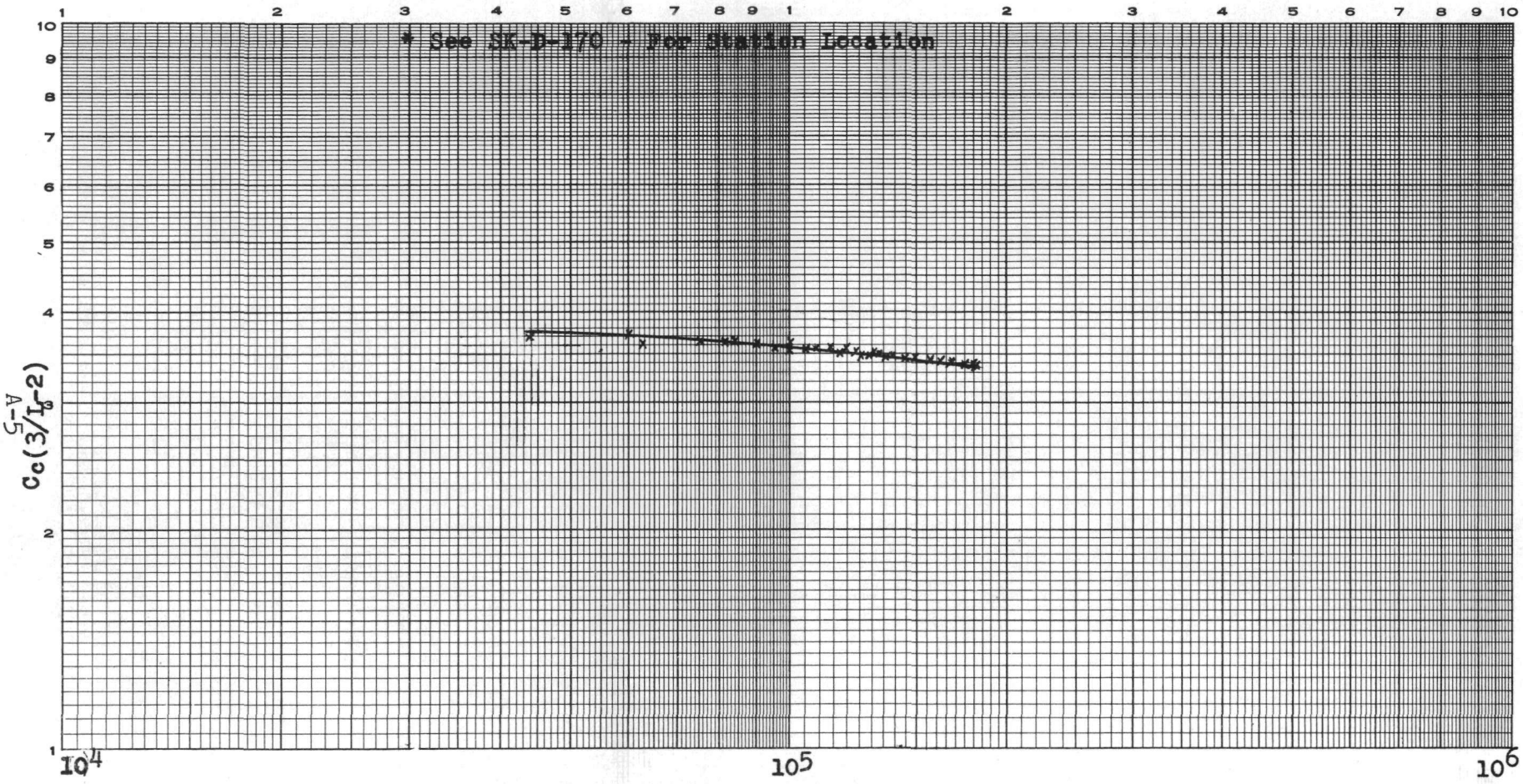
FIGURE 2

CONTRACTION COEFFICIENT, C_c (STATIONS * 3/1-6), VS REYNOLDS NUMBER (Inlet Plenum to Upstream of First Fuel Assembly)



TEST ASSEMBLY NO. 10
ADJUSTABLE ORIFICE PLUG POSITIONS- 3", 3.5", 4", & 5"
(AT ZERO POSITION PLUG NOSE IS FLUSH WITH ORIFICE FACE)
RUN NUMBERS - STARTING WITH 506

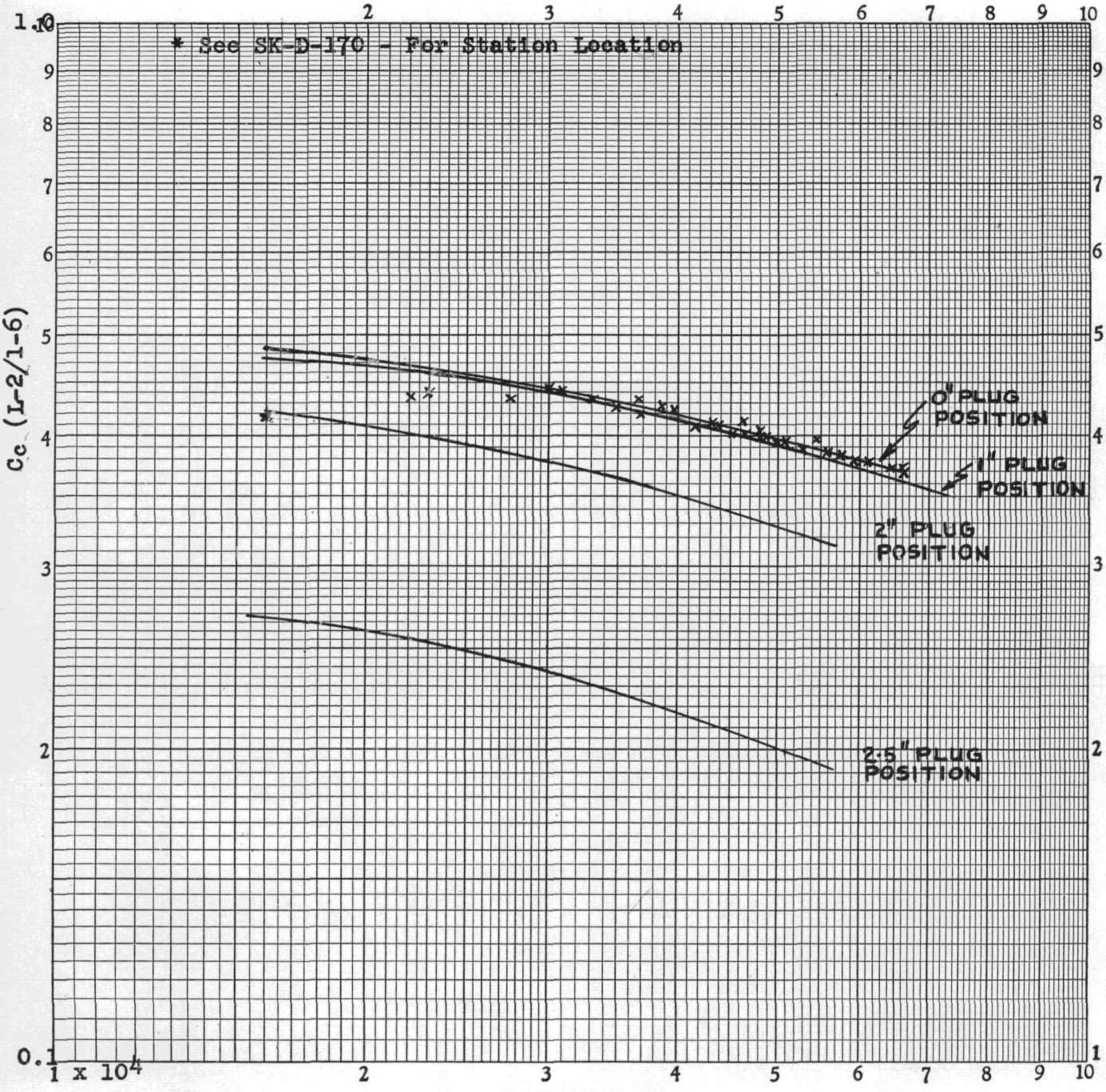
FIGURE 3
CONTRACTION COEFFICIENT, C_c (STATIONS* 3/L-2), VS REYNOLDS NUMBER (Inlet Plenum to Downstream End of Lower Dummy)



TEST ASSEMBLY NO. 10
ADJUSTABLE ORIFICE POSITION - 0"
(AT ZERO POSITION PLUG NOSE IS FLUSH WITH ORIFICE FACE)
RUN NUMBERS - STARTING WITH 449

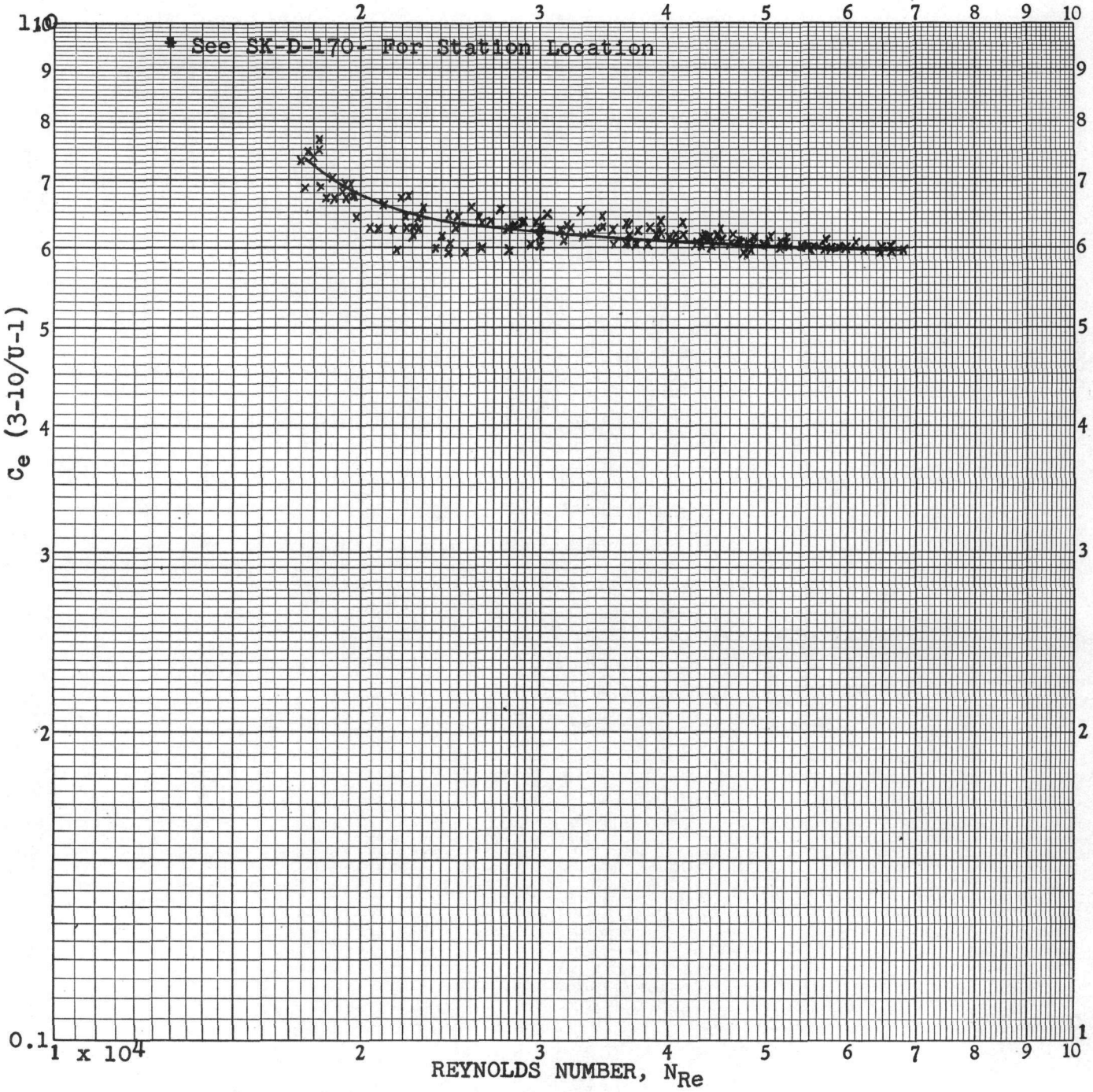
FIGURE 4

CONTRACTION COEFFICIENT, C_c (STATIONS* L-2/1-6), VS REYNOLDS NUMBER (Downstream End of Lower Dummy to Upstream of First Fuel Assembly)



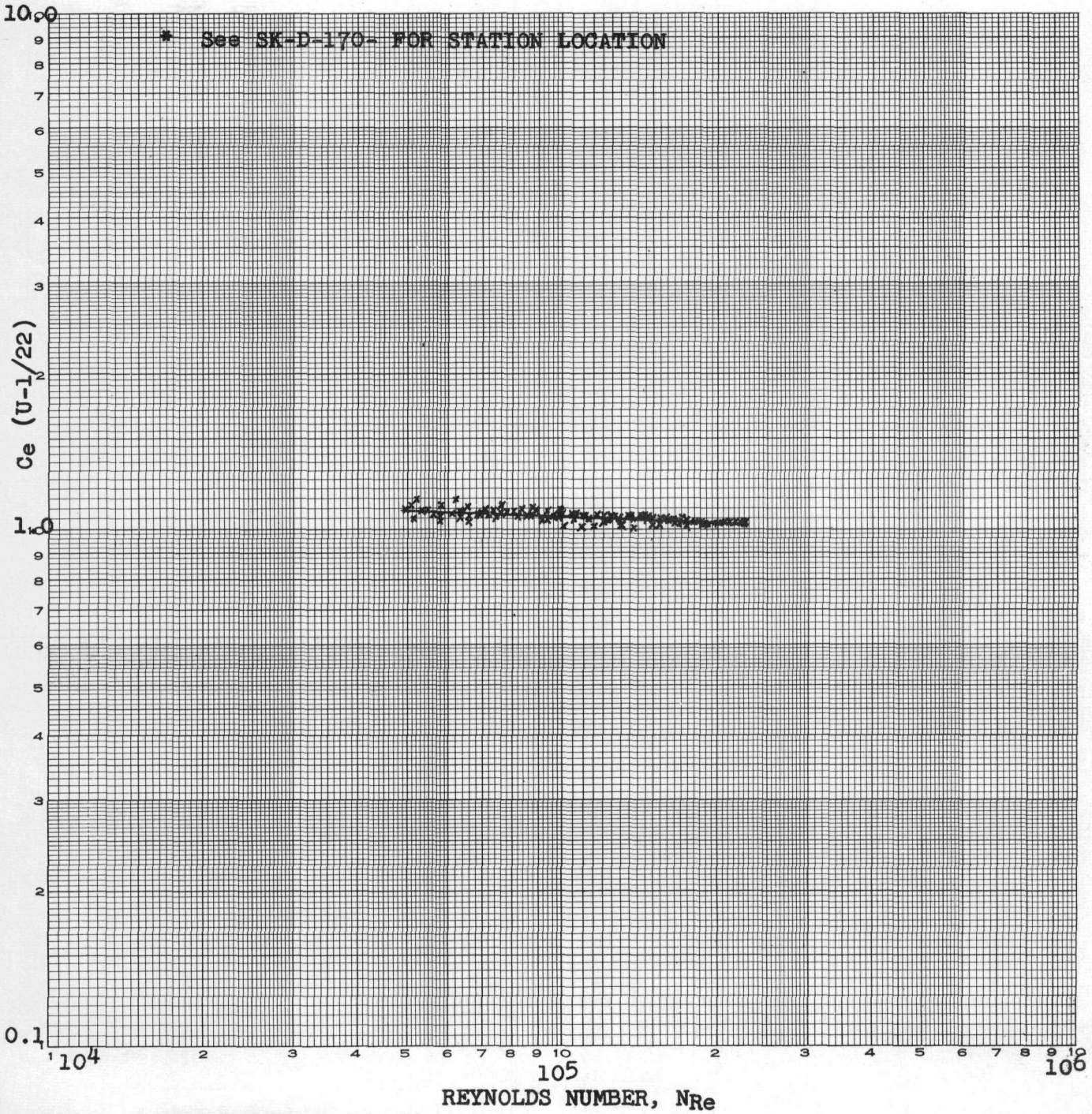
TEST ASSEMBLY NO. 10
ADJUSTABLE ORIFICE PLUG POSITIONS - 0", 1", 2", 2-1/2"
(AT ZERO POSITION PLUG NOSE IS FLUSH WITH ORIFICE FACE)
RUN NUMBERS - STARTING WITH 449

FIGURE 5
EXPANSION COEFFICIENT, C_e (STATIONS * 3-10/U-1), VS REYNOLDS NUMBER (Downstream of Third Fuel Assembly to Upstream End of Upper Dummy)



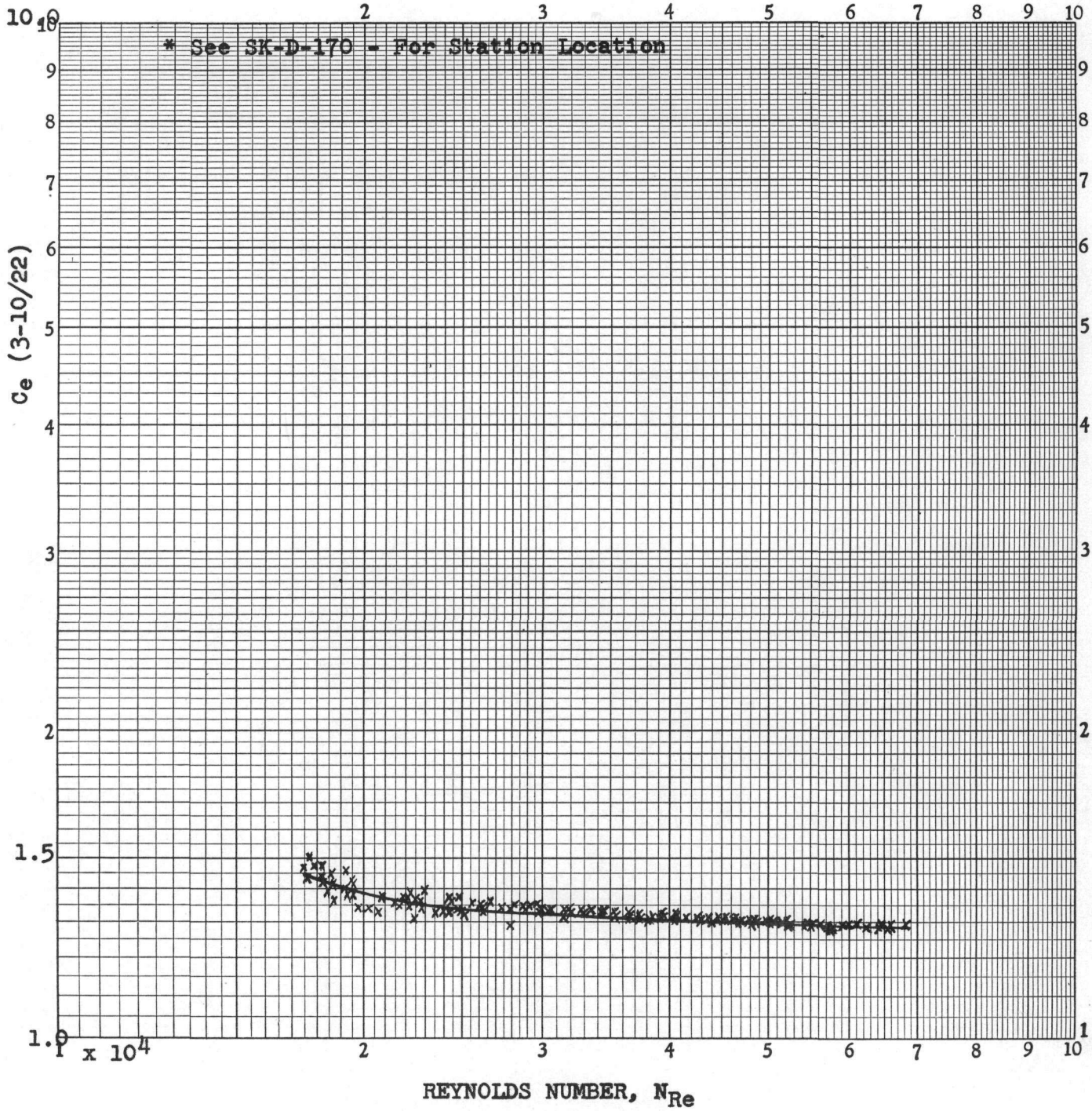
TEST ASSEMBLY NO. 10
RUN NUMBERS- STARTING WITH 449

FIGURE 6
EXPANSION COEFFICIENT, C_e (STATIONS * U-1/22), VS REYNOLDS NUMBER (Upstream End of Upper Dummy to Exit Plenum)



TEST ASSEMBLY NO. 10
RUN NUMBERS- STARTING WITH 449

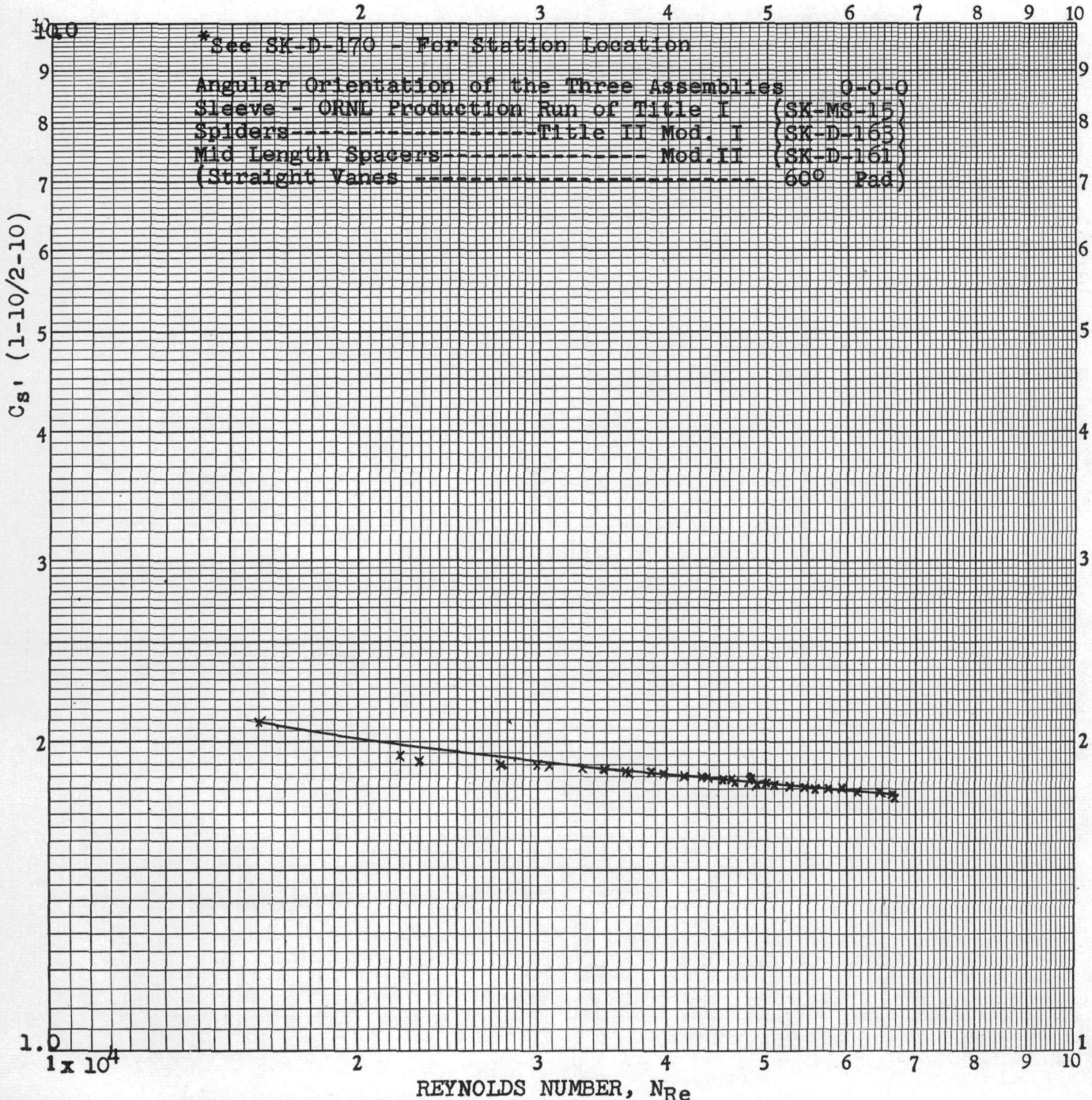
FIGURE 7
EXPANSION COEFFICIENT, C_e (STATIONS* 3-10/22), VS
REYNOLDS NUMBER (Downstream of Third Fuel Assembly to Exit Plenum)



TEST ASSEMBLY NO. 10
RUN NUMBERS - STARTING WITH 449

FIGURE 8

FORM COEFFICIENT, $C_{s'}$ (STATIONS* 1-10/2-10), vs REYNOLDS NUMBER (Downstream of First Fuel Assembly to Downstream of Second Fuel Assembly)



TEST ASSEMBLY NO. 10
RUN NUMBERS - STARTING WITH 449

FIGURE 9

FORM COEFFICIENT, C_s (STATIONS* 1-6/1-10), VS REYNOLDS NUMBER (UPSTREAM OF FIRST FUEL ASSEMBLY TO DOWNSTREAM OF FIRST FUEL ASSEMBLY)

* See SK-D-170- For Station Location

TEST ASSEMBLY NO. 10

RUN NUMBERS- STARTING WITH 449

Sleeve ----ORNL Production Run of Title I (SK-MS-15)

Spiders----Title II Mod. I (SK-D-163)

Mid Length Spacers- Mod. II (SK-D-161)

(Straight Vanes 60° Pad)

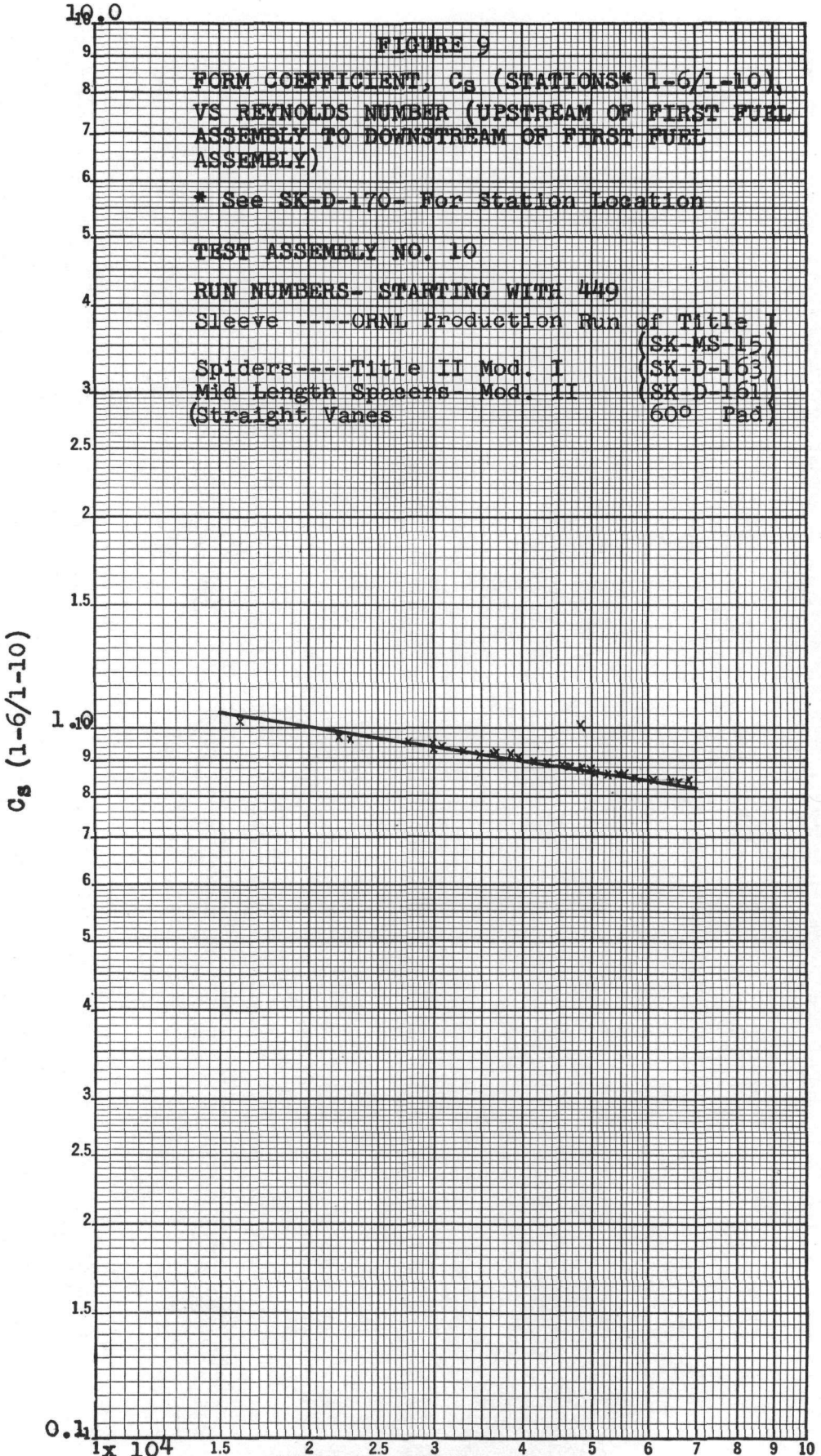


FIGURE 10

PRESSURE LOSS OF DUMMY ASSEMBLY AT VARIOUS
ADJUSTABLE ORIFICE PLUG POSITIONS

Across Stations * 3/1-6 for 8 plug positions
Across Stations * 3/L-2 for 0 inch position only

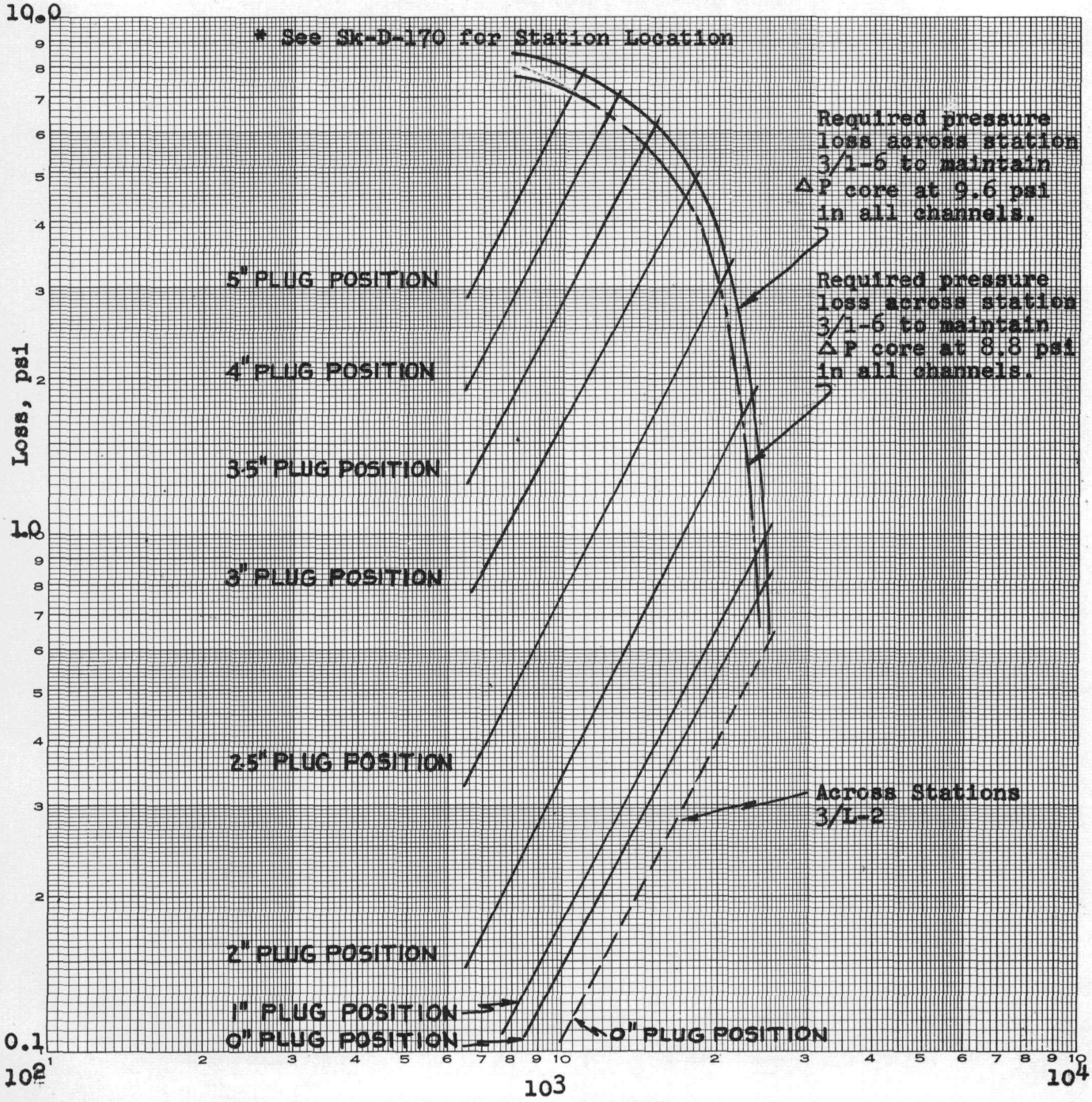


FIGURE 11

PRESSURE LOSS OF UPPER DUMMY (Measured Across Stations* 6-10/22 and Across Stations* U-1/22) VS HELIUM FLOW

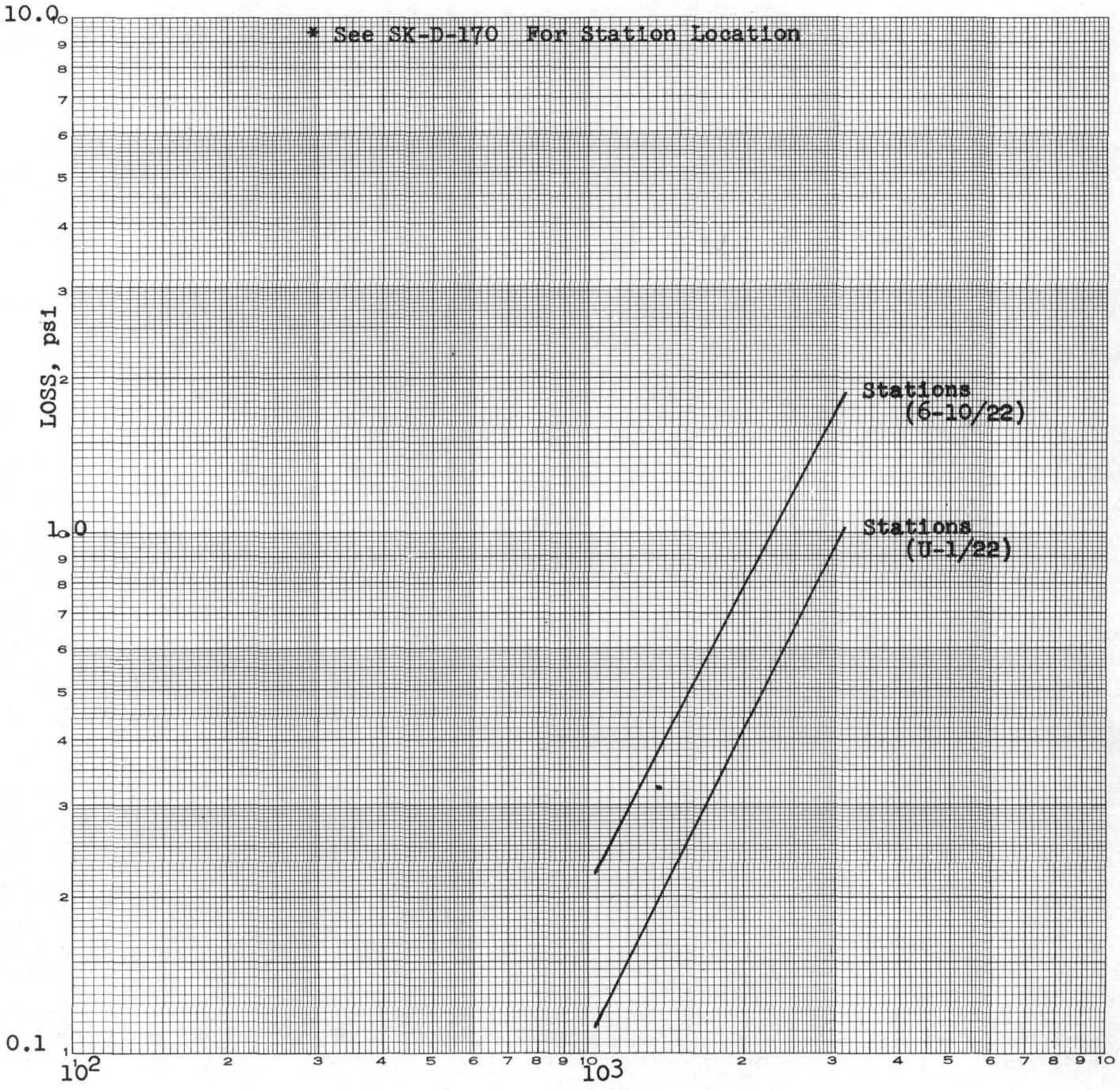
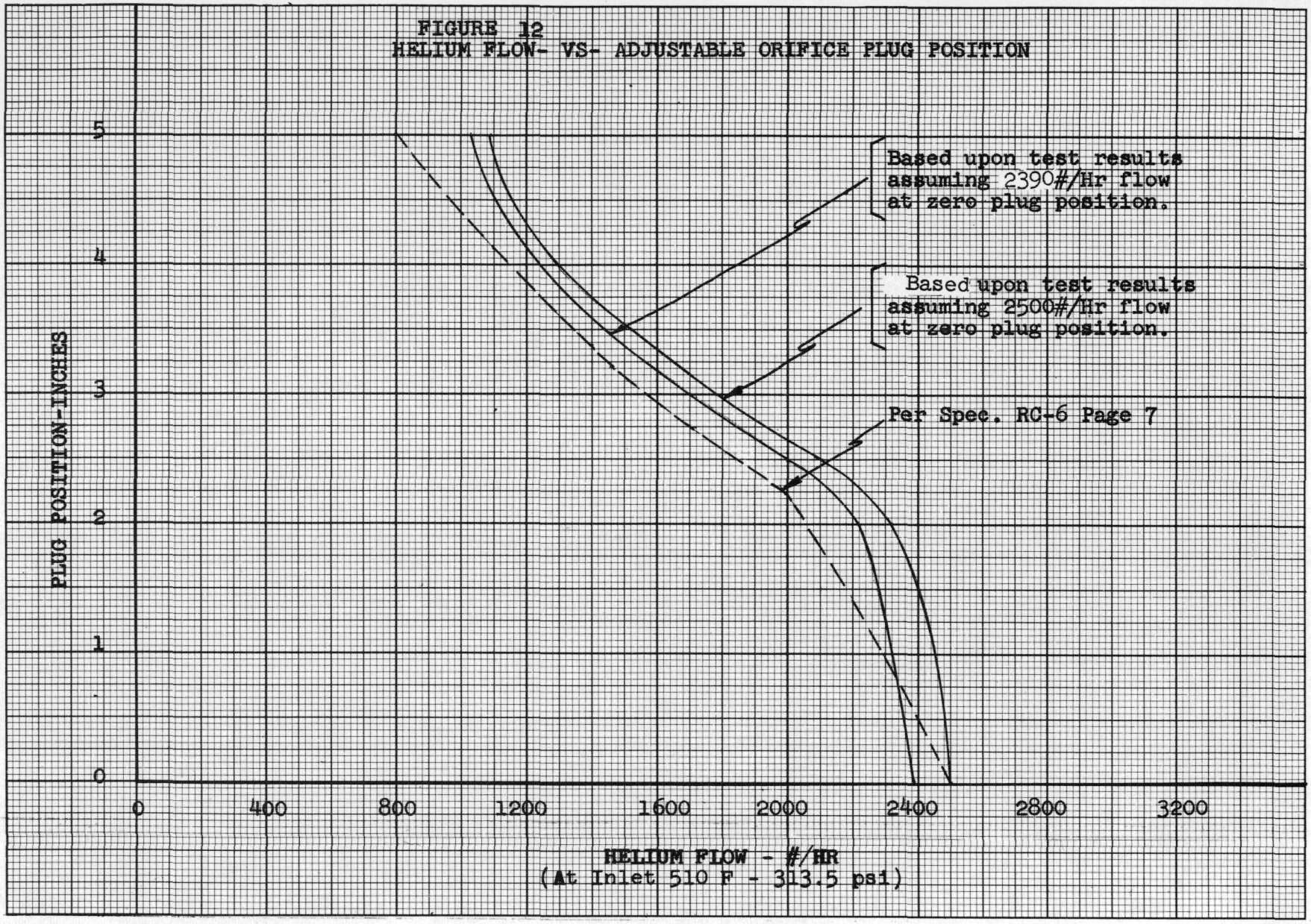


FIGURE 12
HELIUM FLOW- VS- ADJUSTABLE ORIFICE PLUG POSITION



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APPENDIX B

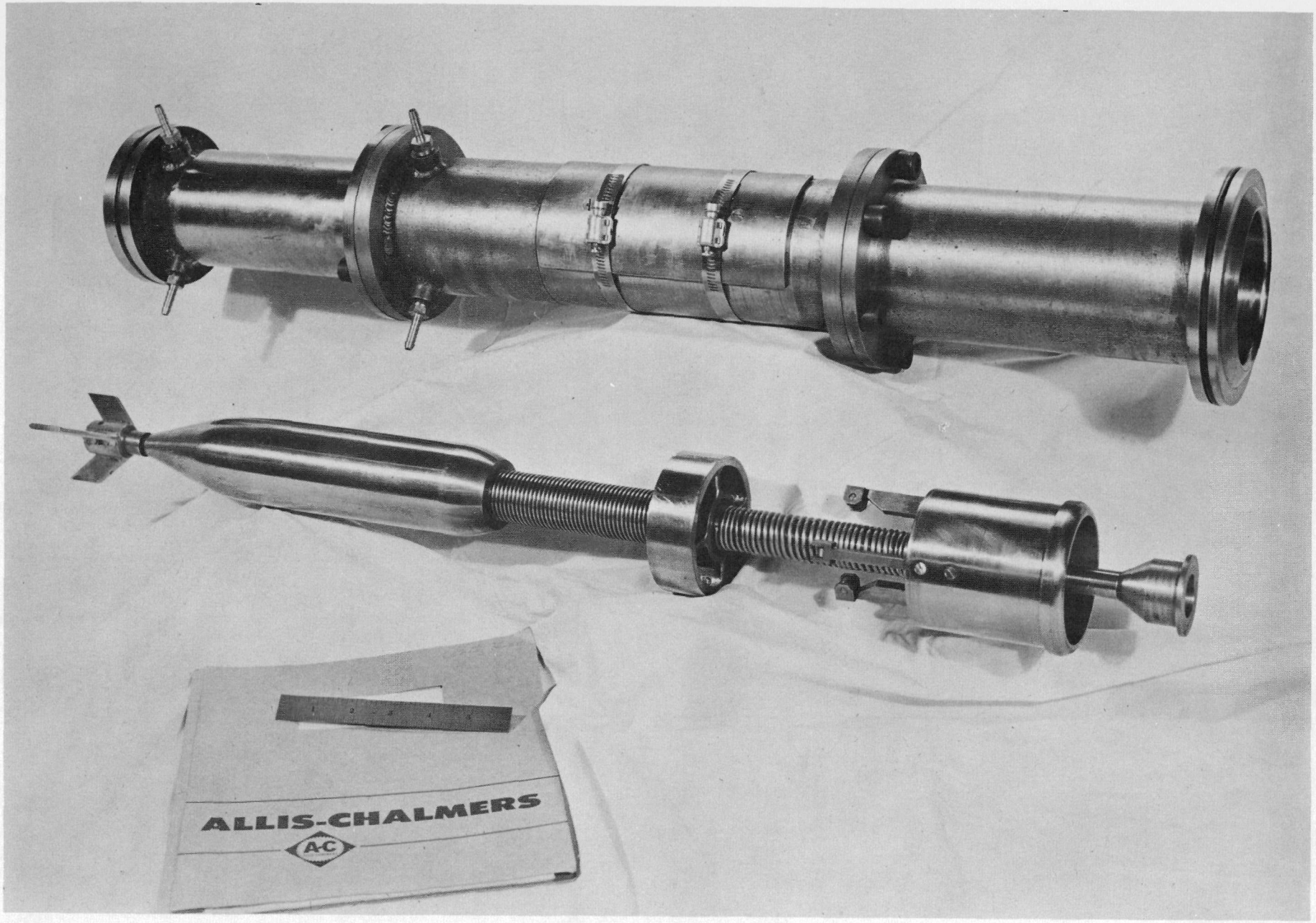
I PHOTOGRAPHS

II DRAWINGS

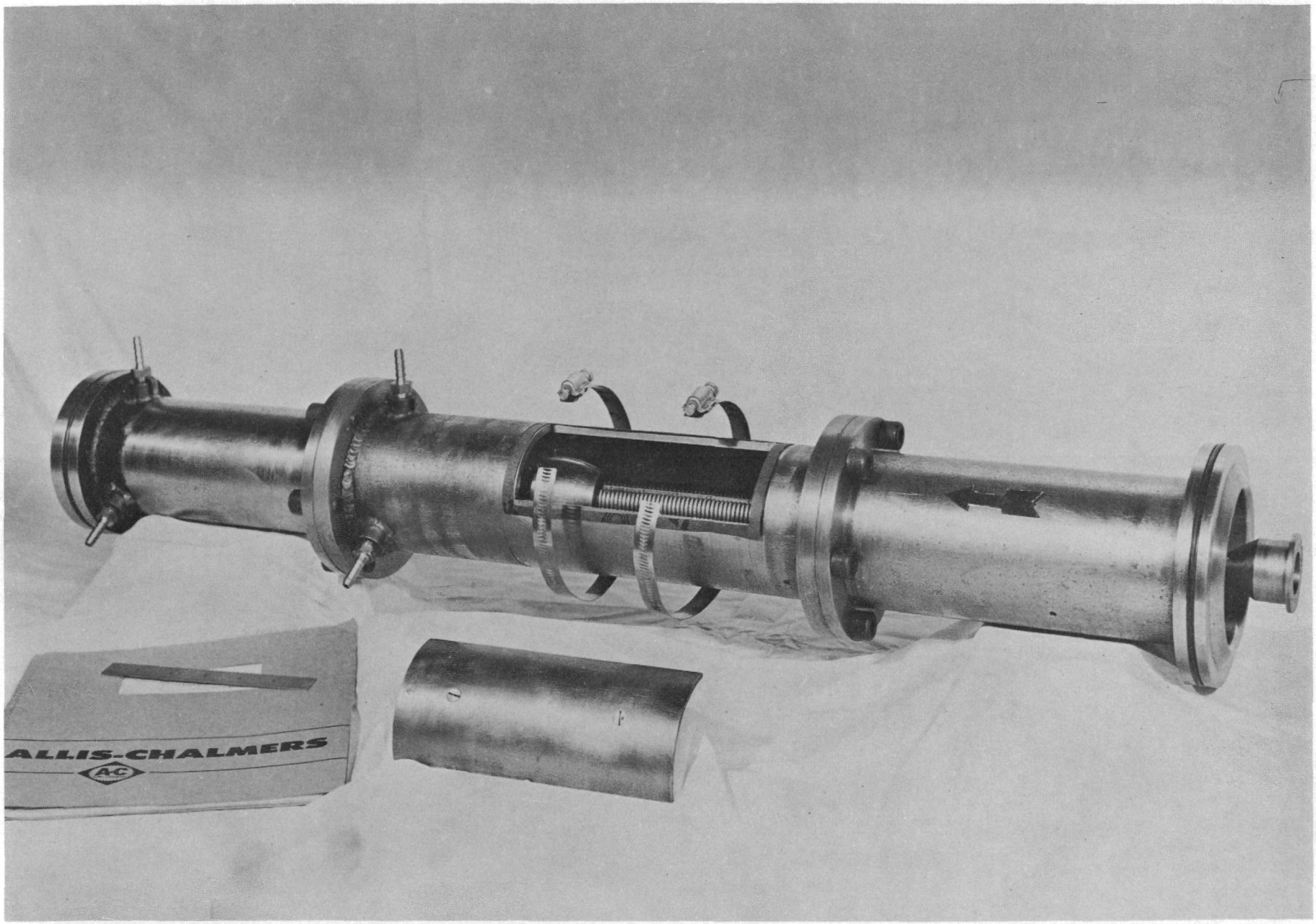
LIST OF PHOTOGRAPHS

LIST OF DRAWINGS

1.	SK-D-170	-	Schematic Pressure Drop Flow Sheet
2.	D-124-RD	-	Lower Dummy Test Piece Assembly
3.	D-125-RD	-	Lower Dummy Test Piece, Details - Sheet 1
4.	D-126-RD	-	Lower Dummy Test Piece, Details - Sheet 2
5.	D-127-RD	-	Top Dummy Test Piece, Assembly
6.	D-130-RD	-	Top Dummy Test Piece, Details
7.	D-128-RD	-	Upper and Lower Plenum and Adapter
8.	SK-61560-285-00		Botton Dummy Assembly (Design Drawing)
9.	5927-EGCR-MS-284-00		Top Dummy Assembly (Design Drawing)
10.	SK-D-161	-	Mid-Length Spacers, Mod. II and IV
11.	SK-D-163	-	Mod. I Spiders

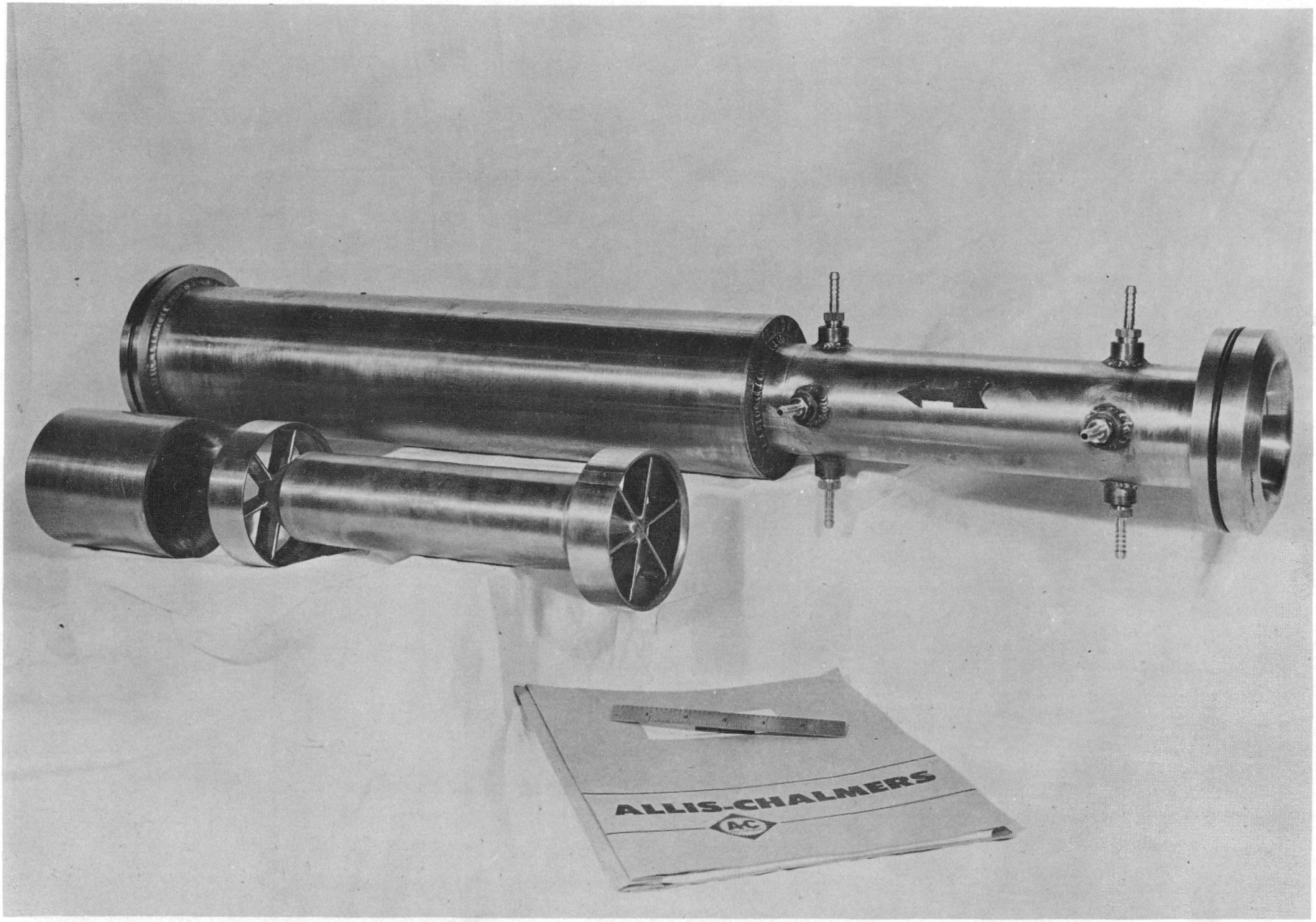


LOWER DUMMY HOUSING AND INTERNALS AS SEPARATE SUB-ASSEMBLIES

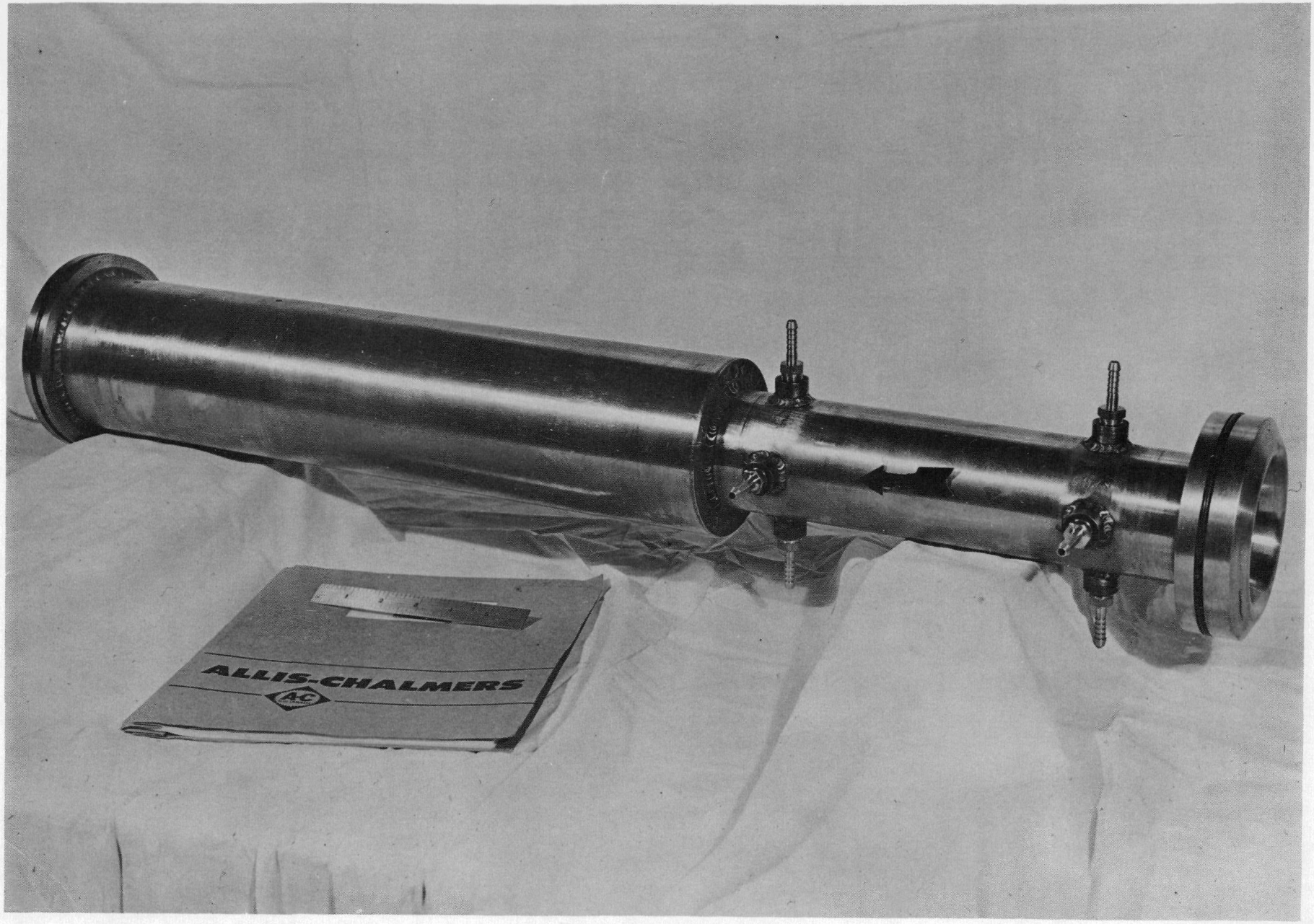


LOWER DUMMY ASSEMBLED WITH ACCESS COVER REMOVED

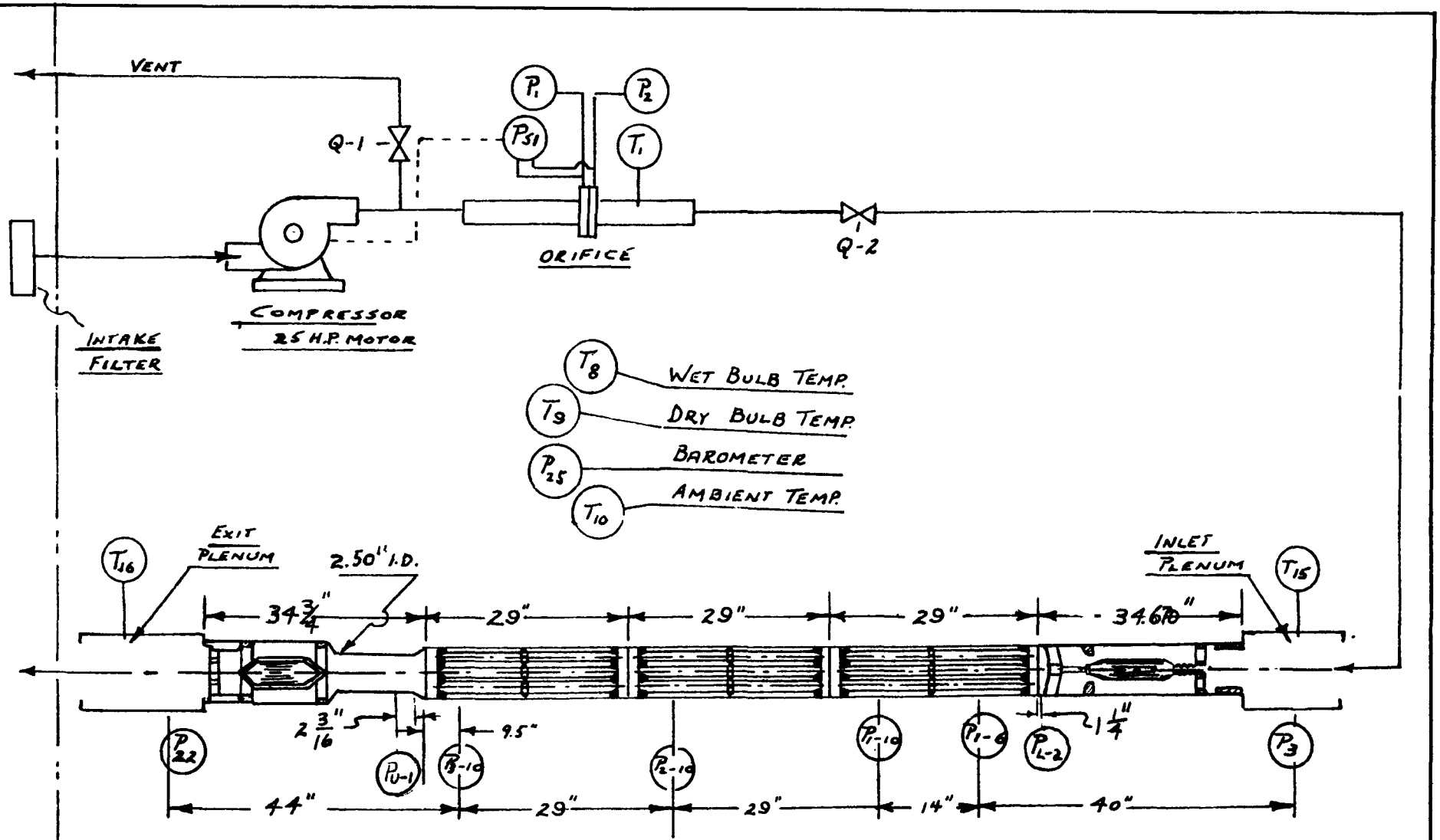
ASSEMBLED LOWER DUMMY



UPPER DUMMY HOUSING AND INTERNALS AS SEPARATE SUB-ASSEMBLIES



ASSEMBLED UPPER DUMMY

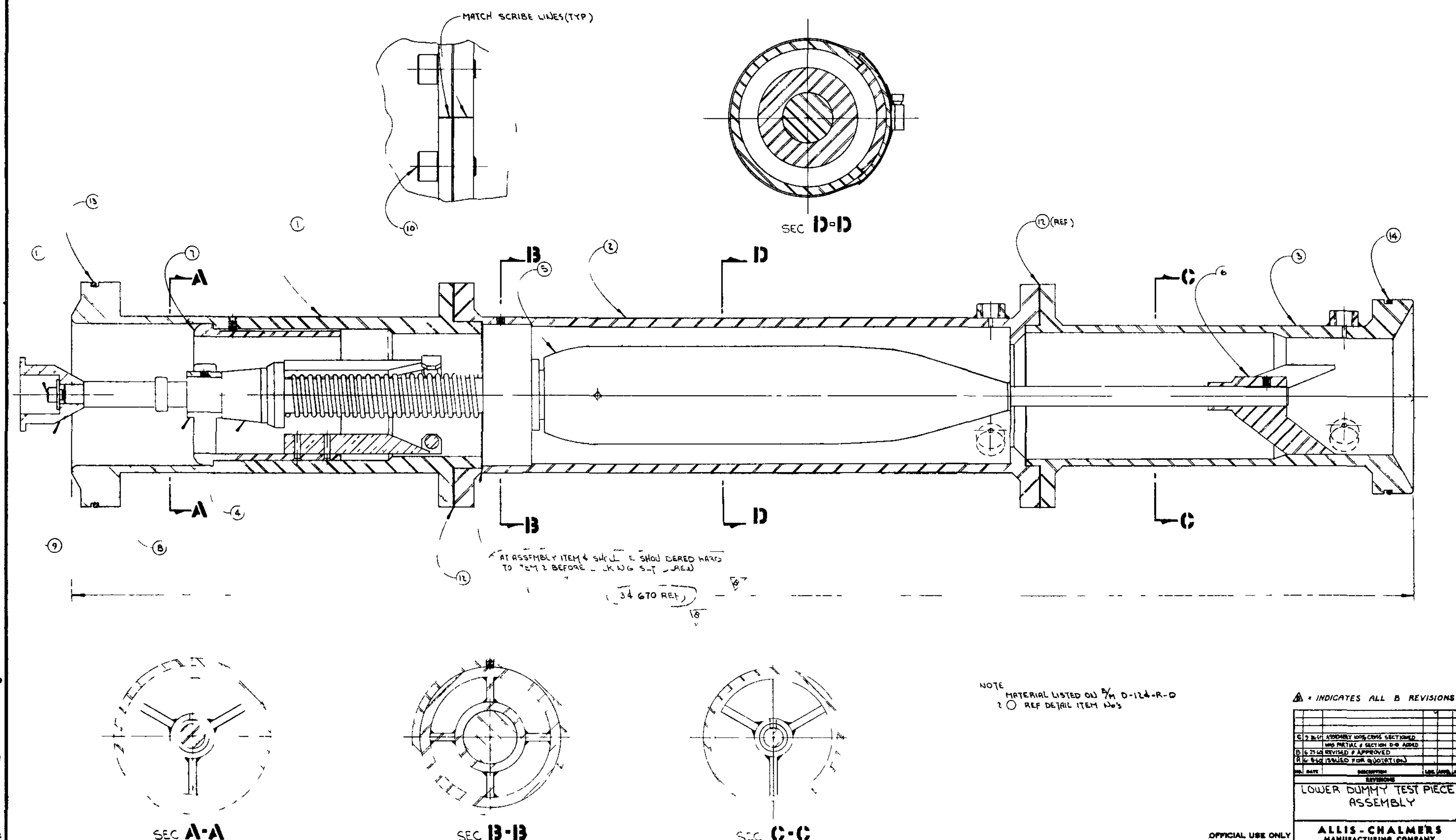


SCHEMATIC
PRESSURE DROP
FLOW SHEET
(ORIFICED DUMMY) 9 3 2 6 R 4 H

SK-D-170

B-10

OFFICIAL USE ONLY



NOTE
MATERIAL LISTED ON B/M D-124-R-D
2 ○ REF DETAIL ITEM No's

△ = INDICATES ALL B REVISIONS.

NO.	DATE	DESCRIPTION	LDE.	APPD.	AEC APPD.
C	7 3 61	ASSEMBLY 100% CROSS SECTIONED WAS PARTIAL & SECTION D-D ADDED			
B	6 23 60	REVISED & APPROVED			
A	6 8 60	ISSUED FOR QUOTATION			

REVISIONS

LOWER DUMMY TEST PIECE ASSEMBLY

REF NO.	TITLE	DWG. NO.
1	LOWER DUMMY TEST PIECE DETAILS SHT 1	D 25 R&D
2	LOWER DUMMY TEST PIECE DETAILS SHT 2	D 26 R&D

REFERENCES

OFFICIAL USE ONLY

	BY	DATE
DRAWN	CWC	6-6-60
CHECKED	[illegible]	6-21-60
APPROVED	[illegible]	6-6-60
APPROVED	[illegible]	[illegible]
APPROVED	[illegible]	[illegible]
APPROVED		
APPROVED		
AEC APPROVED		
AEC APPROVED		

SCALE: FULL
DATE:

ALLIS-CHALMERS MANUFACTURING COMPANY
ATOMIC ENERGY DIVISION
NUCLEAR POWER DEPARTMENT
WASHINGTON, D. C.

FOR

KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND, CALIFORNIA

FOR

US ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE

DWG. No. D-124 R&D

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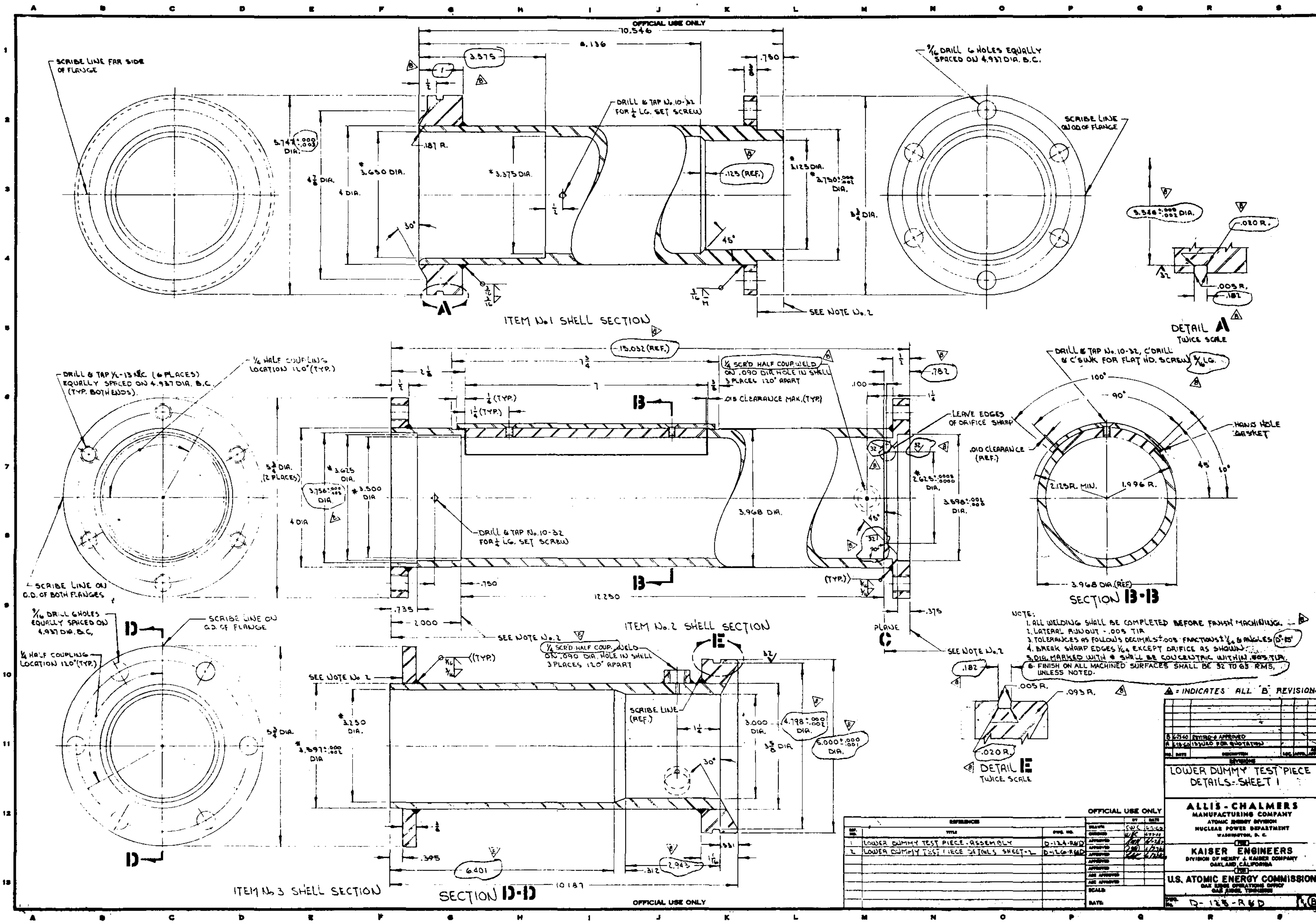

OFFICIAL USE ONLY
ITEM No. 1 SHELL SECTION
DETAIL A
TWICE SCALE
ITEM No. 2 SHELL SECTION
SECTION B-B
ITEM No. 3 SHELL SECTION
SECTION D-D
DETAIL E
TWICE SCALE
SCRIBE LINE FAR SIDE OF FLANGE
9/16 DRILL 6 HOLES EQUALLY SPACED ON 4.937 DIA. B.C.
SCRIBE LINE ON O.D. OF FLANGE
DRILL & TAP No. 10-32 FOR 1/2 LG. SET SCREW
SEE NOTE No. 2
DRILL & TAP 1/2-13 NC (6 PLACES) EQUALLY SPACED ON 4.937 DIA. B.C. (TYP. BOTH ENDS)
1/4 HALF COUPLING LOCATION 120° (TYP.)
SCRIBE LINE ON O.D. OF BOTH FLANGES
1/4 SCR'D HALF COUP. WELD ON .090 DIA. HOLE IN SHELL 3 PLACES 120° APART
.015 CLEARANCE MAX. (TYP.)
LEAVE EDGES OF ORIFICE SHARP
.010 CLEARANCE (REF.)
DRILL & TAP No. 10-32, C'DRILL & C'SINK FOR FLAT HD. SCREW 3/4 LG.
HAND HOLE GASKET
PLANE C
NOTE:
1. ALL WELDING SHALL BE COMPLETED BEFORE FINISH MACHINING.
2. LATERAL RUNOUT - .005 TIR
3. TOLERANCES AS FOLLOWS DECIMALS ±.005 FRACTIONS ±1/64 & ANGLES ±0°-15'
4. BREAK SHARP EDGES 1/64 EXCEPT ORIFICE AS SHOWN.
5. DIA. MARKED WITH * SHALL BE CONCENTRIC WITHIN .005 TIR.
6. FINISH ON ALL MACHINED SURFACES SHALL BE 32 TO 63 RMS, UNLESS NOTED.
B = INDICATES ALL "B" REVISIONS
REVISED & APPROVED
ISSUED FOR QUOTATION
LOWER DUMMY TEST PIECE DETAILS - SHEET 1
REFERENCES
1 LOWER DUMMY TEST PIECE ASSEMBLY D-124-R&D
2 LOWER DUMMY TEST PIECE DETAILS SHEET 2 D-126-R&D
ALLIS-CHALMERS MANUFACTURING COMPANY
ATOMIC ENERGY DIVISION
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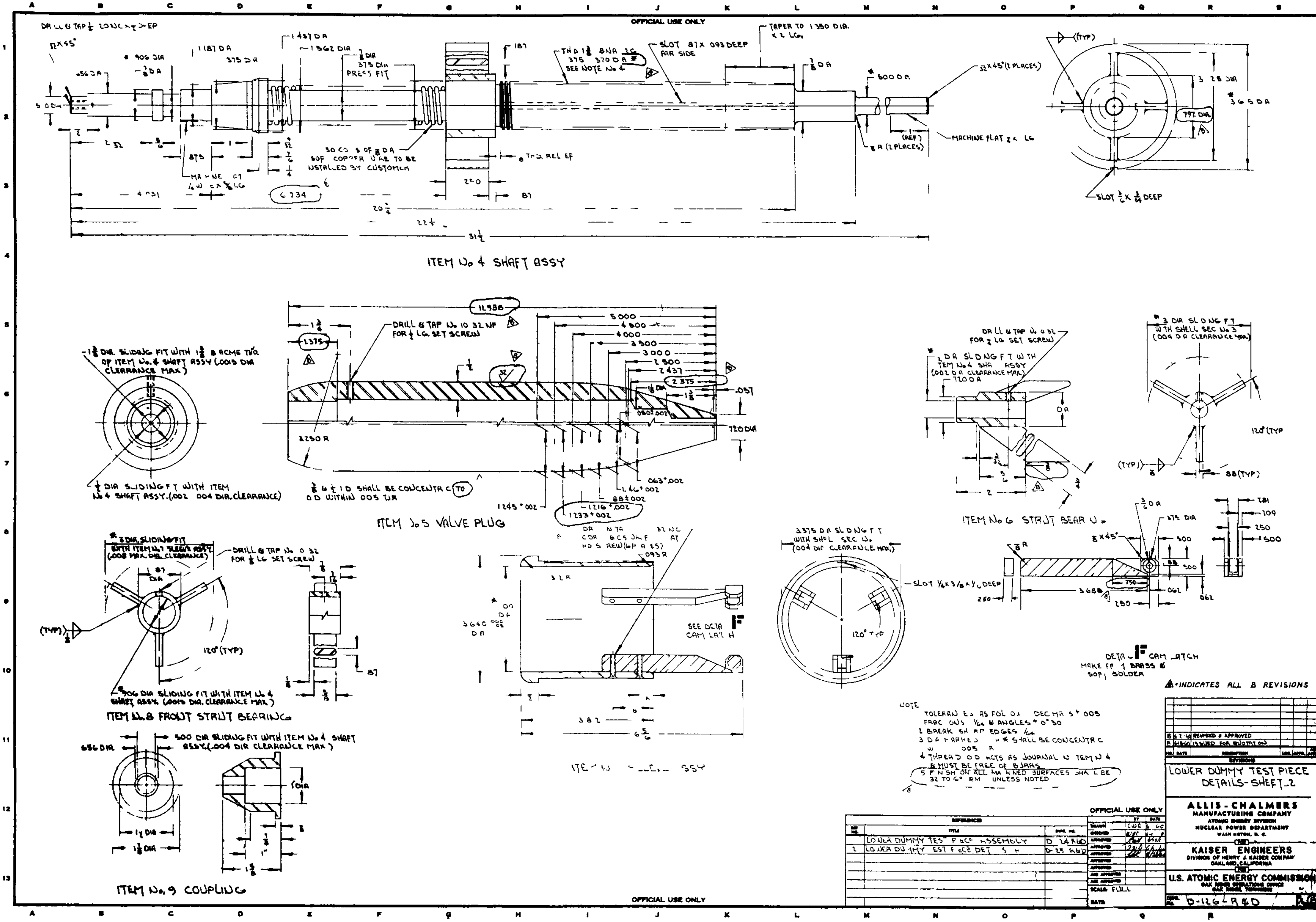
OAK RIDGE, TENNESSEE
D-123-R&D


OFFICIAL USE ONLY
ITEM No. 4 SHAFT ASSY
SLOT .81 X .093 DEEP FAR SIDE
TAPER TO 1.350 DIA.
MACHINE FLAT
SLOT 3/16 X 3/16 DEEP
ITEM No. 5 VALVE PLUG
DRILL & TAP No. 10 32 NF FOR 1/4 LG. SET SCREW
ITEM No. 6 STRUT BEARING
120° (TYP)
ITEM No. 8 FRONT STRUT BEARING
ITEM No. 9 COUPLING
.500 DIA SLIDING FIT WITH ITEM No. 4 SHAFT ASSY. (.004 DIA CLEARANCE MAX)
SEE DETAIL F CAM LATCH
DETAIL F CAM LATCH
MAKE FR 1 BRASS & SOFT SOLDER
SLOT 1/8 X 3/16 X 1/16 DEEP
B - INDICATES ALL B REVISIONS
NOTE
TOLERANCES AS FOLLOWS: DECIMALS ± .005 FRACTIONS ± 1/64 & ANGLES ± 0°30'
2 BREAK SHARP EDGES 1/64
4 THREAD O.D. ACTS AS JOURNAL IN ITEM No. 4 & MUST BE FREE OF BURRS
5 FINISH ON ALL MACHINED SURFACES SHALL BE 32 TO 63 RMS UNLESS NOTED
REVISED & APPROVED
ISSUED FOR QUOTATION
REVISIONS
LOWER DUMMY TEST PIECE DETAILS-SHEET 2
ALLIS-CHALMERS MANUFACTURING COMPANY
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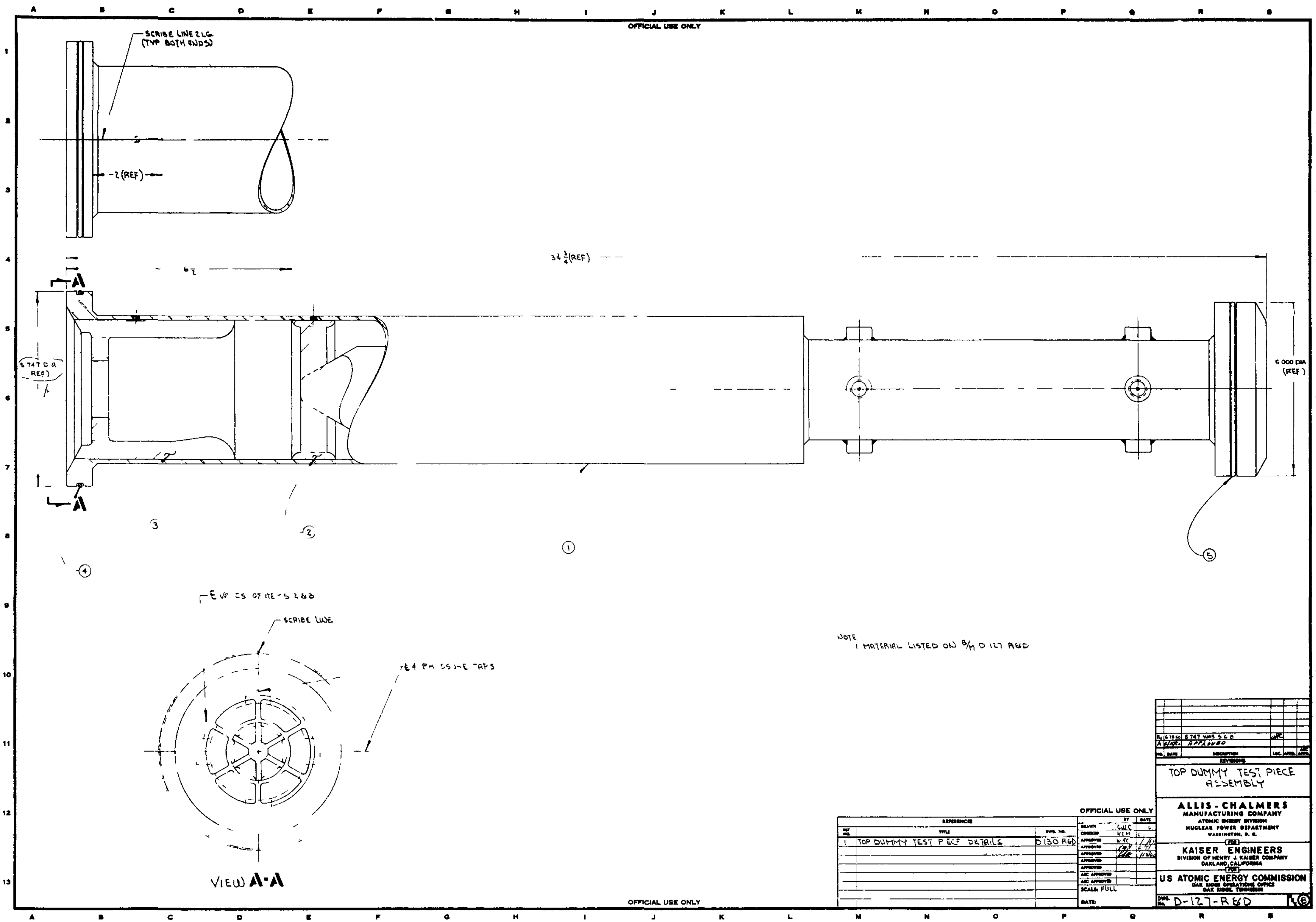
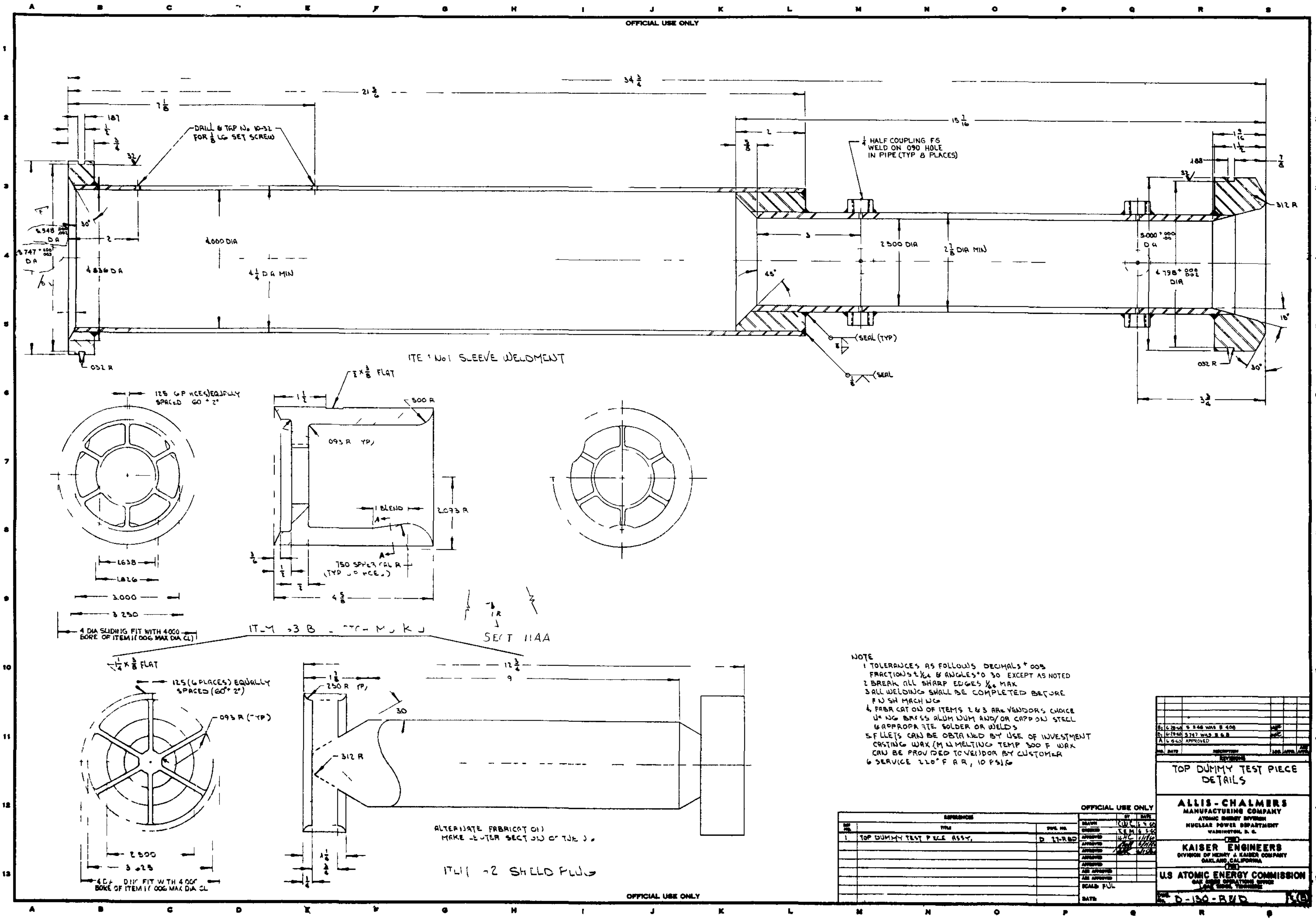
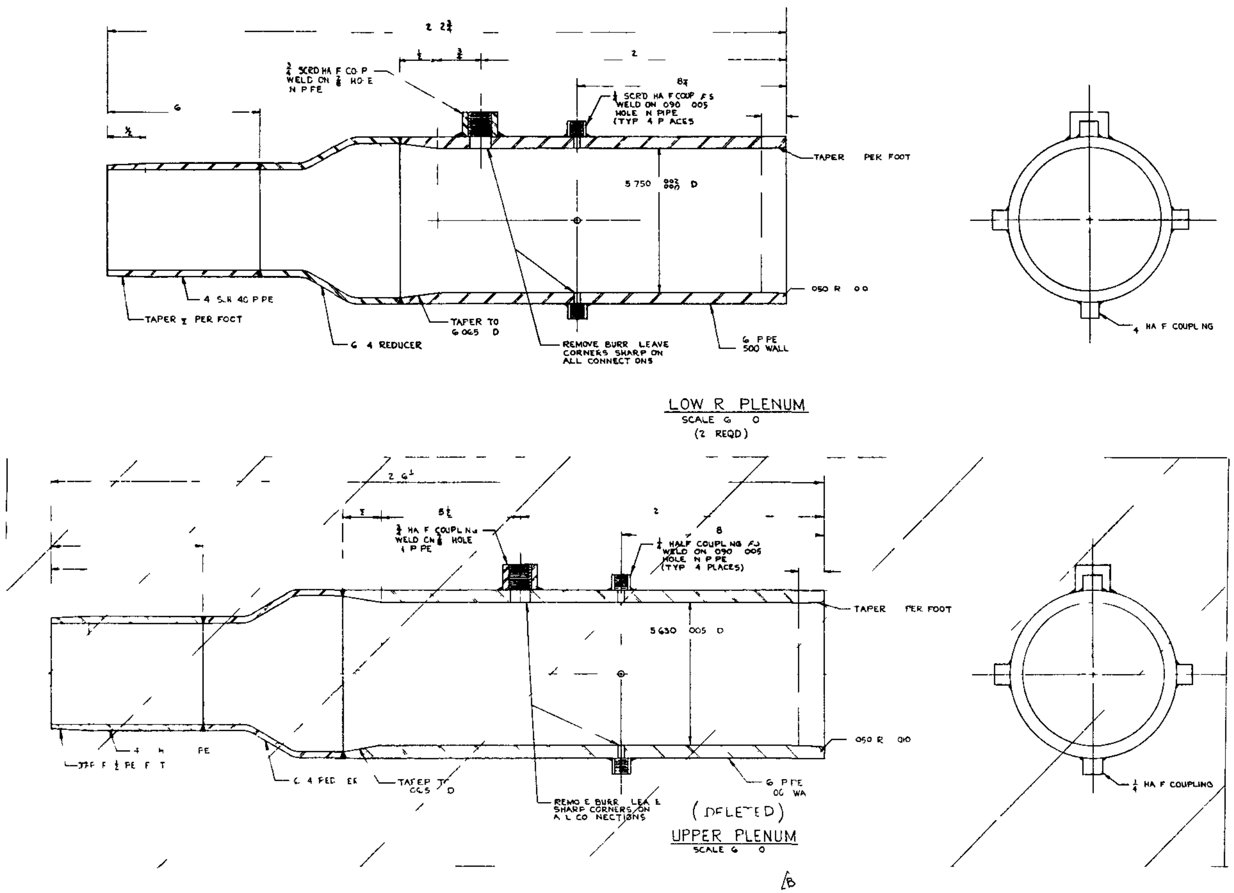
U.S. ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE
REFERENCES
LOWER DUMMY TEST PIECE ASSEMBLY
LOWER DUMMY TEST PIECE DETAILS SH
SCALE FULL
D-126-R&D


OFFICIAL USE ONLY
SCRIBE LINE 2 LG.
(TYP BOTH ENDS)
2 (REF)
34 3/4 (REF)
A
5.747 DIA
REF)
5.000 DIA
(REF)
VIEW A-A
SCRIBE LINE
NOTE
1 MATERIAL LISTED ON B/M D 127 R&D
REFERENCES
TOP DUMMY TEST PIECE DETAILS
D130 R&D
OFFICIAL USE ONLY
DRAWN GWC
CHECKED KEM
SCALE: FULL
DATE:
B 5.747 WAS 5.68
A APPROVED
REVISIONS
TOP DUMMY TEST PIECE
ASSEMBLY
ALLIS-CHALMERS
MANUFACTURING COMPANY
ATOMIC ENERGY DIVISION
NUCLEAR POWER DEPARTMENT
WASHINGTON, D. C.
FOR
KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND, CALIFORNIA
FOR
US ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE
DWG. No. D-127-R&D
B
OFFICIAL USE ONLY


OFFICIAL USE ONLY
DRILL & TAP No 10-32 FOR 1/8 LG SET SCREW
1/4 HALF COUPLING FS WELD ON 090 HOLE IN PIPE (TYP 8 PLACES)
4.000 DIA
4 1/4 DIA MIN
2.500 DIA
2 7/8 DIA MIN
SEAL (TYP)
SEAL
ITEM No 1 SLEEVE WELDMENT
125 6 PLACES EQUALLY SPACED 60° ± 2°
1/8 x 3/8 FLAT
.500 R
1.638
1.826
3.000
3.250
4 DIA SLIDING FIT WITH 4.000 BORE OF ITEM 1 (.006 MAX DIA CL)
SECT AA
125 (6 PLACES) EQUALLY SPACED (60° ± 2°)
.093 R (TYP)
.312 R
2.500
3.625
ALTERNATE FABRICATION MAKE CENTER SECTION OF TUBE
NOTE
1 TOLERANCES AS FOLLOWS DECIMALS ± .005 FRACTIONS ± 1/64 & ANGLES ± 0 30 EXCEPT AS NOTED
2 BREAK ALL SHARP EDGES 1/64 MAX
3 ALL WELDING SHALL BE COMPLETED BEFORE FINISH MACHINING
4 FABRICATION OF ITEMS 2 & 3 ARE VENDORS CHOICE USING BRASS ALUMINUM AND/OR CARBON STEEL & APPROPRIATE SOLDER OR WELDS
5 FILLETS CAN BE OBTAINED BY USE OF INVESTMENT CASTING WAX (MIN MELTING TEMP 300 F) WAX CAN BE PROVIDED TO VENDOR BY CUSTOMER
6 SERVICE 220° F AIR, 10 PSIG
TOP DUMMY TEST PIECE DETAILS
ALLIS-CHALMERS MANUFACTURING COMPANY
ATOMIC ENERGY DIVISION
NUCLEAR POWER DEPARTMENT
WASHINGTON, D. C.
KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND, CALIFORNIA
U.S ATOMIC ENERGY COMMISSION
REFERENCE
1 TOP DUMMY TEST PIECE ASSY.
SCALE FULL
D-130-B-5-D

OFFICIAL USE ONLY



NOTES
1. BREAK SHARP EDGES EXCEPT AS MARKED
2. MA ER A L TED ON B M D 28 R&D
3. A DIME NS TO HE D W H N ± EXCEPT AS MARK D

NO.	DATE	DESCRIPTION		
B	6 28 60	DELETED UPPER PLENUM		
A		APPROVED		

REVISIONS

REFERENCES		
REF NO.	TITLE	DWG. NO.

OFFICIAL USE ONLY

	BY	DATE
DRAWN	REM	
CHECKED		
APPROVED		
APPROVED		
APPROVED		
APPROVED		
APPROVED		
AEC APPROVED		
AEC APPROVED		
SCALE: 6 0		
DATE		

UPPER & LOWER PLENUM & ADAPTER

ALLIS-CHALMERS MANUFACTURING COMPANY
ATOMIC ENERGY DIVISION
NUCLEAR POWER DEPARTMENT
WASHINGTON D. C.

FOR

KAISER ENGINEERS
DIVISION OF HENRY J. KAISER COMPANY
OAKLAND CALIFORNIA

FOR

U.S ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE

DWG. No. D 128 R&D (B)

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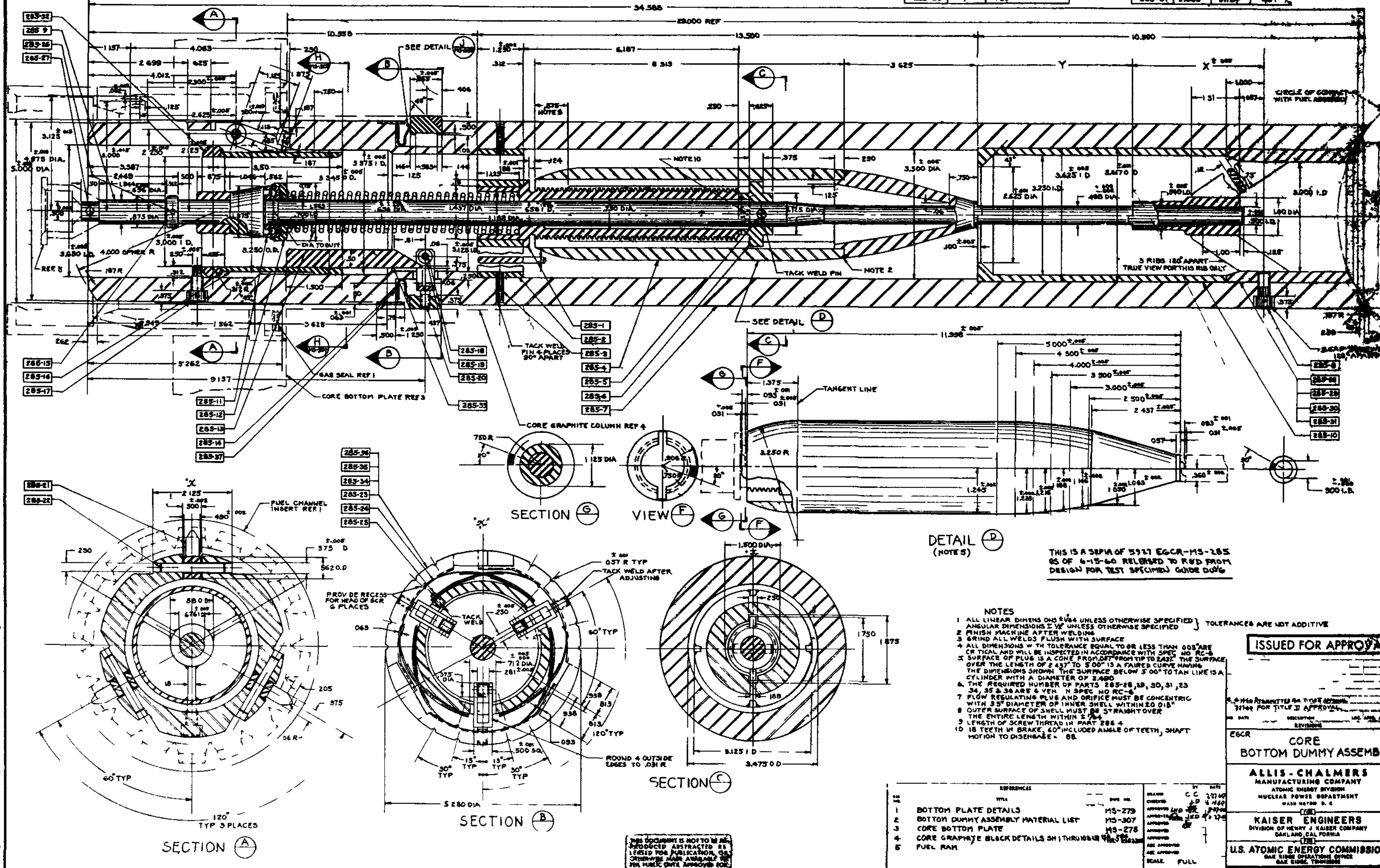

TABLE I

PART NO.	NO OF GROOVES	ANGLE FROM ROLLER CENTERLINE
285-36	4	+30°, -30°, +15°, -15°
285-35	3	+30°, -30°, +15°
285-34	2	+30°, -30°
285-23	1	+30°

TABLE II

PART NO.	X	Y	[illegible]
285-28	3.933	2.674	[illegible]
285-29	4.814	2.400	27
285-30	3.864	4.246	[illegible]
285-31	2.640	5.184	48

THIS IS A SEPIA OF 5927 EGCR-MS-285 RS OF 6-15-60 RELEASED TO R&D FROM DESIGN FOR TEST SPECIMEN GUIDE DWG

NOTES

1. ALL LINEAR DIMENSIONS ±1/64 UNLESS OTHERWISE SPECIFIED; ANGULAR DIMENSIONS ± 1/2° UNLESS OTHERWISE SPECIFIED } TOLERANCES ARE NOT ADDITIVE
2. FINISH MACHINE AFTER WELDING
3. GRIND ALL WELDS FLUSH WITH SURFACE
4. ALL DIMENSIONS WITH TOLERANCE EQUAL TO OR LESS THAN .005" ARE CRITICAL AND WILL BE INSPECTED IN ACCORDANCE WITH SPEC NO RC-6
5. SURFACE OF PLUG IS A CONE FROM .057" FROM TIP TO 2.437". THE SURFACE OVER THE LENGTH OF 2.437" TO 5.00" IS A FAIRED CURVE HAVING THE DIMENSIONS SHOWN. THE SURFACE BELOW 5.00" TO TAN LINE IS A CYLINDER WITH A DIAMETER OF 2.490
6. THE REQUIRED NUMBER OF PARTS 285-28, 29, 30, 31, 23, 34, 35 & 36 ARE 6 VEN N SPEC NO RC-6
7. FLOW REGULATING PLUG AND ORIFICE MUST BE CONCENTRIC WITH 3.5" DIAMETER OF INNER SHELL WITHIN ±.018"
8. OUTER SURFACE OF SHELL MUST BE STRAIGHT OVER THE ENTIRE LENGTH WITHIN ± 1/64
9. LENGTH OF SCREW THREAD IN PART 285-4
10. 18 TEETH IN BRAKE, 60° INCLUDED ANGLE OF TEETH, SHAFT MOTION TO DISENGAGE = .88

ISSUED FOR APPROVAL

REVISIONS: RESUBMITTED FOR TITLE II APPROVAL

REFERENCES

REF NO.	TITLE	DWG NO.
1	BOTTOM PLATE DETAILS	MS-279
2	BOTTOM DUMMY ASSEMBLY MATERIAL LIST	MS-307
3	CORE BOTTOM PLATE	MS-278
4	CORE GRAPHITE BLOCK DETAILS SH 1 THRU 10 [illegible]	[illegible]
5	FUEL RAM	

DRAWN C.C. · SCALE FULL

EGCR
CORE
BOTTOM DUMMY ASSEMBLY

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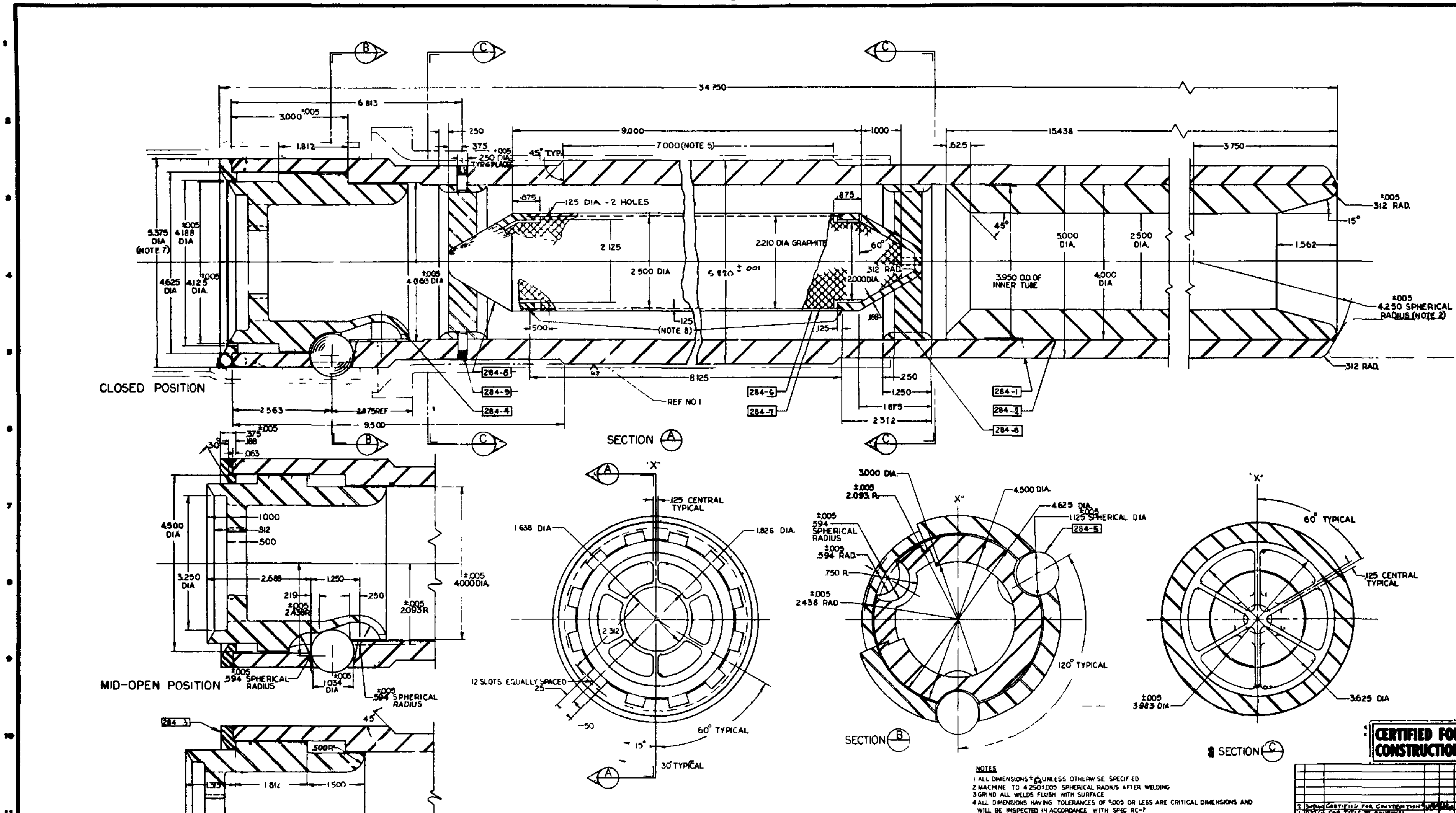
DIVISION OF HENRY J KAISER COMPANY
OAKLAND, CALIFORNIA

U.S. ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE

DWG NO. SK-61560-285 [illegible]



PLAN VIEW

LIST OF MATERIAL						
ITEM	REQ	PART NO	DESCRIPTION	MATERIAL		REMARKS
1	1	284 1	SLEEVE	ASTM A 213 T 5		
2	1	284 2	INSERT	ASTM A-213 T 5		
3	1	284 3	STOP PLATE	AISI TYPE 502		
4	1	284 4	BALL LATCH	ASTM A 217 C-5		
5	3	284 5	BALL	AISI 440 C VACUUM MELT	ROCK C 56 60	
6	1	284 6	SHIELD TUBE	ASTM-A-213-T 5		
7	1	284 7	GRAPHITE FILLER	GRAPHITE		AGOT DENSITY =1.65 G/CC
8	2	284 8	SHIELD SPIDERS	ASTM-A-217-C 5		
9	6	284 9	DOWEL 1/4 × 1/2	AISI TYPE 502		

NOTES

1 ALL DIMENSIONS ± 1/64 UNLESS OTHERWISE SPECIFIED
2 MACHINE TO 4.250±.005 SPHERICAL RADIUS AFTER WELDING
3 GRIND ALL WELDS FLUSH WITH SURFACE
4 ALL DIMENSIONS HAVING TOLERANCES OF ±.005 OR LESS ARE CRITICAL DIMENSIONS AND WILL BE INSPECTED IN ACCORDANCE WITH SPEC RC-7
5 FOR THE FINISHED ASSEMBLY THIS SURFACE MUST BE CONCENTRIC WITH OUTER CYLINDRICAL SURFACE OF ASSEMBLY WITHIN ± 1/64 IN
6 OUTER SURFACE OF FINISHED ASSEMBLY WILL BE STRAIGHT OVER THE ENTIRE LENGTH WITHIN ± 1/64 IN
7 THIS SURFACE MUST BE CONCENTRIC WITH 5 INCH DIA OF LOWER PORTION OF ASSEMBLY WITHIN ± 1/64 IN
8 ALL WELDS TO BE EXAMINED WITH LIQUID PENETRENT AS SPECIFIED IN SPEC RC 7

SPEC RC-7

REFERENCES		
REF NO.	TITLE	DWG. NO.
1	CORE FUEL CHANNEL EXTENSION	MS-301

	BY	DATE
DRAWN	E.J.J.	[illegible]
CHECKED	A.S.	[illegible]
APPROVED	[illegible]	[illegible]
APPROVED	[illegible]	[illegible]
APPROVED	[illegible]	[illegible]
APPROVED		
APPROVED	W.J.P.	4-21-60
AEC APPROVED	W.B.	5-18-60
AEC APPROVED	L.H.A.	5-19-60
SCALE: FULL		
DATE 5-19-60		

NO.	DATE	DESCRIPTION
2	3-19-60	CERTIFIED FOR CONSTRUCTION
1	2-27-60	FOR TITLE II APPROVAL

REVISIONS

EGCR

TOP DUMMY ASSEMBLY

ALLIS-CHALMERS MANUFACTURING COMPANY
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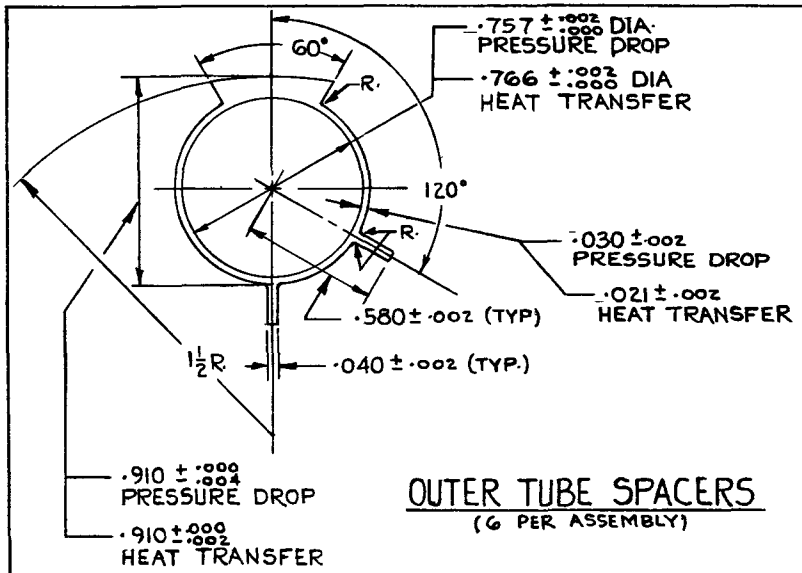
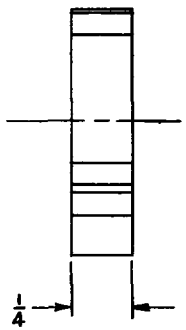
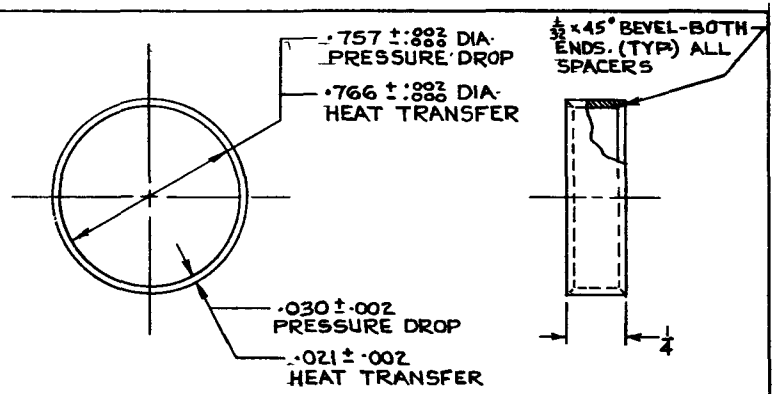
OAK RIDGE OPERATIONS OFFICE
OAK RIDGE, TENNESSEE

5927-EGCR-MS-284



OUTER TUBE SPACERS
(6 PER ASSEMBLY)

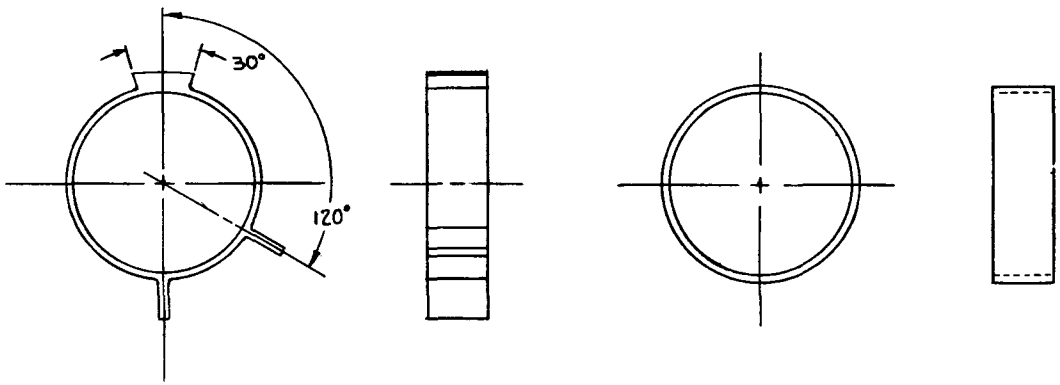




INNER TUBE SPACER
(1 PER ASSEMBLY)

NOTE
1. MOD. II SPACERS RECEIVED AS SHOWN

MOD. II SPACERS
REF. DWG. A-103-5



OUTER TUBE SPACERS
(6 PER ASSEMBLY)

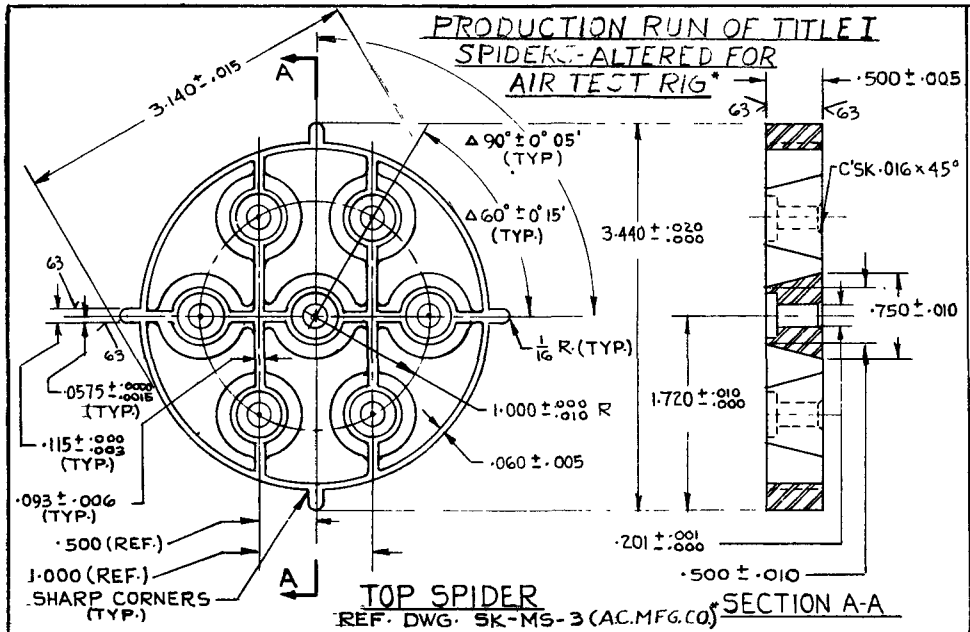
INNER TUBE SPACER
(1 PER ASSEMBLY)

NOTE
1. MOD. IV DIM. SAME AS MOD II EXCEPT AS NOTED.

MOD IV SPACERS
REF. DWG. A-103-26A

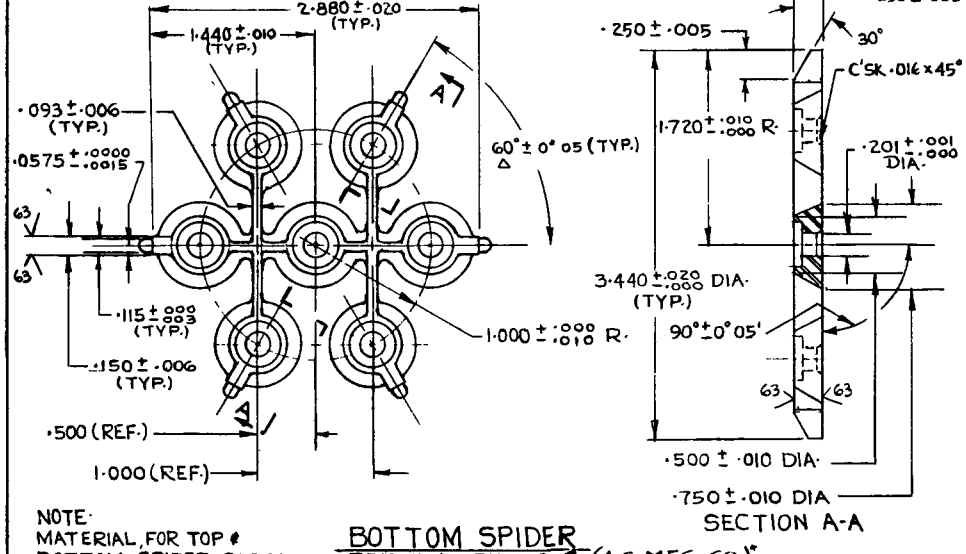
CENTRAL SPACERS		MOD. II & IV
REM	5-19-60	SK-D-161

PRODUCTION RUN OF TITLE I SPIDERS - ALTERED FOR AIR TEST RIG*



TOP SPIDER
REF. DWG. 5K-MS-3 (A.C. MFG. CO.)*

SECTION A-A

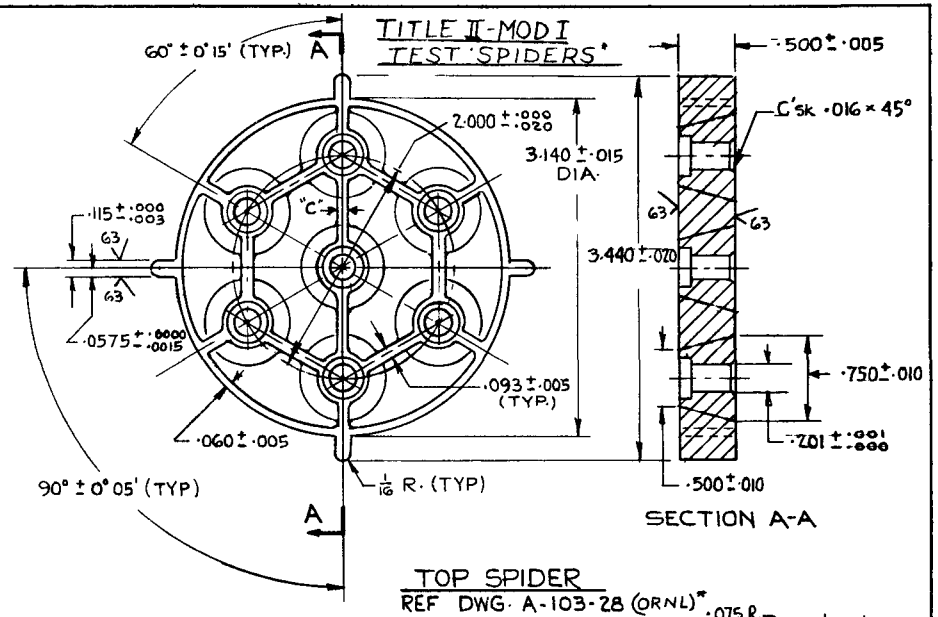


SECTION A-A

NOTE:
MATERIAL, FOR TOP & BOTTOM SPIDER-CASTING STAINLESS STEEL TYPE 304

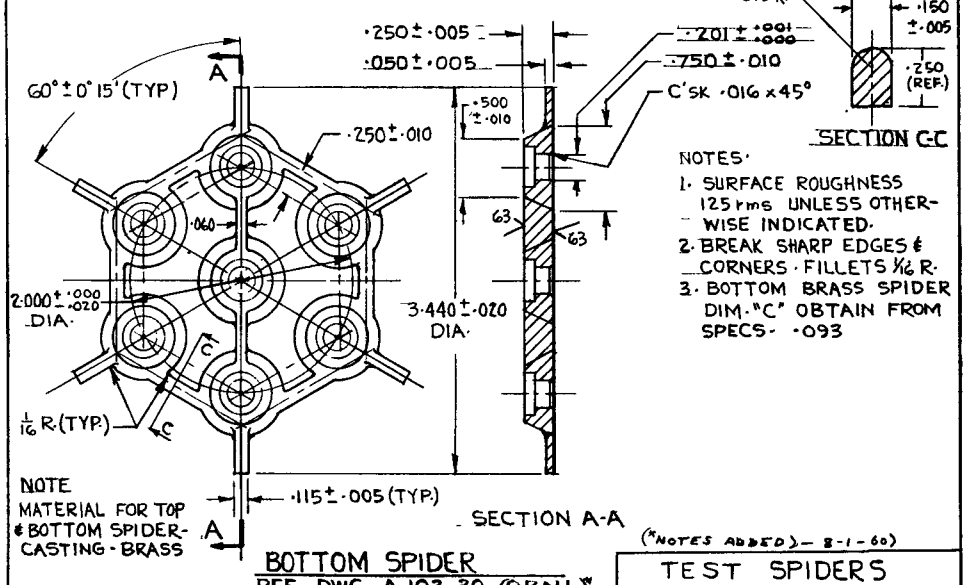
BOTTOM SPIDER
REF. DWG. 5K-MS-4 (A.C. MFG. CO.)*

TITLE II-MOD I TEST SPIDERS*



SECTION A-A

TOP SPIDER
REF DWG. A-103-28 (ORNL)*



NOTES:
1. SURFACE ROUGHNESS 125 rms UNLESS OTHERWISE INDICATED.
2. BREAK SHARP EDGES & CORNERS. FILLETS 1/16 R.
3. BOTTOM BRASS SPIDER DIM. "C" OBTAIN FROM SPECS. .093

NOTE
MATERIAL FOR TOP & BOTTOM SPIDER-CASTING - BRASS

BOTTOM SPIDER
REF. DWG. A-103-30 (ORNL)*

(*NOTES ADDED) — 8-1-60)

TEST SPIDERS
REM 5-31-60 SK-D-163