



AUSTRALIAN ATOMIC ENERGY COMMISSION
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November 1974

ISBN 0 642 99660 1

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ABSTRACT

Burnout and pressure drop data are presented for a series of 29 annuli cooled by upflow of Freon-12 at an inlet pressure of 1.04 MPa with internal, external and combined internal and external heating. The test sections had a uniform axial heat flux distribution, except for one internally heated test section which had a chopped cosine axial heat flux profile (form factor = 1.4). The test sections covered a range of annulus geometries; heated lengths range from 457 mm to 4,277 mm; hydraulic and internal tube diameter ranges are 1.55 mm to 8 mm and 8 mm to 19 mm respectively. The mass velocity range is 0.7 to 4 Mg m⁻²s⁻¹, and inlet subcooling values range up to 26 kJ kg⁻¹.

National Library of Australia card number and ISBN 0 642 99660 1

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ANNULAR SPACE; BURNOUT; CRITICAL HEAT FLUX; DATA; FLOW RATE; FREONS;
GEOMETRY; PRESSURE DROP; SHROUDS; SPACERS; SUBCOOLING

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1. INTRODUCTION

The results of 417 boiling crisis tests with Freon-12 (dichlorodifluoromethane) are presented for a series of 29 annulus test sections covering a substantial range of geometric parameters for an inlet pressure of 1.04 MPa.

This series of tests was carried out as part of a collaborative programme, with the UK Atomic Energy Establishment, Winfrith providing data on which to establish a model fluid technique for boiling crisis experiments. The 29 annulus test sections used in the experiments are listed in Table 1.

The ranges of parameters covered in the present series of tests are:

Geometry

Centre tube external diameter	7.95 - 18.6 mm
Shroud internal diameter	9.5 - 26.6 mm
Hydraulic diameter	1.55 - 8.0 mm
Length	457 - 4,277 mm
Ratio of length to hydraulic diameter	180 : 1,180

Heating Modes

Centre tube only

Shroud only

Both centre tube and shroud at same heat flux

Flow Conditions

Mass Velocity	0.7 - 4 Mg m ⁻² s ⁻¹
Inlet subcooling	2.4 - 26 kJ kg ⁻¹

Following the tests it was found (Ilic & Lawther 1973) that spacer elements, used to locate centrally the inner rod in these test sections, could have a significant effect on the boiling crisis conditions. Figure 2 from Ilic and Lawther (1973) shows the effect of such spacers on burnout power (heat flux) with Freon-12 compared with an essentially bare annulus. The effect varies considerably with inlet temperature and mass velocity, and such effects may, in some cases, be substantial (up to 80 per cent is indicated on Figure 2). This means that the quantitative results reported here are only applicable to the geometries tested (i.e. with the same spacer arrangements).

Spacer element arrangements are detailed in each case with the tables of data.

2. EXPERIMENTS

2.1 Test Rig

The AAEC Freon-12 loop, ACTOR (Ilic 1972), was used for the experiments. Layout of a typical test section assembly in the rig is shown in Figure 1.

2.2 Instrumentation

The mass flowrate was measured with a multiorifice system (V. Ilic, AAEC unpublished report), specially designed for operation on the Freon-12 rig. Pressure drop across an orifice plate was indicated by a differential mercury manometer. The pressure difference so obtained was substituted in the mass flow equation derived either from the British Standard BS1042: Part 1, 1964, if the mass flowrate was greater than 0.2 kg s^{-1} , or from calibration data for non-standard orifices (V. Ilic, AAEC unpublished report) if the flowrate was less than 0.2 kg s^{-1} . The fluid temperature at the inlet to the test section was measured by a platinum resistance thermometer. The temperature of the metered fluid was measured by a chromel-alumel thermocouple placed 2 m upstream of the orifice and read off the printed record from a multipoint temperature recorder.

The power to the test section was obtained from separate measurements of the voltage drop between heater power clamps and the current through the test section. The latter was obtained by measuring the voltage drop across a calibrated precision resistance in the power supply line. The test section pressure drop was measured by means of a differential mercury manometer. The test section inlet static pressure was obtained from a pressure indicator connected to a pressure transmitter unit. All the above data were recorded manually.

Owing to the test section construction, static pressure drop over the test section includes pressure drop over 76 mm (38 mm at each end of the section) of unheated test section length. With the heated outer shroud test sections, brass clamps 64 mm long were used, such that the heated surface was always 38 mm below the top pressure tapping, and 38 mm above the lower pressure tapping.

Burnout detection was by means of a thermocouple, thermopile or a bridge detector which monitored the change in electrical resistance of the test section. The hot junction of the chromel-alumel thermocouple was located on the heater wall about 5 mm upstream of the end of the heater length. The thermopile detector consisted of 4 chromel-alumel thermocouples connected in series and equally spaced around the periphery at the same axial position. The data tables indicate the device used for each test section.

2.3 Experimental Method

In all cases, the required flow conditions were initially established with a trial burnout obtained through a fairly rapid succession of test section power increments. The power was then reduced such that the test section voltage was about 0.5 V below the burnout value, and conditions were allowed to settle. The burnout was then approached at small rates of power increments, until the pen monitor registered a substantial deviation in the burnout signal (corresponding to a power variation of the order 1 watt). A record was then made of all the relevant parameter values.

2.4 Error Estimates

The estimate of random errors associated with each measurement is given below:

flowrate	± 1.5%	heater power	± 2%
inlet pressure	± 14 kPa	heater area	± 0.6%
inlet temperature	± 1°C	pressure drop	± 1%

3. RESULTS

3.1 General

Burnout data recorded in the experiments were processed on an IBM360/50 computer using a specially developed computer program FREON (M.A. Cowper, AAEC unpublished report). The data are tabulated in Tables 2 to 30. A summary of the data is shown in Figures 2 and 3 for a constant mass velocity of approximately $1,336 \text{ kg m}^{-2}\text{s}^{-1}$.

Exit quality and boiling length were obtained from a heat balance calculation neglecting losses (ΔQ) to the surrounding air from the test section and copper power clamps. Although such losses are estimated to be fairly small, calculated qualities slightly in excess of unity (Table 24) probably reflect the consequence of neglecting such losses; this can be seen from the overall heat balance equation:

$$x_o = \frac{1}{\lambda_o} (h_{f_i} - h_{f_o} + \frac{Q}{W}) - \frac{\Delta Q}{W\lambda_o} .$$

In the case of those tests in which both inner and outer surfaces of the annulus were heated, burnout was always detected on both heaters (shroud and inner rod) simultaneously.

Test section pressure drop for a given mass velocity and at zero power was found not to be much affected by the inlet subcooling, and was sometimes assumed constant for experimental convenience, after taking a reading at one

value of inlet subcooling for a given mass velocity. These assumed values are shown in brackets in the tables.

Because of test section manometer malfunction during the burnout runs on test section 9F (Table 10), separate tests were done especially to record the pressure drop data.

Variation of burnout power (BOP) with inlet subcooling is shown in Figure 3. It is seen that, in general, the BOP increases with inlet subcooling in an approximately linear manner. Figure 4 provides the same information in terms of burnout heat flux (BHF). For convenience in analysing the data, BOP and BHF values corresponding to zero inlet subcooling were obtained by extrapolation.

3.2 Effect of Geometry on Test Section Performance

3.2.1 Effect of heated length

With reference to Figure 5 it can be seen that, for given inlet flow conditions, increase of the heated length

- (i) in general, increases BOP,
- (ii) decreases BHF, and
- (iii) increases static pressure drop at burnout.

3.2.2 Effect of mass flux change with L/D constant

A change in test section size (keeping L/D constant) had a substantial effect on BOP (Figure 6a) for given inlet flow conditions (mass velocity and subcooling), but the effect on BHF was, in general, small (Figure 6b). Figure 5 shows results for a change in size by a factor of 2. Figure 8 shows variation of BHF against L/D for all 29 test sections.

3.2.3 Effect of shroud diameter variation

Increasing the shroud diameter increases BOP for a given mass velocity, in the manner illustrated in Figure 7a for test sections 3F, 9F and 29F. The effect of increasing the shroud diameter is less pronounced for a given mass flowrate, as shown in Figure 7b for the three test sections.

3.3 Effect of Heat Flux Distribution on Test Section Performance

3.3.1 Effect of chopped cosine axial heat flux

The effect of a chopped cosine axial heat flux profile (CAHFP) was obtained by comparing results from test section 27F (form factor = 1.4) with those from test section 9F, which had a uniform axial heat flux profile (UAHFP). In Figures 9 and 10 it is seen that:

- (i) The BOPs for UAHFP and CAHFP are similar at a high value of subcooling over the range of mass velocities tested. The differences are greatest at zero inlet subcooling, where BOP(U) is less than BOP(C) (at moderate to

high mass velocities) by up to about 17 per cent.

(ii) The static pressure drop at burnout does not show significant variation between the two tests even though the BOPs (and hence the exit qualities) are in general higher with CAHFP.

3.3.2 Effect of transverse distribution of heat flux

Several sets of geometrically identical test sections were used with heating applied either to the central rod, to the shroud, or to both. In the latter case, identical heat flux was present on the heated shroud and the heated inner rod. In general, it was found that for the same inlet flow conditions, BHF was least in the case of bilateral heating. This is illustrated in Figure 8, which indicates that the BHF's for test sections with heating from only one surface are approximately 40-50 per cent higher than for heating from both surfaces.

4. CONCLUSIONS

(i) BHF substantially decreases with increase of the L/D ratio.

(ii) With bilaterally heated test sections, where the heat flux is the same on both heated surfaces, the BHF is less than with either internal or external heating alone.

(iii) BHF's for annulus test sections of different sizes but having the same L/D ratio and flow conditions are approximately equal.

(iv) In general, BOP varies with L towards a maximum, which depends on G and Δh_i .

(v) Static pressure drop at burnout shows a linear increase with L.

(vi) Increase in shroud diameter does not appreciably change BOP at the same mass flowrate.

(vii) Comparison of the average BOP for the cosine test section (27F) with the BOP for the corresponding uniformly heated test section (9F) showed that the power was generally higher, depending on the mass velocity and inlet subcooling. The disparity diminished with increase in inlet subcooling and reduction in mass velocity.

(viii) BHF is generally least and the power greatest for the bilaterally heated test section compared with heating the central rod or shroud only.

5. NOMENCLATURE

Roman Letters

- D = hydraulic diameter
 G = mass velocity
 h = enthalpy
 P = pressure

L = heater length
 Q = total test section power input
 W = mass flowrate
 X = quality

Greek letters

Δ = a small portion
 λ = latent heat of vaporisation
 ϕ = burnout heat flux

Subscripts

f = liquid
 i = inlet
 o = outlet

Abbreviations

BHF = burnout heat flux
 BOP = burnout power
 BOP(C) = burnout power for test section with cosine axial heat flux profile
 BOP(U) = burnout power for test section with uniform axial heat flux profile
 UAHFP = uniform axial heat flux profile
 CAHFP = cosine axial heat flux profile.

6. ACKNOWLEDGEMENTS

Tests were done at the instigation of Dr. K.R. Lawther, Head of Heat Transfer Section, Engineering Research Division. The assistance of Messrs. J.R. Stevens and H.N. Harvey, who carried out the tests, and Miss B.A. Beard, who helped with data processing, is gratefully acknowledged.

7. REFERENCES

- Ilic, V. & Lawther, K.R. (1973) - The Effect of Spacers on Burnout in an Annulus with a Uniformly Heated Central Rod Cooled by Freon-12. First Australasian Conference on Heat and Mass Transfer, Monash University, Melbourne, Australia, 23-25 May.
- Ilic, V. (1972) - The AAEC Freon-12 Rig ACTOR and Initial Boiling Crisis (Burnout) Results. AAEC/TM632.

TABLE 1
TEST SECTIONS LISTING

Annulus Code No.	Diameter mm (in)		Heated Length mm (in)	Mode of Heating	Table
	Shroud	Inner Tube			
1F	22.733 (0.895)	15.88 (0.625)	3,658 (144)	I*	2
2F	22.733 (0.895)	15.88 (0.625)	1,829 (72)	I	3
3F	11.38 (0.448)	7.95 (0.313)	1,829 (72)	I	4
4F	11.38 (0.448)	7.95 (0.313)	914 (36)	I	5
5F	26.59 (1.047)	18.57 (0.731)	4,277 (168.4)	I	6
6F	26.59 (1.047)	18.57 (0.731)	2,139 (84.2)	I	7
7F	20.96 (0.825)	15.88 (0.625)	3,658 (144)	I	8
8F	20.96 (0.825)	15.88 (0.625)	1,829 (72)	I	9
9F	10.49 (0.413)	7.95 (0.313)	1,829 (72)	I	10
10F	10.49 (0.413)	7.95 (0.313)	914 (36)	I	11
11F	24.51 (0.965)	18.57 (0.731)	4,277 (168.4)	I	12
12F	24.51 (0.965)	18.57 (0.731)	2,140 (84.25)	I	13
13F	20.96 (0.825)	15.88 (0.625)	3,658 (144)	O**	14
14F	20.96 (0.825)	15.88 (0.625)	1,829 (72)	O	15
15F	10.49 (0.413)	7.95 (0.313)	1,829 (72)	O	16
16F	10.49 (0.413)	7.95 (0.313)	914 (36)	O	17
17F	24.51 (0.965)	18.57 (0.731)	4,277 (168.4)	O	18
18F	24.51 (0.965)	18.57 (0.731)	2,139 (84.2)	O	19
19F	20.96 (0.825)	15.88 (0.625)	3,658 (144)	I/O***	20
20F	10.49 (0.413)	7.95 (0.313)	1,829 (72)	I/O	21
21F	24.51 (0.965)	18.57 (0.731)	4,277 (168.4)	I/O	22
24F	11.38 (0.448)	7.95 (0.313)	1,829 (72)	O	23
25F	11.38 (0.448)	7.95 (0.313)	1,829 (72)	I/O	24
26F	10.49 (0.413)	7.95 (0.313)	457 (18)	I	25
27F†	10.49 (0.413)	7.95 (0.313)	1,829 (72)	I	26
28F	9.5 (0.374)	7.95 (0.313)	1,829 (72)	O	27
29F	9.5 (0.374)	7.95 (0.313)	1,829 (72)	I	28
30F	9.5 (0.374)	7.95 (0.313)	1,829 (72)	I/O	29
31F	9.5 (0.374)	7.95 (0.313)	914 (36)	I	30

* I = internal heating

** O = external heating

*** I/O = internal and external heating

† = chopped cosine axial heat flux profile (with form factor of 1.4).

TABLE 2

Test section	code number	1 F
type	annulus	inner
mode of heating		
outer diameter mm (in)	15.88 (0.625)	
wall thickness mm (in)	1.22 (0.048)	
material	stainless steel	
bore mm (in)	22.73 (0.895)	
wall thickness mm (in)	2.11 (0.083)	
material	stainless steel	
Heater resistance (at 20 C) ohm	0.04872	
Axial heat flux profile	Uniform	

Spacer	type	cylindrical
material	Tufnol	
outer diameter mm (in)	3.35 (0.132)	
length mm (in)	12.7 (0.5)	
total number	72 (24 x 3)	
pitch mm (in)	152.4 (6.0)	
distance from heater end mm (in)	76.2 (3.0)	
configuration	and longitudinally in line	
Burnout detector	Thermopile	
Heater length mm (in)	3658 (144)	
Distance between pressure taps mm (in)	3734 (147)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux		Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹	kg s ⁻¹ m ⁻² x 10 ⁻³	lb h ⁻¹ ft ⁻² x 10 ⁻⁶	kW m ⁻² x 10 ⁻⁴	Btu h ⁻¹ ft ⁻² x 10 ⁻⁴			kPa	psi	kPa	psi	m	ft
19047109	1.043	151.33	5.30	2.28	0.703	0.518	58.45	1.853	0.548	10.66	(53.78)	(7.80)	58.67	8.51	3.392	11.13
19047107	1.043	151.33	5.35	2.30	0.703	0.518	59.24	1.878	0.556	10.81	(53.78)	(7.80)	58.67	8.51	3.392	11.13
19047105	1.043	151.33	13.35	5.74	0.703	0.518	63.69	2.019	0.536	11.62	(53.78)	(7.80)	57.43	8.33	3.045	9.99
19047103	1.043	151.33	22.52	9.68	0.704	0.519	70.28	2.228	0.528	12.82	53.78	7.80	57.43	8.33	2.719	8.92
18047107	1.043	151.33	5.28	2.27	0.934	0.689	70.41	2.232	0.500	12.85	(57.43)	(8.33)	80.26	11.64	3.365	11.04
18047105	1.043	151.33	13.37	5.75	0.934	0.689	77.13	2.445	0.485	14.07	(57.43)	(8.33)	77.22	11.20	2.981	9.78
18047103	1.043	151.33	22.79	9.80	0.934	0.689	84.51	2.679	0.465	15.41	57.43	8.33	74.46	10.80	2.606	8.55
19047112	1.043	151.33	23.70	10.19	1.393	1.027	112.3	3.560	0.401	20.49	65.91	9.56	110.66	16.05	2.432	7.98
19047113	1.043	151.33	23.63	10.16	1.393	1.027	112.27	3.559	0.401	20.48	(65.91)	(9.56)	110.66	16.05	2.435	7.99
19047115	1.043	151.33	13.86	5.96	1.394	1.028	101.07	3.204	0.425	18.44	(65.91)	(9.56)	121.00	17.55	2.859	9.38
19047118	1.043	151.33	5.12	2.20	1.394	1.028	92.90	2.945	0.456	16.95	(65.91)	(9.56)	134.72	19.54	3.338	10.95
19047121	1.043	151.33	5.70	2.45	2.749	2.027	121.63	3.862	0.353	22.22	81.98	11.89	316.33	45.88	3.121	10.24
19047124	1.043	151.33	13.72	5.90	2.749	2.027	135.81	4.305	0.313	24.78	(81.98)	(11.89)	286.69	38.68	2.499	8.20
19047127	1.043	151.33	22.89	9.84	2.750	2.028	154.1	4.885	0.271	27.94	(81.98)	(11.89)	219.60	31.85	1.945	6.38

TABLE 3(i)

Test section	code number type mode of heating	2 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	15.88 (0.625) 1.22 (0.048) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	22.73 (0.895) 2.11 (0.083) stainless steel
Heater resistance (at 20 C) ohm	0.0245	
Axial heat flux profile	Uniform	

Spacer	type material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	cylindrical Tufnol 3.55 (0.132) 12.7 (0.5) 36 (12 x 3) 152.4 (6.0) 76.2 (3.0) and longitudi- nally in line
Burnout detector	Thermopile	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run Number	Inlet Pressure		Inlet Subcooling kJ kg ⁻¹ Btu lb ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Velocity lb h ⁻¹ ft ⁻² x 10 ⁻⁶	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop			Boiling Length		
	MPa	psia							Zero Power kPa	psi	With Power kPa	psi	m	ft
11087002	1.040	150.82	21.12	0.690	0.509	115.40	0.419	10.53	27.37	3.97	28.13	4.08	1.301	4.27
11087001	1.040	150.82	21.12	0.690	0.509	115.17	0.418	10.50	27.37	3.97	28.13	4.08	1.301	4.27
11087003	1.040	150.82	15.61	0.692	0.510	108.23	0.426	9.87	26.96	3.91	28.48	4.13	1.414	4.64
11087004	1.040	150.82	15.61	0.693	0.511	108.77	0.428	9.92	26.96	3.91	28.48	4.13	1.414	4.64
11087005	1.043	151.33	8.28	0.693	0.511	100.28	0.443	9.15	26.48	3.84	28.61	4.15	1.591	5.22
11087006	1.043	151.33	8.75	0.694	0.512	99.50	0.435	9.08	26.48	3.84	28.75	4.17	1.573	5.16
5087006	1.043	151.33	22.56	1.397	1.03	164.32	0.243	14.99	32.68	4.74	46.40	6.73	1.030	3.38
5087007	1.043	151.33	9.70	1.397	1.03	140.41	0.287	12.81	32.41	4.70	53.71	7.79	1.426	4.68
5087005	1.040	150.82	22.61	1.397	1.03	167.79	0.252	13.31	32.68	4.74	47.30	6.86	1.045	3.43
6087001	1.043	151.33	4.21	1.397	1.03	129.02	0.303	11.77	31.65	4.59	56.12	8.14	1.640	5.38
6087002	1.043	151.33	4.21	1.397	1.03	128.14	0.301	11.69	31.65	4.59	56.12	8.14	1.637	5.37
5087008	1.040	150.82	9.77	1.397	1.03	141.36	0.289	12.89	32.41	4.70	54.33	7.88	1.426	4.68
17087002	1.043	151.33	20.96	1.753	2.03	207.67	0.122	18.94	48.54	7.04	79.84	11.58	0.671	2.20
17087003	1.047	151.83	13.61	1.756	2.032	192.08	0.165	17.52	48.54	7.04	97.49	14.14	1.015	3.33
17087001	1.047	151.83	21.10	1.756	2.032	206.88	0.119	18.87	48.54	7.04	78.05	11.32	0.658	2.16
17087004	1.043	151.33	13.40	1.756	2.032	195.05	0.160	16.88	48.54	7.04	104.18	15.11	0.997	3.27
6087004	1.043	151.33	23.03	1.757	2.033	213.19	0.112	19.45	49.92	7.24	79.57	11.54	0.588	1.93
6087003	1.040	150.82	22.42	1.757	2.033	214.07	0.117	19.52	49.92	7.24	78.32	11.36	0.625	2.05
6087005	1.043	151.33	8.75	1.761	2.036	173.41	0.185	15.82	49.16	7.13	115.14	16.70	1.247	4.09
6087006	1.047	151.83	9.03	1.761	2.036	175.30	0.185	15.99	49.16	7.13	113.97	16.53	1.237	4.06
6087008	1.043	151.33	3.95	1.761	2.036	166.44	0.219	15.18	50.06	7.26	136.17	19.75	1.554	5.10
6087007	1.043	151.33	3.95	1.763	2.037	166.59	0.218	15.20	50.06	7.26	132.52	19.22	1.554	5.10

TABLE 3 (ii)

Run Number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop			Boiling Length		
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹	kg s ⁻¹ m ⁻² x 10 ⁻³	lb h ⁻¹ ft ⁻² x 10 ⁻⁶				kPa	psi	With Power kPa	psi	m	ft
18087002	1.043	151.33	13.21	5.68	4.143	3.055	213.00	0.137	19.43	77.15	11.19	192.43	27.91	0.756	2.48
27107003	1.043	151.33	9.21	3.96	4.143	3.055	209.37	0.172	19.10	74.39	10.79	215.33	31.26	1.067	3.50
27107005	1.043	151.33	7.54	3.24	4.143	3.055	198.93	0.185	18.14	74.39	10.79	242.90	35.23	1.173	3.85
7087002	1.043	151.33	22.79	9.80	4.150	3.060	255.30	0.075	23.29	80.81	11.72	123.07	17.85	0.283	0.93
7087001	1.043	151.33	22.79	9.80	4.150	3.060	255.11	0.075	23.27	80.81	11.72	124.86	18.11	0.280	0.92
18087001	1.043	151.33	13.21	5.68	4.161	3.068	216.00	0.139	19.70	77.15	11.19	192.43	27.91	0.768	2.52
17087006	1.040	150.82	20.52	8.82	4.166	3.072	242.94	0.085	22.16	78.05	11.32	132.79	19.26	0.363	1.19
17087007	1.040	150.82	20.17	8.67	4.166	3.072	239.56	0.084	21.85	78.05	11.32	130.38	18.91	0.366	1.20

TABLE 4

Test section	code number	3F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	11.38 (0.448) 0.61 (0.024) stainless steel
Heater resistance (at 20 C) ohm	0.0663	
Axial heat flux profile	Uniform	

Spacer	type material	outer diameter mm (in)	length mm (in)	total number	pitch mm (in)	distance from heater end mm (in)	configuration
	cylindrical Degussit Al 23	12.7 (0.5)	36 (12 x 3)	152.4 (6.0)	76.2 (3.0)	and longitudinally in line	
Burnout detector	Resistance Type						
Heater Length mm (in)	1829 (72)						
Distance between pressure taps mm (in)	1905 (75)						

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻²	Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	Zero Power psi	With Power kPa	With Power psi	m	ft
18037105	1.043	151.33	22.79	9.80	0.705	66.06	0.479	3.02	29.10	4.22	39.09	5.67	1.32	4.34
18037110	1.043	151.33	6.42	2.76	0.705	54.83	0.498	2.50	(29.10)	(4.22)	41.85	6.07	1.66	5.43
18037108	1.043	151.33	14.35	6.17	0.705	59.75	0.484	2.73	(29.10)	(4.22)	39.99	5.80	1.48	4.84
18037113	1.043	151.33	24.52	10.54	1.397	109.94	0.374	5.02	40.33	5.85	81.98	11.89	1.18	3.87
18037115	1.043	151.33	14.00	6.02	1.397	93.85	0.380	4.29	(40.33)	(5.85)	93.22	13.52	1.40	4.58
18037117	1.043	151.33	5.44	2.34	1.397	84.20	0.403	3.85	(40.33)	(5.85)	104.80	15.20	1.64	5.38
18037119	1.043	151.33	5.05	2.17	1.397	81.51	0.392	3.72	(40.33)	(5.85)	102.66	14.89	1.65	5.41
18037121	1.043	151.33	24.17	10.39	2.824	162.34	0.260	7.42	85.98	12.47	174.16	25.26	0.95	3.12
18037123	1.043	151.33	14.26	6.13	2.824	136.50	0.286	6.23	(85.98)	(12.47)	215.26	31.22	1.21	3.98
18037125	1.054	152.84	6.91	2.97	2.824	121.01	0.321	5.53	(85.98)	(12.47)	267.24	38.76	1.49	4.90
18037127	1.043	151.33	6.47	2.78	2.824	120.92	0.326	5.52	(85.98)	(12.47)	273.31	39.64	1.51	4.97

TABLE 5

Test section	code number	4 F annulus inner
Spacer	type material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	annulus inner 7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	11.38 (0.448) 0.61 (0.024) stainless steel
Heater resistance (at 20 C) ohm	0.0325	
Axial heat flux profile	Uniform	

Spacer	type material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	axial heat flux profile
Spacer	cylindrical Degussit Al 23 1.7 (0.067) 12.7 (0.5) 18 (6 x 3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line	Uniform
Burnout detector	Thermopile and resistance type	
Heater Length mm (in)	914 (36)	
Distance between pressure taps mm (in)	980 (39)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux Btu h ⁻¹ ft ⁻² x10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	psi	With Power kPa	psi	m	ft
6057107	1.043	151.33	6.68	2.87	0.701	87.76	0.387	2.00	(14.27)	(2.07)	20.35	2.952	0.802	2.63
5057105	1.043	151.33	24.45	10.51	0.705	109.40	0.350	2.50	(14.89)	(2.16)	19.14	2.776	0.565	1.92
6057102	1.043	151.33	14.17	6.09	0.705	95.96	0.365	2.19	(14.89)	(2.16)	19.75	2.864	0.698	2.29
6057104	1.043	151.33	14.07	6.05	0.705	99.15	0.381	2.26	(14.89)	(2.16)	20.05	2.908	0.704	2.31
5057103	1.043	151.33	24.35	10.47	0.705	109.28	0.350	2.50	14.89	2.16	19.14	2.776	0.585	1.92
6057110	1.043	151.33	23.03	9.90	1.390	168.3	0.250	3.84	20.68	3.00	39.82	5.776	0.518	1.70
6057112	1.043	151.33	23.07	9.92	1.390	173.16	0.261	3.95	(20.68)	(3.00)	39.82	5.776	0.527	1.73
6057114	1.043	151.33	13.33	5.73	1.393	150.86	0.283	3.44	(20.68)	(3.00)	45.91	6.659	0.658	2.16
6057116	1.043	151.33	4.47	1.92	1.396	132.59	0.309	3.03	(20.68)	(3.00)	51.99	7.541	0.817	2.68
7057103	1.043	151.33	24.07	10.35	2.809	250.66	0.146	5.72	41.78	6.06	83.32	12.085	0.354	1.16
7057105	1.043	151.33	24.05	10.34	2.809	245.52	0.138	5.61	(41.78)	(6.06)	77.85	11.291	0.341	1.12
7057107	1.043	151.33	13.49	5.80	2.813	200.73	0.172	4.58	(41.78)	(6.06)	98.23	14.247	0.521	1.71
7057109	1.043	151.33	13.47	5.79	2.813	199.69	0.170	4.56	(41.78)	(6.06)	96.71	14.027	0.518	1.70
7057111	1.043	151.33	4.93	2.12	2.817	162.62	0.198	3.71	(41.78)	(6.06)	119.22	17.292	0.738	2.42
7057113	1.043	151.33	4.86	2.09	2.817	164.35	0.201	3.75	(41.78)	(6.06)	121.05	17.556	0.741	2.43

TABLE 6

Test section	code number	5 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	26.59 (1.047) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm	0.046	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Tufool
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	3.94 (0.155) 12.7 (0.5) 84 (28 x 3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Thermopile	
Heater length mm (in)	4277 (168.4)	
Distance between pressure taps mm (in)	4353 (171.4)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Flux Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	Zero Power psi	With Power kPa	With Power psi	m	ft
22047110	1.043	151.33	5.12	2.20	1.071	77.00	0.480	19.22	(65.02)	(9.43)	93.56	13.57	3.929	12.89
22047105	1.043	151.33	13.21	5.68	1.071	82.71	0.452	20.63	(65.02)	(9.43)	87.77	12.73	3.441	11.29
22047108	1.043	151.33	4.86	2.09	1.071	75.55	0.473	18.85	(65.02)	(9.43)	92.39	13.40	3.941	12.93
22047103	1.043	151.33	22.79	9.80	1.073	91.80	0.434	22.90	65.02	9.43	85.08	12.34	2.978	9.77
22047113	1.043	151.33	5.51	2.37	2.103	106.88	0.364	26.67	91.77	13.31	199.74	28.97	3.749	12.30
22047115	1.043	151.33	12.82	5.51	2.103	117.82	0.339	29.40	(91.77)	(13.31)	185.47	26.90	3.161	10.37
22047117	1.043	151.33	23.70	10.19	2.106	134.61	0.302	33.58	(91.77)	(13.31)	159.89	23.19	2.466	8.09
22047119	1.043	151.33	23.70	10.19	2.106	134.67	0.302	33.60	(91.77)	(13.31)	159.61	23.15	2.469	8.10
23047111	1.043	151.33	22.98	9.88	2.938	161.26	0.283	40.23	(130.38)	(18.91)	280.69	40.71	2.234	7.33
23047109	1.043	151.33	12.51	5.38	2.938	155.93	0.317	33.92	(130.38)	(18.91)	320.54	46.49	2.957	9.70
23047107	1.043	151.33	12.61	5.42	2.938	158.99	0.315	33.93	(130.38)	(18.91)	316.54	45.91	2.947	9.67
23047105	1.043	151.33	5.65	2.43	2.942	118.64	0.337	29.60	(130.38)	(18.91)	348.53	50.55	3.594	11.79
23047103	1.043	151.33	5.84	2.51	2.942	119.05	0.338	29.71	130.38	18.91	352.19	51.08	3.575	11.73

TABLE 7

Test section	code number	6 F annulus inner
Inner rod	type mode of heating outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	26.59 (1.047) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm		0.022
Axial heat flux profile		Uniform

Spacer	type material	cylindrical Tufrol
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	3.94 (0.155) 12.7 (0.5) 42 (14 x 3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Thermopile	
Heater Length mm (in)		2139 (84.2)
Distance between pressure taps mm (in)		2215 (87.25)

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux		Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg^{-1}	Btu lb^{-1}	$\text{kg s}^{-1} \text{m}^{-2} \times 10^{-3}$	$\text{lb h}^{-1} \text{ft}^{-2} \times 10^{-6}$	kW m^{-2}	$\text{Btu h}^{-1} \text{ft}^{-2} \times 10^{-4}$			Zero Power kPa	Zero Power psi	With Power kPa	With Power psi	m	ft
3057109	1.043	151.33	14.05	6.04	1.073	0.791	128.99	4.089	0.317	16.10	(34.06)	(4.94)	41.37	6.00	1.570	5.15
3057107	1.043	151.33	14.17	6.09	1.073	0.791	128.99	4.089	0.316	16.10	(34.06)	(4.94)	41.09	5.96	1.564	5.13
3057105	1.043	151.33	23.40	10.06	1.073	0.791	143.57	4.551	0.290	17.92	(34.06)	(4.94)	39.37	5.71	1.286	4.22
3057103	1.043	151.33	23.59	10.14	1.073	0.791	145.74	4.620	0.295	18.19	(34.06)	(4.94)	39.37	5.71	1.292	4.24
3057111	1.043	151.33	5.75	2.47	1.073	0.791	114.35	3.625	0.336	14.27	(34.06)	(4.94)	42.89	6.22	1.878	6.16
3057113	1.043	151.33	5.44	2.34	1.073	0.791	114.92	3.643	0.340	14.35	(34.06)	(4.94)	43.23	6.27	1.893	6.21
4057112	1.043	151.33	5.02	2.16	2.095	1.545	154.01	4.882	0.241	19.23	(42.47)	(6.16)	87.01	12.62	1.807	5.93
4057105	1.043	151.33	21.77	9.36	2.095	1.545	183.91	5.830	0.152	22.96	(42.89)	(6.22)	62.05	9.00	0.930	3.05
4057109	1.043	151.33	13.61	5.85	2.097	1.546	168.01	5.326	0.192	20.97	(42.47)	(6.16)	71.98	10.44	1.311	4.30
4057103	1.043	151.33	22.05	9.48	2.097	1.546	183.00	5.801	0.148	22.84	(42.89)	(6.22)	62.05	9.00	0.905	2.97
4057120	1.043	151.33	13.26	5.70	4.149	3.059	211.17	6.694	0.127	26.36	(56.88)	(8.25)	168.23	24.40	0.869	2.85
4057118	1.043	151.33	13.51	5.81	4.149	3.059	216.34	6.858	0.129	27.01	(56.88)	(8.25)	166.72	24.18	0.875	2.87
4057116	1.043	151.33	4.26	1.83	4.151	3.061	193.53	6.135	0.214	24.16	(56.88)	(8.25)	270.41	39.22	1.695	5.56
4057114	1.043	151.33	4.61	1.98	4.151	3.061	192.53	6.103	0.210	24.03	(56.88)	(8.25)	268.00	38.87	1.655	5.43
4057122	1.043	151.33	23.54	10.12	4.151	3.061	245.71	7.789	0.058	30.67	(56.88)	(8.25)	113.76	16.50	0.198	0.65

TABLE 8

Test section	code number type mode of heating	7 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	15.88 (0.625) 1.22 (0.048) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	20.96 (0.825) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm		0.0489
Axial heat flux profile		Uniform

Spacer	type material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	cylindrical Tufnol 2.46 (0.097) 12.7 (0.5) 72 (24 x 3) 152.4 (6.0) 76.2 (3.0) and longitudi- nally in line
Burnout detector	Thermopile	
Heater Length mm (in)		3658 (144)
Distance between pressure taps mm (in)		3734 (147)

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity $\text{kg s}^{-1}\text{m}^{-2} \times 10^{-3}$	Burnout Flux $\text{Btu ft}^{-2} \times 10^{-4}$	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length		
	MPa	psia	kJ kg^{-1}	Btu lb^{-1}					Zero Power kPa	With Power psi	m	ft	
21127003	1.043	151.33	22.68	9.75	0.662	52.21	0.609	9.52	34.40	7.89	61.71	2.810	9.22
21127006	1.043	151.33	13.26	5.70	0.662	48.01	0.620	8.76	53.78	7.80	59.23	3.121	10.24
21127009	1.043	151.33	5.30	2.28	0.662	43.15	0.606	7.87	48.61	7.05	35.85	3.417	11.21
21127019	1.043	151.33	4.91	2.11	1.317	69.12	0.506	12.61	65.36	9.48	124.93	3.383	11.10
21127012	1.043	151.33	22.98	9.88	1.320	80.13	0.432	14.62	61.71	8.95	71.43	2.542	8.34
21127015	1.043	151.33	13.03	5.60	1.322	72.05	0.459	13.15	60.61	8.79	107.63	2.954	9.69
23127006	1.043	151.33	13.84	5.95	2.144	88.30	0.353	16.11	85.08	12.34	208.02	2.667	8.75
23127003	1.043	151.33	23.07	9.92	2.146	97.73	0.319	17.83	89.98	13.05	189.47	2.167	7.11
23127009	1.043	151.33	4.40	1.89	2.147	82.97	0.410	15.13	87.84	12.74	242.97	3.322	10.90
21127027	1.043	151.33	13.40	5.76	2.660	101.10	0.339	18.45	100.04	14.51	249.66	2.618	8.59
21127023	1.043	151.33	23.98	10.31	2.668	111.07	0.276	20.26	96.39	13.98	193.54	1.960	6.43
6017105	1.043	151.33	6.95	2.99	2.678	101.42	0.410	18.50	99.70	14.46	337.02	3.118	10.23
6017103	1.043	151.33	6.49	2.79	2.680	94.10	0.388	17.17	99.70	14.46	334.26	3.112	10.21

TABLE 9

Test section	code number	8 F annulus inner
Inner rod	type of heating outer diameter mm (in) wall thickness mm (in) material	15.88 (0.625) 1.22 (0.048) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	20.96 (0.825) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm	0.02418	
Axial heat flux profile	Uniform	

Spacer	type material	outer diameter mm (in)	length mm (in)	total number	pitch mm (in)	distance from heater end mm (in)	configuration
	cylindrical Tufnol	2.46 (0.097)	12.7 (0.5)	36 (12 x 3)	152.4 (6.0)	76.2 (3.0)	and longitudinally in line
Burnout detector	Thermopile						
Heater Length mm (in)	1829 (72)						
Distance between pressure taps mm (in)	1905 (75)						

Run Number	Inlet Pressure		Inlet Subcooling kJ kg ⁻¹	Mass Velocity kg m ⁻² x 10 ⁻³	Burnout Flux kW m ⁻²	Burnout Flux Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia							Zero Power kPa	psi	With Power kPa	psi	m	ft
3097030	1.043	151.33	21.21	0.677	86.91	2.755	0.470	7.93	28.06	4.07	32.54	4.72	1.341	4.40
3097032	1.043	151.33	21.17	0.677	85.68	2.716	0.462	7.82	28.06	4.07	32.13	4.66	1.335	4.38
3097039	1.043	151.33	13.61	0.678	79.87	2.532	0.478	7.28	27.51	3.99	32.68	4.74	1.487	4.88
3097037	1.043	151.33	13.49	0.678	78.45	2.487	0.469	7.16	27.51	3.99	32.89	4.77	1.484	4.87
3097044	1.043	151.33	4.79	0.679	71.10	2.254	0.484	6.49	27.03	3.92	33.65	4.88	1.695	5.56
3097046	1.043	151.33	4.75	0.679	71.04	2.252	0.484	6.48	27.03	3.92	33.72	4.89	1.695	5.56
4097022	1.043	151.33	4.68	1.360	107.60	3.411	0.371	9.82	34.27	4.97	75.15	10.90	1.655	5.43
4097007	1.043	151.33	21.40	1.360	132.43	4.198	0.326	12.08	35.39	5.13	63.29	9.18	1.183	3.88
4097015	1.043	151.33	13.93	1.360	122.37	3.879	0.350	11.16	34.82	5.05	68.33	9.91	1.372	4.50
4097006	1.043	151.33	21.63	1.362	134.39	4.260	0.331	12.26	35.37	5.13	62.95	9.13	1.183	3.88
4097013	1.043	151.33	14.19	1.362	122.68	3.889	0.349	11.19	34.82	5.05	67.98	9.86	1.366	4.48
4097020	1.043	151.33	4.84	1.363	106.53	3.377	0.366	9.72	34.27	4.97	75.29	10.92	1.646	5.40
4097028	1.043	151.33	22.14	2.702	173.91	5.513	0.175	15.86	55.23	8.01	107.21	15.55	0.814	2.67
4097030	1.043	151.33	22.17	2.702	173.66	5.505	0.174	15.84	55.23	8.01	106.94	15.51	0.814	2.67
4097036	1.043	151.33	13.91	2.703	153.76	4.874	0.208	14.03	54.33	7.88	126.73	18.38	1.109	3.64
4097038	1.043	151.33	13.79	2.703	154.01	4.882	0.209	14.05	54.33	7.88	126.38	18.33	1.116	3.66
4097044	1.043	151.33	5.42	2.703	139.24	4.414	0.256	12.70	54.61	7.92	154.37	22.39	1.518	4.98
4097046	1.043	151.33	5.56	2.703	137.48	4.358	0.252	12.54	54.61	7.92	153.75	22.30	1.506	4.94
20107008	1.043	151.33	13.30	4.033	178.80	5.668	0.182	16.31	81.70	11.85	216.77	31.44	0.945	3.10
20107010	1.043	151.33	13.70	4.033	178.74	5.666	0.179	16.30	81.70	11.85	218.29	31.66	0.917	3.01
20107012	1.043	151.33	20.79	4.033	198.65	6.297	0.133	18.12	81.70	11.85	169.89	24.64	0.585	1.92
20107014	1.043	151.33	5.16	4.033	152.15	4.823	0.234	13.88	81.70	11.85	285.79	41.45	1.426	4.68

TABLE 10

Test section	code number type, mode of heating	9 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.413) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.065	
Axial heat flux profile	Uniform	

Spacer	type material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	cylindrical Degussit Al 23 1.27 (0.05) 12.7 (0.5) 36 (12x3) 152.4 (6.0) 76.2 (3.0) and longitudi- nally in line
Burnout detector	Thermopile and resistance type	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻²	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	With Power kPa	psi	psi	m	ft
1127106	1.049	152.2	5.47	2.35	1.366	61.11	0.428	2.79	42.7	6.2	128.4	18.62	1.65	5.41
1127107	1.043	151.26	15.49	6.66	1.363	71.58	0.422	3.27	(42.7)	(6.2)	116.8	16.94	1.39	4.57
2127102	1.039	150.69	25.19	10.83	1.362	82.34	0.420	3.76	(42.7)	(6.2)	108.2	15.70	1.21	3.98
9127101	1.045	151.56	6.05	2.60	1.366	60.01	0.416	2.74	(42.7)	(6.2)	128.7	18.67	1.62	5.33
9127102	1.047	151.81	15.00	6.45	1.363	69.69	0.413	3.18	(42.7)	(6.2)	117.8	17.08	1.40	4.58
9127103	1.049	152.2	24.86	10.69	1.370	80.19	0.405	3.66	(42.7)	(6.2)	108.0	15.66	1.20	3.94
29117101	1.040	150.88	14.28	6.14	2.009	81.48	0.329	3.72	64.8	9.4	159.3	23.11	1.31	4.29
29117103	1.043	151.26	24.91	10.71	2.014	104.73	0.356	4.78	(64.8)	(9.4)	159.3	23.11	1.12	3.68
1127102	1.037	150.46	14.40	6.19	2.022	85.11	0.358	3.88	(64.8)	(9.4)	215.5	31.26 *	1.32	4.34
1127103	1.042	151.07	4.09	1.76	2.004	66.53	0.363	3.04	(64.8)	(9.4)	245.7	35.63 *	1.65	5.40
1127104	1.045	151.54	23.35	10.04	2.032	103.22	0.368	4.71	(64.8)	(9.4)	196.1	28.44 *	1.15	3.77
10127102	1.042	151.07	2.37	1.02	2.013	65.02	0.368	2.97	(64.8)	(9.4)	250.5	36.33 *	1.72	5.65
15127101	1.041	151.01	5.07	2.18	2.003	68.45	0.364	3.12	(64.8)	(9.4)	247.5	35.89 *	1.61	5.28
15127102	1.047	151.79	16.17	6.95	2.017	89.53	0.367	4.09	(64.8)	(9.4)	214.5	31.11 *	1.29	4.23
15127103	1.044	151.45	24.21	10.41	1.995	104.32	0.375	4.76	(64.8)	(9.4)	193.1	28.0 *	1.15	3.76
30117106	1.048	151.98	24.96	10.73	2.654	120.66	0.328	5.51	(93.1)	(13.5)	271.8	39.42 *	1.02	3.34
15127105	1.040	150.88	8.54	3.67	2.632	79.50	0.333	3.63	93.1	13.5	350.6	50.85 *	1.41	4.63

*estimate

TABLE 11

Test section	code number	10 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.51 (0.02) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.413) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.06	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Degussit Al 23
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	1.27 (0.05) 12.7 (0.5) 18 (6x3) 152.4 (6.0) 76.2 (3.0) A and longitudinally in line
Burnout detector	Thermocouple	
Heater Length mm (in)	914 (36)	
Distance between pressure taps mm (in)	980 (39)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Flux kW m ⁻²	Exit Quality	Power kW	Test Section Pressure Drop			Boiling Length		
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	psi	With Power kPa	psi	m	ft
17117003	1.043	151.33	23.68	10.18	0.681	96.85	0.517	2.21	15.51	2.25	25.99	3.769	0.671	2.20
18117003	1.043	151.33	14.05	6.04	0.681	87.10	0.523	1.99	15.17	2.20	27.35	3.967	0.753	2.47
18117006	1.043	151.33	4.00	1.72	0.682	79.46	0.547	1.81	15.17	2.20	29.33	4.254	0.863	2.83
18117013	1.043	151.33	13.54	5.82	1.032	128.17	0.514	2.93	17.79	2.58	49.86	7.232	0.753	2.47
18117017	1.043	151.33	22.86	9.83	1.032	130.88	0.452	2.99	18.41	2.67	41.95	6.085	0.649	2.13
18117023	1.043	151.33	4.61	1.98	1.033	114.95	0.522	2.63	17.93	2.60	53.06	7.695	0.853	2.80
18117020	1.043	151.33	13.51	5.81	1.033	120.47	0.477	2.75	18.41	2.67	46.52	6.747	0.744	2.44
19117022	1.043	151.33	23.14	9.95	1.389	138.68	0.323	3.17	22.82	3.31	56.71	8.225	0.573	1.88
19117019	1.043	151.33	13.40	5.76	1.391	125.52	0.354	2.87	22.20	3.22	64.77	9.394	0.695	2.28
19117017	1.043	151.33	5.30	2.28	1.393	116.75	0.389	2.67	21.58	3.13	74.05	10.740	0.820	2.69
19117028	1.043	151.33	13.91	5.98	2.712	175.05	0.254	4.00	50.75	7.36	153.29	22.233	0.597	1.96
20117003	1.043	151.33	4.21	1.81	2.712	137.82	0.274	3.15	50.19	7.28	192.54	27.925	0.792	2.60
19117025	1.043	151.33	23.47	10.09	2.712	202.87	0.220	4.63	50.75	7.36	123.78	17.953	0.454	1.49
20117005	1.043	151.33	4.02	1.73	3.572	137.70	0.252	3.14	77.57	11.25	304.78	44.205	0.759	2.49
20117007	1.043	151.33	14.35	6.17	3.574	186.34	0.209	4.26	75.57	10.96	210.18	30.484	0.509	1.67
20117009	1.043	151.33	24.07	10.35	3.574	226.09	0.174	5.16	73.29	10.63	167.59	24.307	0.354	1.16

TABLE 12

Test section	code number	11F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	24.51 (0.965) 1.27 (0.05) stainless steel
Heater resistance (at 20 C) ohm	0.046	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Tufnol
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	2.9 (0.116) 12.7 (0.5) 84 (28x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Thermopile	
Heater Length mm (in)	4277 (168.4)	
Distance between pressure taps mm (in)	4353 (171.4)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Velocity lb ft ⁻¹ s ⁻¹ x 10 ⁻⁶	Burnout Flux Btu ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹						Zero Power kPa	Zero Power psi	With Power kPa	With Power psi	m	ft
9017109	1.043	151.33	4.61	1.98	0.662	0.488	43.75	0.623	10.92	49.16	7.13	54.47	7.90	4.039	13.25
9017105	1.043	151.33	13.56	5.83	0.665	0.490	48.01	0.612	11.98	46.75	6.78	52.54	7.62	3.630	11.91
9017103	1.043	151.33	23.63	10.16	0.665	0.490	52.81	0.604	13.18	47.64	6.91	52.68	7.64	3.252	10.67
9017112	1.043	151.33	23.70	10.19	1.316	0.970	83.79	0.457	20.91	69.84	10.13	79.01	11.46	2.993	9.82
9017114	1.043	151.33	14.12	6.07	1.316	0.970	73.91	0.469	18.44	71.09	10.31	119.76	17.37	3.411	11.19
9017116	1.043	151.33	4.63	1.99	1.316	0.970	70.66	0.521	17.63	71.98	10.44	127.97	18.56	3.981	13.06
18027105	1.043	151.33	14.96	6.43	2.140	1.578	86.37	0.336	21.55	89.29	12.95	204.64	29.68	3.002	9.85
18027103	1.043	151.33	23.68	10.18	2.140	1.578	97.70	0.312	24.38	92.05	13.35	176.64	25.62	2.490	8.17
18027107	1.043	151.33	4.51	1.94	2.140	1.578	76.44	0.378	19.07	86.25	12.51	229.25	33.25	3.840	12.60
17027106	1.043	151.33	14.44	6.21	2.673	1.971	95.43	0.310	23.81	104.80	15.20	232.63	33.74	2.883	9.46
17027104	1.043	151.33	23.68	10.18	2.676	1.973	109.65	0.282	27.36	106.52	15.45	224.70	32.59	2.286	7.50
17027111	1.043	151.33	4.19	1.80	2.711	1.999	84.48	0.364	21.08	104.25	15.12	320.82	46.53	3.813	12.51

TABLE 13

Test section	code number	12 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	24.51 (0.965) 1.27 (0.05) stainless steel
Heater resistance (at 20 C) ohm	0.022	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Tufnol
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	3.66 (0.144) 12.7 (0.5) 42 (14x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Thermopile	
Heater Length mm (in)	2140 (84.25)	
Distance between pressure taps mm (in)	2216 (87.25)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity $\frac{\text{kg}}{\text{s} \cdot \text{m}^2} \times 10^{-3}$	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	Mpa	psia	$\frac{\text{kJ}}{\text{kg}} \cdot \text{kg}^{-1}$	Btu lb ⁻¹				Zero Power kPa	psi	With Power kPa	psi	m	ft
28117003	1.043	151.33	22.75	9.78	0.685	0.464	11.08	31.65	4.59	33.30	4.83	1.533	5.03
28117006	1.043	151.33	13.49	5.80	0.685	0.481	10.11	30.75	4.46	33.78	4.90	1.747	5.73
28117009	1.043	151.33	5.02	2.16	0.686	0.488	9.05	30.20	4.38	34.06	4.94	1.975	6.48
28117019	1.043	151.33	4.33	1.86	1.356	0.370	13.27	37.03	5.37	72.12	10.46	1.951	6.40
28117015	1.043	151.33	12.82	5.51	1.360	0.341	14.67	37.58	5.43	66.60	9.66	1.628	5.34
28117012	1.043	151.33	23.40	10.06	1.364	0.321	16.99	38.34	5.56	59.92	8.69	1.332	4.37
29117009	1.043	151.33	5.23	2.25	2.684	0.248	17.05	52.95	7.68	133.28	19.33	1.786	5.86
29117006	1.043	151.33	13.84	5.95	2.689	0.204	18.96	54.12	7.85	118.04	17.12	1.295	4.25
29117003	1.043	151.33	21.49	9.24	2.693	0.166	20.86	53.85	7.81	99.91	14.49	0.945	3.10
29117018	1.043	151.33	23.66	10.17	4.024	0.110	25.49	82.12	11.91	145.41	21.09	0.533	1.75
29117014	1.043	151.33	13.75	5.91	4.025	0.174	22.54	81.84	11.87	195.61	28.37	1.082	3.55
29117012	1.043	151.33	5.42	2.33	4.028	0.229	19.28	83.36	12.09	268.00	38.87	1.652	5.42

TABLE 14

Test section	code number	13F annulus outer	Spacer	type material	cylindrical Tufnol
Inner rod	mode of heating	15.88 (0.625) 1.22 (0.048) stainless steel	outer diameter mm (in) wall thickness mm (in) material	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	2.46 (0.097) 12.7 (0.5) 72 (28x3) 152.4 (6.0) 76.2 (3.0) A and longitudinal-nally in line
Shroud	bore mm (in) wall thickness mm (in) material	20.96 (0.825) 1.78 (0.07) stainless steel		Resistance type	
Heater resistance (at 20 C) ohm	0.0489		Heater Length mm (in)	3658 (144)	
Axial heat flux profile	Uniform		Distance between pressure taps mm (in)	3734 (147)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity $\text{kg s}^{-1} \text{m}^{-2} \times 10^{-3}$	Burnout Flux kW m^{-2}	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg^{-1}	Btu lb ⁻¹					Zero Power kPa	psi	With Power kPa	psi	m	ft
25027103	1.043	151.33	22.69	9.75	0.682	49.78	0.781	11.99	60.47	8.77	79.91	11.59	2.97	9.73
25027113	1.043	151.33	4.79	1.06	0.682	41.92	0.773	10.10	53.16	7.71	77.98	11.31	3.48	11.43
25027109	1.043	151.33	14.26	6.13	0.682	46.21	0.778	11.13	55.02	7.98	76.88	11.15	3.19	10.46
25027105	1.043	151.33	22.77	9.79	0.682	49.84	0.780	12.00	60.47	8.77	79.91	11.59	2.96	9.72
25027118	1.043	151.33	23.21	9.98	1.364	73.22	0.545	17.63	68.67	9.96	143.55	20.82	2.69	8.83
25027122	1.043	151.33	14.35	6.17	1.364	67.95	0.568	16.36	68.19	9.89	158.72	23.02	3.01	9.89
25027126	1.043	151.33	4.49	1.93	1.364	60.63	0.580	14.60	67.02	9.72	173.96	25.23	3.43	11.26
26027103	1.043	151.33	5.44	2.34	2.544	78.42	0.454	18.89	103.97	15.08	362.87	52.63	3.26	10.71
26027105	1.043	151.33	6.61	2.84	2.544	81.01	0.456	19.50	103.97	15.08	357.70	51.88	3.19	10.48
26027107	1.043	151.33	13.07	5.62	2.546	82.30	0.399	19.82	100.32	14.55	302.89	43.93	2.76	9.04
26027109	1.043	151.33	23.54	10.12	2.546	92.97	0.358	22.39	101.56	14.73	250.01	36.26	2.22	7.28
26027111	1.043	151.33	13.75	5.91	2.546	83.50	0.399	20.11	100.32	14.55	300.48	43.58	2.72	8.93

TABLE 15

Test section	code number	14F annulus outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	15.88 (0.625) 1.22 (0.048) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	20.96 (0.825) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm		
Axial heat flux profile		

Spacer	type material	cylindrical Tufnol
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	2.46 (0.097) 12.7 (0.5) 36 (12x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Thermocouple	
Heater Length mm (in)		
Distance between pressure taps mm (in)		

Run Number	Inlet Pressure		Inlet Subcooling kJ kg ⁻¹ Btu lb ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia						Zero Power kPa psi	With Power kPa psi	m	ft		
16097019	1.043	151.33	4.88	1.374	105.25	0.479	12.67	34.68	5.03	89.63	13.00	1.69	5.53
16097009	1.043	151.33	21.49	1.374	124.48	0.436	14.99	35.65	5.17	75.91	11.01	1.30	4.26
16097014	1.043	151.33	13.58	1.377	113.63	0.448	13.68	35.23	5.11	82.46	11.96	1.46	4.80
22107003	1.043	151.33	5.05	2.697	134.10	0.331	16.15	51.57	7.48	174.78	25.35	1.60	5.26
16097025	1.043	151.33	21.05	2.710	159.78	0.249	19.24	54.95	7.97	111.49	16.17	1.03	3.38
16097030	1.043	151.33	13.84	2.711	149.53	0.291	18.00	53.85	7.81	148.45	21.53	1.27	4.16
16097024	1.043	151.33	21.17	2.711	160.06	0.252	19.27	54.95	7.97	125.21	18.16	1.03	3.38
22107002	1.043	151.33	21.40	4.025	181.58	0.185	21.86	81.98	11.89	194.57	28.22	0.77	2.53
22107004	1.043	151.33	6.42	4.031	149.78	0.289	18.03	81.98	11.89	324.47	47.06	1.44	4.74
22107003	1.043	151.33	13.89	4.035	169.59	0.243	20.42	81.98	11.89	259.31	37.61	1.09	3.58

TABLE 16

Test section	code number	15 F annulus outer
Inner rod	type mode of heating	outer
	outer diameter mm (in)	7.95 (0.313)
	wall thickness mm (in)	0.89 (0.035)
	material	stainless steel
Shroud	bore mm (in)	10.49 (0.413)
	wall thickness mm (in)	0.56 (0.022)
	material	stainless steel
Heater resistance (at 20 C) ohm		0.065
Axial heat flux profile		Uniform

Spacer	type material	cylindrical Degussit Al 23
	outer diameter mm (in)	1.27 (0.05)
	length mm (in)	12.7 (0.5)
	total number	36 (12x3)
	pitch mm (in)	152.4 (6.0)
	distance from heater end mm (in)	76.2 (3.0)
	configuration	Δ and longitudinal-nally in line
Burnout detector	Thermopile	
Heater Length mm (in)		1829 (72)
Distance between pressure taps mm (in)		1905 (75)

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻²	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	psi	MIch Power kPa	psi	m	ft
25037106	1.043	151.33	22.91	9.85	1.043	67.86	0.685	4.09	36.06	5.23	114.25	16.57	1.436	4.71
25037108	1.043	151.33	22.91	9.85	1.043	69.15	0.700	4.17	(36.06)	(5.23)	114.87	16.66	1.442	4.73
25037110	1.043	151.33	14.51	6.24	1.043	63.47	0.698	3.82	(36.06)	(5.23)	121.21	17.58	1.564	5.13
25037112	1.043	151.33	14.49	6.23	1.043	63.94	0.704	3.85	(36.06)	(5.23)	121.56	17.63	1.567	5.14
25037114	1.043	151.33	7.30	3.14	1.043	59.27	0.703	3.57	(36.06)	(5.23)	125.49	18.20	1.686	5.53
25037116	1.043	151.33	7.35	3.16	1.043	59.46	0.705	3.58	(36.06)	(5.23)	125.21	18.16	1.686	5.53
25037118	1.043	151.33	23.35	10.04	1.404	80.00	0.588	4.82	41.85	6.07	153.75	22.30	1.372	4.50
26037102	1.043	151.33	13.14	5.65	1.404	71.58	0.593	4.31	(41.85)	(6.07)	165.34	23.98	1.542	5.06
26037107	1.043	151.33	5.56	2.39	1.404	65.46	0.599	3.94	(41.85)	(6.07)	173.54	25.17	1.695	5.56
26037109	1.043	151.33	4.75	2.04	1.518	67.45	0.581	4.06	44.26	6.42	190.02	27.56	1.710	5.61
26037111	1.043	151.33	14.03	6.03	1.518	74.54	0.565	4.49	(44.26)	(6.42)	171.75	24.91	1.509	4.95
26037113	1.043	151.33	22.45	9.65	1.518	82.49	0.565	4.97	(44.26)	(6.42)	168.37	24.42	1.369	4.49

TABLE 17

Test section	code number	16 F annulus outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.413) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.0325	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical
outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	Degussit Al 23 1.27 (0.05) 12.7 (0.5) 18 (6x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line	
Burnout detector	Resistance type	
Heater Length mm (in)	914 (36)	
Distance between pressure taps mm (in)	980 (39)	

Run number	Inlet Pressure		Inlet Subcooling kJ kg ⁻¹ Btu lb ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Velocity lb h ⁻¹ ft ⁻² x 10 ⁻⁶	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power KW	Test Section Pressure Drop		Boiling Length				
	MPa	psia							Zero Power kPa	psi	With Power kPa	psi	m	ft	
24117013	1.043	151.33	21.61	0.674	0.497	87.13	2.762	0.674	2.63	15.93	2.31	36.20	5.25	0.728	2.39
23117005	1.043	151.33	21.40	0.674	0.497	94.83	3.006	0.749	2.86	15.79	2.29	38.61	5.60	0.744	2.44
26117009	1.043	151.33	23.75	0.677	0.499	89.53	2.838	0.676	2.70	15.79	2.29	32.96	4.78	0.713	2.34
24117005	1.043	151.33	14.24	0.677	0.499	82.59	2.618	0.685	2.49	15.51	2.25	36.82	5.34	0.783	2.57
24117009	1.043	151.33	4.12	0.679	0.501	78.71	2.495	0.726	2.37	14.89	2.16	40.89	5.93	0.875	2.87
24117018	1.043	151.33	22.93	1.375	1.014	136.22	4.318	0.480	4.11	22.34	3.24	81.50	11.82	0.655	2.15
25117005	1.043	151.33	4.56	1.377	1.015	115.49	3.661	0.531	3.48	21.86	3.17	98.25	14.25	0.853	2.80
24117023	1.043	151.33	13.47	1.377	1.015	124.51	3.947	0.501	3.75	22.34	3.24	89.43	12.97	0.747	2.45
22117015	1.043	151.33	4.14	2.687	1.981	147.98	4.691	0.391	4.46	51.37	7.45	244.56	35.47	0.832	2.73
22117010	1.043	151.33	13.77	2.692	1.985	163.22	5.174	0.340	4.92	51.85	7.52	197.40	28.63	0.661	2.17
22117005	1.043	151.33	23.26	2.695	1.987	178.96	5.673	0.283	5.39	51.37	7.45	126.86	18.40	0.524	1.72
25117010	1.043	151.33	23.73	3.533	2.605	196.03	6.214	0.230	5.91	75.70	10.98	190.43	27.62	0.436	1.43
26117005	1.043	151.33	10.16	3.540	2.610	168.30	5.335	0.320	5.07	75.70	10.98	313.30	45.44	0.677	2.22
25117012	1.043	151.33	14.28	3.540	2.610	172.40	5.465	0.282	5.20	75.08	10.89	265.24	38.47	0.588	1.93

TABLE 18

Test section	code number	17F annulus outer
Inner rod	type of heating outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	24.51 (0.965) 1.27 (0.05) stainless steel
Heater resistance (at 20 C) ohm	0.046	
Axial heat flux profile	Uniform	

Spacer	type material	outer diameter mm (in)	length mm (in)	total number	pitch mm (in)	distance from heater end mm (in)	configuration
	cylindrical Tufnol	2.9 (0.114)	12.7 (0.5)	84 (28x3)	152.4 (6.0)	76.2 (3.0)	end longitudinally in line
Burnout detector	Resistance type and thermocouple						
Heater Length mm (in)	4277 (168.4)						
Distance between pressure taps mm (in)	4353 (171.4)						

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻²	Burnout Flux Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹						Zero Power kPa	Zero Power psi	With Power kPa	With Power psi	m	ft
22027108	1.043	151.33	23.35	10.04	0.686	50.98	1.616	0.790	16.79	63.43	9.20	76.88	11.15	3.46	11.34
19027119	1.043	151.33	23.73	10.20	0.686	50.73	1.608	0.782	16.70	63.16	9.16	75.36	10.93	3.44	11.28
19027112	1.043	151.33	14.33	6.16	0.688	46.59	1.477	0.778	15.35	61.50	8.92	75.02	10.88	3.72	12.22
19027114	1.043	151.33	14.24	6.12	0.688	45.93	1.456	0.767	15.13	61.50	8.92	75.77	10.99	3.72	12.21
19027121	1.043	151.33	23.70	10.19	0.688	50.54	1.602	0.778	16.65	63.16	9.16	75.36	10.93	3.44	11.27
19027105	1.043	151.33	4.95	2.13	0.688	41.10	1.303	0.748	13.54	60.40	8.76	74.60	10.82	4.06	13.32
19027107	1.043	151.33	4.91	2.11	0.688	41.04	1.301	0.747	13.52	60.40	8.76	74.74	10.84	4.06	13.33
19027131	1.043	151.33	14.03	6.03	1.362	70.51	2.235	0.595	23.23	76.39	11.08	156.86	22.75	3.57	11.71
19027136	1.043	151.33	4.77	2.05	1.362	63.22	2.004	0.602	20.82	75.64	10.97	173.89	25.22	4.01	13.15
19027126	1.043	151.33	23.82	10.24	1.364	79.40	2.517	0.599	26.15	76.39	11.08	152.31	22.09	3.21	10.53
20027119	1.043	151.33	14.28	6.14	2.146	84.95	2.693	0.461	27.98	88.12	12.78	238.70	34.62	3.33	10.94
20027117	1.043	151.33	4.95	2.13	2.146	75.58	2.396	0.485	24.89	88.12	12.78	267.31	38.77	3.91	12.83
20027128	1.043	151.33	23.89	10.27	2.146	97.19	3.081	0.455	32.02	92.05	13.35	224.08	32.50	2.90	9.51
20027108	1.043	151.33	14.47	6.22	2.711	94.29	2.989	0.423	31.05	107.70	15.62	32.82	46.53	3.19	10.47
20027106	1.043	151.33	22.70	9.76	2.712	104.79	3.322	0.403	34.52	107.70	15.62	297.99	43.22	2.74	9.00
22027104	1.043	151.33	27.47	11.61	2.718	112.15	3.555	0.396	36.94	108.66	15.76	286.75	41.59	2.54	8.33

TABLE 19

Test section	code number	18 F annulus outer
Inner rod	type mode of heating outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	24.51 (0.965) 1.27 (0.05) stainless steel
Heater resistance (at 20 C) ohm		0.022
Axial heat flux profile		Uniform

Spacer	type material	cylindrical
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	Tufohol 3.66 (0.144) 12.7 (0.5) 42 (14x3) 152.4 (6.0) 76.2 (3.0) band longitudinal-nally in line
Burnout detector	Resistance type	
Heater Length mm (in)		2139 (84.2)
Distance between pressure taps mm (in)		2215 (87.25)

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	With Power kPa	psi	psi	m	ft
1127032	1.043	151.33	22.91	9.85	0.673	92.78	0.721	15.29	32.27	4.68	42.27	6.13	1.71	5.60
2127005	1.043	151.33	14.05	6.04	0.674	86.81	0.731	14.31	31.51	4.57	41.09	5.96	1.86	6.09
2127010	1.043	151.33	4.28	1.84	0.674	80.13	0.744	13.20	31.03	4.50	42.27	6.13	2.05	6.71
2127028	1.043	151.33	5.19	2.23	1.329	103.50	0.484	17.05	37.44	5.43	82.60	11.98	1.97	6.45
2127022	1.043	151.33	14.10	6.06	1.336	112.27	0.452	18.50	38.06	5.52	75.15	10.90	1.70	5.58
2127016	1.043	151.33	22.86	9.83	1.340	122.97	0.432	20.26	38.47	5.58	70.60	10.24	1.49	4.89
30117006	1.043	151.33	22.82	9.81	2.678	153.94	0.226	25.37	53.99	7.83	111.08	16.11	1.10	3.52
30117020	1.043	151.33	5.61	2.41	2.681	127.76	0.308	21.05	55.09	7.99	150.58	21.84	1.83	6.01
30117014	1.043	151.33	13.26	5.70	2.681	139.65	0.272	23.01	53.71	7.79	132.66	19.24	1.48	4.84
30117012	1.043	151.33	13.35	5.74	2.681	142.02	0.276	23.40	53.71	7.79	131.41	19.06	1.48	4.86
1127007	1.043	151.33	22.89	9.84	4.024	188.20	0.179	31.01	85.15	12.35	179.20	25.99	0.86	2.83
1127014	1.043	151.33	13.75	5.91	4.032	172.71	0.243	28.46	85.15	12.35	240.63	34.90	1.30	4.27
1127027	1.043	151.33	5.35	2.30	4.033	149.72	0.291	24.67	85.15	12.35	306.34	44.43	1.76	5.79

TABLE 20

Test section	code number type mode of heating	19F annulus inner/outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	15.88 (0.625) 2.11 (0.083) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	20.96 (0.825) 1.78 (0.07) stainless steel
Heater resistance (at 20 C) ohm	0.03109	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Tufco
	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	2.46 (0.097) 12.7 (0.5) 72 (24x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	thermocouple	
Heater Length mm (in)	3658 (144)	
Distance between pressure taps mm (in)	3733 (147)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux		Exit Quality	Power kW	Test Section Pressure Drop			Boiling Length		
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹	kg s ⁻¹ m ⁻² x 10 ⁻³	lb h ⁻¹ ft ⁻² x 10 ⁻⁶	kW m ⁻²	Btu h ⁻¹ ft ⁻² x 10 ⁻⁴			kPa	psi	With Power kPa	psi	m	ft
16047123	1.043	151.33	4.56	1.96	0.682	0.503	29.75	0.943	0.968	12.59	55.57	8.06	87.22	12.65	3.52	11.56
16047121	1.043	151.33	14.54	6.25	0.682	0.503	31.48	0.998	0.947	13.32	55.57	8.06	85.43	12.39	3.26	10.69
16047118	1.043	151.33	22.82	9.81	0.682	0.503	33.60	1.065	0.951	14.21	55.57	8.06	83.01	12.04	3.07	10.07
16047103	1.043	151.33	23.93	10.29	1.364	0.990	58.33	1.849	0.832	24.69	69.50	10.08	188.50	27.34	2.96	9.70
16047112	1.043	151.33	5.42	2.33	1.364	1.006	49.81	1.579	0.825	21.08	68.40	9.92	211.53	30.65	3.47	11.38
16047114	1.043	151.33	5.63	2.42	1.364	1.006	49.68	1.575	0.821	21.03	68.40	9.92	209.53	30.39	3.46	11.36
16047109	1.043	151.33	14.63	6.29	1.364	1.006	53.85	1.77	0.817	22.78	69.50	10.08	196.43	28.49	3.19	10.45
16047107	1.043	151.33	14.63	6.29	1.364	1.006	53.94	1.710	0.818	22.82	69.50	10.08	196.43	28.49	3.19	10.46
16047105	1.043	151.33	23.89	10.27	1.364	1.006	58.80	1.864	0.826	24.89	69.50	10.08	194.02	28.14	2.95	9.69
16047128	1.043	151.33	6.00	2.58	1.524	1.124	56.85	1.802	0.844	24.06	72.05	10.45	253.31	36.74	3.45	11.33
16047131	1.043	151.33	13.51	5.81	1.526	1.125	60.51	1.918	0.836	25.61	72.05	10.45	237.80	34.49	3.22	10.58
17047134	1.043	151.33	22.75	9.78	1.526	1.125	65.05	2.062	0.829	27.53	72.05	10.45	225.94	32.77	2.98	9.78

TABLE 21

Test section	code number	20F annulus inner/outer
Inner rod	mode of heating outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.71 (0.028) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.413) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.08	
Axial heat flux profile	Uniform	

Spacer	type material	outer diameter mm (in)	length mm (in)	total number	pitch mm (in)	distance from heater end mm (in)	configuration
	cylindrical Degussit Al 23	1.27 (0.05)	12.7 (0.5)	36 (12x3)	152.4 (6.0)	76.2 (3.0)	and longitudinally in line
Burnout detector	Resistance type and thermopile						
Heater Length mm (in)	1829 (72)						
Distance between pressure taps mm (in)	1905 (75)						

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity $\text{kg s}^{-1} \text{m}^{-2} \times 10^{-3}$	Burnout Flux $\text{Btu h}^{-1} \text{ft}^{-2} \times 10^{-4}$	Exit Quality	Power kW	Test Section Pressure Drop			Boiling Length		
	MPa	psia	kJ kg^{-1}	Btu lb^{-1}					Zero Power kPa	psi	With Power kPa	psi	m	ft
23037114	1.043	151.33	21.59	9.28	0.688	31.20	0.874	3.31	30.27	4.39	73.50	10.66	1.527	5.01
23037110	1.043	151.33	14.61	6.28	0.689	29.50	0.872	3.13	30.27	4.39	73.15	10.61	1.612	5.29
23037112	1.043	151.33	4.88	2.10	0.689	29.38	0.878	2.90	30.27	4.39	76.53	11.10	1.750	5.74
23037116	1.043	151.33	23.14	9.95	1.404	46.66	0.608	4.94	43.99	6.38	154.37	22.39	1.387	4.55
23037118	1.043	151.33	13.58	5.84	1.405	41.86	0.608	4.44	43.99	6.38	170.48	24.78	1.539	5.05
23037120	1.043	151.33	5.56	2.39	1.405	38.20	0.614	4.05	43.99	6.38	176.02	25.53	1.698	5.57
24037106	1.043	151.33	22.98	9.88	2.726	68.11	0.480	7.22	96.32	13.97	356.39	51.69	1.244	4.08
24037109	1.043	151.33	19.77	8.50	2.726	66.40	0.494	7.04	96.32	13.97	371.91	53.94	1.314	4.31
24037114	1.043	151.33	25.75	11.07	2.727	68.11	0.454	7.22	94.80	13.75	333.85	48.42	1.173	3.85
24037116	1.043	151.33	25.68	11.04	2.727	69.43	0.468	7.36	94.80	13.75	348.46	50.54	1.189	3.90

TABLE 22

Test section	code number	21.F annulus inner/outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	18.57 (0.731) 1.37 (0.054) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	24.51 (0.965) 1.27 (0.05) stainless steel
Heater resistance (at 20 C) ohm	0.046	
Axial heat flux profile	Uniform	

Spacer	type	cylindrical
	material outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	Tufnol 12.7 (0.5) 84 (28 x 3) 152.4 (6.0) 76.2 (3.0) A and longitudinally in line
Burnout detector	Thermopile	
Heater Length mm (in)	4277 (168.4)	
Distance between pressure taps mm (in)	4353 (171.4)	

Run number	Inlet Pressure		Inlet Subcooling	Mass Velocity	Burnout Flux	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia						Zero Power	With Power	m	ft		
23027113	1.043	151.33	4.44	0.686	26.12	0.843	15.12	60.40	8.76	79.01	11.46	4.10	13.46
23027111	1.043	151.33	13.61	0.688	28.20	0.839	16.32	61.92	8.98	78.05	11.32	3.79	12.42
23027106	1.043	151.33	23.24	0.688	30.44	0.837	17.61	63.16	9.16	78.05	11.32	3.50	11.48
23027120	1.043	151.33	22.91	1.366	52.59	0.727	30.44	76.53	11.10	166.72	24.18	3.39	11.13
23027125	1.043	151.33	13.40	1.366	48.27	0.732	27.94	75.02	10.88	175.40	25.44	3.71	12.18
23027130	1.043	151.33	4.75	1.366	44.80	0.743	25.93	73.64	10.68	184.50	26.76	4.06	13.33
24027111	1.043	151.33	13.26	2.147	60.76	0.603	35.17	86.60	12.56	279.45	40.53	3.58	11.75
24027109	1.043	151.33	5.26	2.147	55.99	0.619	32.42	86.87	12.60	298.89	43.35	3.98	13.05
24027119	1.043	151.33	22.98	2.148	65.46	0.572	37.89	91.43	13.26	258.49	37.49	3.15	10.35
24027103	1.043	151.33	22.84	2.716	75.77	0.542	43.87	107.90	15.65	354.88	51.47	3.06	10.04

TABLE 23

Test section	code number type mode of heating	24F annulus outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	11.38 (0.448) 0.61 (0.024) stainless steel
Heater resistance (at 20 C) ohm	0.066	
Axial heat flux profile	Uniform	

Spacer	type material outer diameter mm (in) length total number pitch distance from heater end mm (in) configuration	cylindrical Degussit Al 23 1.7 (0.067) 12.7 (0.5) 36 (12 x 3) 152.4 (6.0) 76.2 (3.0) and longitudinal nally in line
Burnout detector	Thermopile and thermocouple	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux		Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹	kg s ⁻¹ m ⁻² x 10 ⁻³	lb h ⁻¹ ft ⁻² x 10 ⁻⁶	kW m ⁻²	Btu h ⁻¹ ft ⁻² x 10 ⁻⁴			kPa	psi	kPa	psi	m	ft
19037105	1.043	151.33	22.98	9.88	0.705	0.520	60.04	2.157	0.787	4.45	29.37	4.26	54.61	7.92	1.481	4.86
19037107	1.043	151.33	13.82	5.94	0.705	0.520	63.79	2.022	0.799	4.17	(29.37)	(4.26)	58.61	8.50	1.606	5.27
19037110	1.043	151.33	5.98	2.57	0.705	0.520	60.66	1.923	0.818	3.97	(29.37)	(4.26)	60.40	8.76	1.728	5.67
19037113	1.043	151.33	23.47	10.09	1.397	1.03	105.08	3.331	0.589	6.87	39.99	5.80	124.86	18.11	1.375	4.51
19037115	1.043	151.33	13.03	5.60	1.397	1.03	97.38	3.087	0.619	6.37	(39.99)	(5.80)	137.07	19.88	1.558	5.11
19037117	1.043	151.33	13.14	5.65	1.397	1.03	96.91	3.072	0.615	6.34	(39.99)	(5.80)	138.24	20.05	1.551	5.09
19037119	1.043	151.33	5.84	2.51	1.397	1.03	89.91	2.850	0.624	5.88	(39.99)	(5.80)	146.51	21.25	1.698	5.57
19037121	1.043	151.33	6.54	2.81	2.824	2.082	121.80	3.861	0.475	7.96	89.29	12.95	372.18	53.98	1.609	5.28
19037123	1.043	151.33	14.17	6.09	2.824	2.082	133.00	4.216	0.439	8.70	(89.29)	(12.95)	312.89	45.38	1.390	4.56
19037125	1.043	151.33	23.96	10.30	2.824	2.082	144.92	4.594	0.390	9.48	(89.29)	(12.95)	254.49	36.91	1.149	3.77

TABLE 24

Test section	code number type mode of heating	25F annulus inner/outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.71 (0.028) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	11.38 (0.448) 0.61 (0.024) stainless steel
Heater resistance (at 20 C) ohm	0.08	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Degussit Al 23
	outer diameter mm (in) length mm (in)	1.7 (0.067) 12.7 (0.5)
	total number pitch mm (in) distance from heater end mm (in) configuration	36 (12x3) 52.4 (6.0) 76.2 (3.0) Δ and longitudinal- nally in line
Burnout detector	Resistance type and thermocouple	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity $\text{kg s}^{-1} \text{m}^{-2}$ $\times 10^{-3}$	Burnout Flux kW m^{-2}	Burnout Flux $\text{Btu h}^{-1} \text{ft}^{-2}$ $\times 10^{-4}$	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length		
	MPa	psia	kJ kg^{-1}	Btu lb^{-1}						Zero Power kPa	With Power kPa	m	ft	
22037112	1.043	151.33	5.91	2.54	0.705	43.94	1.393	1.013	4.88	(29.10)	63.16	9.16	1.747	5.73
22037109	1.043	151.33	13.93	5.99	0.705	46.97	1.489	1.022	5.22	(29.10)	63.16	9.16	1.649	5.41
22037106	1.043	151.33	21.42	9.21	0.705	49.72	1.576	1.028	5.52	(29.10)	61.64	8.94	1.570	5.15
22037105	1.043	151.33	21.28	9.15	0.705	50.32	1.595	1.043	5.59	29.10	61.64	8.94	1.573	5.16
20037103	1.043	151.33	22.91	9.85	1.397	69.28	2.196	0.682	7.69	42.47	133.41	19.35	1.433	4.70
20037105	1.043	151.33	22.89	9.84	1.397	68.33	2.166	0.671	7.59	(42.47)	133.69	19.39	1.426	4.68
20037107	1.043	151.33	12.79	5.50	1.397	62.15	1.970	0.677	6.90	(42.47)	139.21	20.19	1.582	5.19
20037109	1.043	151.33	6.44	2.77	1.397	58.93	1.868	0.691	6.54	(42.47)	150.17	21.78	1.698	5.57
20037115	1.043	151.33	8.28	3.56	2.824	83.19	2.637	0.525	9.24	(89.29)	370.39	53.72	1.588	5.21
20037113	1.043	151.33	13.72	5.90	2.824	89.65	2.842	0.516	9.96	(89.29)	353.63	51.29	1.460	4.79
20037111	1.043	151.33	24.70	10.62	2.824	100.28	3.179	0.480	11.14	89.29	297.65	43.17	1.231	4.04

TABLE 25

Test section	code number	26 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.3 (0.012) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.313) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.044	
Axial heat flux profile	Uniform	

Spacer	type material	outer diameter mm (in) length mm (in) total number pitch mm (in) distance from heater end mm (in) configuration	cylindrical Degussit Al 23 1.27 (0.05) 12.7 (0.5) 9 (3x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Burnout detector	Resistance type and thermocouple		
Heater Length mm (in)	457 (18)		
Distance between pressure taps mm (in)	533 (21)		

Run number	Inlet Pressure		Inlet Subcooling Btu lb ⁻¹ kJ kg ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux Btu h ⁻¹ ft ⁻² x10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length			
	MPa	psia						Zero Power kPa	psi	With Power kPa	psi	m	ft
31057106	1.043	151.33	3.88	1.149	153.8	0.306	1.76	10.20	1.48	27.99	4.06	0.415	1.36
31057104	1.043	151.33	4.21	1.150	154.4	0.304	1.76	10.20	1.48	27.99	4.06	0.411	1.35
29057111	1.043	151.33	13.79	1.150	177.1	0.276	2.02	10.34	1.50	24.96	3.62	0.326	1.07
29057113	1.043	151.33	13.93	1.150	177.6	0.276	2.03	10.34	1.50	24.96	3.62	0.323	1.06
29057107	1.043	151.33	22.33	1.150	199.7	0.256	2.28	10.55	1.53	22.82	3.31	0.268	.88
29057105	1.043	151.33	22.42	1.151	200.4	0.257	2.29	10.55	1.53	22.55	3.27	0.268	0.88
1067111	1.043	151.33	4.19	2.353	208.0	0.206	2.37	22.27	3.23	71.84	10.42	0.387	1.27
1067109	1.043	151.33	4.44	2.353	208.5	0.204	2.38	22.27	3.23	71.50	10.37	0.384	1.26
1067106	1.043	151.33	13.93	2.354	251.7	0.170	2.87	22.27	3.23	57.50	8.34	0.265	0.87
1067104	1.043	151.33	13.82	2.356	252.6	0.172	2.88	22.27	3.23	58.12	8.43	0.268	0.88
31057112	1.043	151.33	23.56	2.356	281.4	0.121	3.21	22.06	3.20	43.51	6.31	0.168	0.55
31057110	1.043	151.33	23.35	2.356	281.4	0.122	3.21	22.06	3.20	43.51	6.31	0.168	0.55
1067115	1.043	151.33	23.26	3.540	297.2	0.041	3.39	38.68	5.61	54.95	7.97	0.049	0.16
1067117	1.043	151.33	23.10	3.540	296.3	0.042	3.38	(38.68)	(5.61)	55.57	8.06	0.052	0.17
1067120	1.043	151.33	14.05	3.541	260.8	0.096	2.98	(38.68)	(5.61)	80.32	11.65	0.177	0.58
1067121	1.043	151.33	14.05	3.541	261.4	0.097	2.99	(38.68)	(5.61)	80.94	11.74	0.177	0.58
1067123	1.043	151.33	4.61	3.542	220.6	0.156	2.52	(38.68)	(5.61)	122.18	17.72	0.347	1.14
1067124	1.043	151.33	4.61	3.542	221.6	0.156	2.53	(38.68)	(5.61)	120.93	17.54	0.351	1.15

TABLE 26

Test section	code number	27 F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) variable stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	10.49 (0.413) 0.56 (0.022) stainless steel
Heater resistance (at 20 C) ohm	0.079	
Axial heat flux profile	Chopped cosine (form factor = 1.4)	

Spacer	type	cylindrical
	material	Deussit Al 23
	outer diameter mm (in)	1.17 (0.046)
	length mm (in)	12.7 (0.5)
	total number	36 (12x3)
	pitch mm (in)	152.4 (6.0)
	distance from heater end mm (in)	76.2 (3.0)
	configuration	Δ and longitudinally in line
Burnout detector	Resistance type	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length		
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	With Power psi	m	ft	
17127102	1.044	151.45	8.16	3.51	1.368	1.941	0.405	2.80	40.7	5.9	114.7	1.561	5.12
17127103	1.045	151.54	16.35	7.03	1.368	2.226	0.403	3.21	(40.7)	(5.9)	107.1	1.359	4.46
20127103	1.043	151.31	24.03	10.33	1.383	2.548	0.407	3.67	(40.7)	(5.9)	102.6	1.219	4.00
20127104	1.046	151.64	24.17	10.39	1.374	2.509	0.401	3.61	(40.7)	(5.9)	101.1	1.210	3.97
21127101	1.051	152.39	6.14	2.64	2.045	2.337	0.245	3.37	71.0	10.3	227.7	33.03	5.18
21127103	1.046	151.75	15.19	6.53	2.034	2.824	0.298	4.07	(71.0)	(10.3)	235.3	34.13	4.32
21127104	1.042	151.20	24.14	10.38	2.015	3.304	0.431	4.76	(71.0)	(10.3)	188.8	27.38	3.74
22127104	1.039	150.71	24.56	10.56	2.010	2.463	0.314	3.55	(71.0)	(10.3)	219.5	31.83	2.93
22127105	1.043	151.26	21.52	9.25	2.032	3.155	0.464	4.55	(71.0)	(10.3)	194.2	28.17	3.88
22127102	1.057	153.25	7.12	3.06	2.676	2.597	0.326	3.74	98.6	14.3	342.7	49.70	4.88
22127103	1.044	151.45	14.35	6.17	2.651	3.121	0.261	4.50	(98.6)	(14.3)	310.5	45.03	4.13

TABLE 27

Test section	code number	28 F annulus outer
Inner rod	type mode of heating	outer
	outer diameter mm (in)	7.95 (0.313)
	wall thickness mm (in)	0.89 (0.035)
	material	stainless steel
Shroud	bore mm (in)	9.5 (0.374)
	wall thickness mm (in)	0.46 (0.018)
	material	stainless steel
Heater resistance (at 20 C) ohm		0.099
Axial heat flux profile		Uniform

Spacer	type material	cylindrical Degussit Al 23
	outer diameter mm (in)	0.76 (0.03)
	length mm (in)	12.7 (0.5)
	total number	36 (12x3)
	pitch mm (in)	152.4 (6.0)
	distance from heater end mm (in)	76.2 (3.0)
	configuration	Δ and longitudinal-nally in line
Burnout detector	Resistance type	
Heater Length mm (in)		1829 (72)
Distance between pressure taps mm (in)		1905 (75)

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity		Burnout Flux		Exit Quality	Power kW	Test Section Pressure Drop				Boiling Length	
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹	kg s ⁻¹ m ⁻² x 10 ⁻³	lb h ⁻¹ ft ⁻² x 10 ⁻⁶	kW m ⁻²	Btu h ⁻¹ ft ⁻² x 10 ⁻⁴			kPa	psi	kPa	psi	With Power	ft
13037121	1.043	151.33	21.93	9.43	1.033	0.762	43.38	1.375	0.716	2.37	(43.99)	(6.38)	185.40	26.89	1.457	4.78
13037119	1.043	151.33	21.98	9.45	1.033	0.762	43.60	1.382	0.720	2.38	43.99	6.38	184.85	26.81	1.457	4.78
13037129	1.043	151.33	4.30	1.85	1.033	0.762	38.11	1.208	0.756	2.08	(43.99)	(6.38)	218.57	31.70	1.747	5.73
13037127	1.043	151.33	4.28	1.84	1.033	0.762	37.00	1.173	0.736	2.02	(43.99)	(6.38)	217.94	31.61	1.743	5.72
13037125	1.043	151.33	14.63	6.29	1.036	0.764	40.73	1.291	0.722	2.22	(43.99)	(6.38)	198.50	28.79	1.564	5.13
13037123	1.043	151.33	14.68	6.31	1.036	0.764	40.25	1.276	0.713	2.20	(43.99)	(6.38)	198.50	28.79	1.561	5.12
12037107	1.043	151.33	12.56	5.40	1.267	0.934	44.04	1.396	0.664	2.40	(52.19)	(7.57)	266.35	38.63	1.573	5.16
12037109	1.043	151.33	12.63	5.43	1.267	0.934	43.09	1.366	0.647	2.35	(52.19)	(7.57)	259.94	37.70	1.564	5.13
12037111	1.043	151.33	4.86	2.09	1.267	0.934	39.31	1.246	0.652	2.14	(52.19)	(7.57)	279.10	40.48	1.716	5.63
12037113	1.043	151.33	4.72	2.03	1.267	0.934	39.59	1.255	0.658	2.16	(52.19)	(7.57)	279.72	40.57	1.722	5.65
12037105	1.043	151.33	21.19	9.11	1.268	0.935	47.98	1.521	0.653	2.62	(52.19)	(7.57)	240.77	34.92	1.430	4.69
12037103	1.043	151.33	21.17	9.10	1.268	0.935	48.30	1.531	0.658	2.64	52.19	7.57	240.77	34.92	1.433	4.70
13037104	1.043	151.33	15.44	6.64	1.747	1.288	50.06	1.587	0.552	2.73	73.77	10.70	375.22	54.42	1.445	4.74
13037110	1.043	151.33	22.93	9.86	1.747	1.288	58.83	1.865	0.590	3.21	(73.77)	(10.70)	367.63	53.32	1.344	4.41
13037107	1.043	151.33	19.17	8.24	1.747	1.288	55.33	1.754	0.581	3.02	(73.77)	(10.70)	373.15	54.12	1.399	4.59
13037113	1.043	151.33	16.12	6.93	1.748	1.289	53.19	1.686	0.582	2.90	(73.77)	(10.70)	381.14	55.28	1.451	4.76

TABLE 28

Test section	code number type mode of heating	29F annulus inner
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.89 (0.035) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	9.5 (0.374) 0.46 (0.018) stainless steel
Heater resistance (at 20 C) ohm	0.135	
Axial heat flux profile	Uniform	

Spacer	type material length total number pitch distance from heater end mm (in) configuration	cylindrical Degussit A123 0.76 (0.03) 12.7 (0.5) 36 (12x3) 152.4 (6.0) 76.2 (3.0) and longitudi- nally in line
Burnout detector	Resistance type	
Heater Length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling		Mass Velocity kg s ⁻¹ m ⁻² x10 ⁻³	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power KW	Test Section Pressure Drop		Boiling Length			
	MPa	psia	kJ kg ⁻¹	Btu lb ⁻¹					Zero Power kPa	psi	With Power kPa	psi	m	ft
12037103	1.043	151.33	6.00	2.58	1.035	38.71	0.632	1.77	44.13	6.40	201.54	29.23	1.69	5.55
11037120	1.043	151.33	13.84	5.95	1.036	40.60	0.599	1.85	(44.13)	(6.40)	185.75	26.94	1.53	5.02
11037118	1.043	151.33	13.72	5.90	1.036	41.77	0.618	1.91	(44.13)	(6.40)	188.16	27.29	1.54	5.05
11037116	1.043	151.33	21.12	9.08	1.036	42.46	0.568	1.94	(44.13)	(6.40)	166.23	24.11	1.39	4.56
11037114	1.043	151.33	21.07	9.06	1.036	42.37	0.567	1.93	(44.13)	(6.40)	167.47	24.29	1.39	4.56
10037116	1.043	151.33	5.28	2.27	1.267	42.37	0.589	1.93	(59.16)	(8.58)	269.10	39.03	1.69	5.56
10037114	1.043	151.33	5.35	2.30	1.267	42.27	0.587	1.93	(59.16)	(8.58)	267.86	38.85	1.69	5.55
11037111	1.043	151.33	22.89	9.84	1.267	48.93	0.527	2.23	(59.16)	(8.58)	211.60	30.69	1.33	4.35
10037118	1.043	151.33	21.33	9.17	1.268	48.17	0.528	2.20	(59.16)	(8.58)	210.98	30.60	1.35	4.43
10037112	1.043	151.33	14.75	6.34	1.268	46.47	0.561	2.12	(59.16)	(8.58)	234.42	34.00	1.49	4.88
10037110	1.043	151.33	14.70	6.32	1.268	46.18	0.558	2.11	59.27	8.59	231.94	33.64	1.48	4.87
11037109	1.043	151.33	15.61	6.71	1.748	52.81	0.480	2.41	(73.77)	(10.70)	343.29	49.79	1.39	4.56
11037106	1.043	151.33	18.86	8.11	1.748	55.74	0.478	2.55	(73.77)	(10.70)	329.02	47.72	1.33	4.35
11037103	1.043	151.33	22.96	9.87	1.748	58.55	0.467	2.67	73.77	10.70	302.27	43.84	1.25	4.09

TABLE 29

Test section	code number type mode of heating	30F annulus inner/outer
Inner rod	outer diameter mm (in) wall thickness mm (in) material	7.95 (0.313) 0.51 (0.02) stainless steel
Shroud	bore mm (in) wall thickness mm (in) material	9.5 (0.374) 0.46 (0.018) stainless steel
Heater resistance (at 20 C) ohm	0.057	
Axial heat flux profile	Uniform	

Spacer	type material	cylindrical Degussit Al23
	outer diameter mm (in)	0.76 (0.03)
	length mm (in)	12.7 (0.5)
	total number	36 (12x3)
	pitch mm (in)	152.4 (6.0)
	distance from heater end mm (in)	76.2 (3.0)
	configuration	and longitudinally in line
Burnout detector	Resistance type	
Heater length mm (in)	1829 (72)	
Distance between pressure taps mm (in)	1905 (75)	

Run number	Inlet Pressure		Inlet Subcooling kJ kg ⁻¹ Btu lb ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Burnout Flux kW m ⁻² Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Test Section Pressure Drop		Boiling Length	
	MPa	psia						Zero Power kPa psi	With Power kPa psi	m	ft
15037104	1.043	151.33	22.33	1.008	28.08	0.890	2.81	43.64 (6.33)	205.19 (29.76)	1.518	4.98
15037106	1.043	151.33	22.28	1.008	27.92	0.885	2.80	(43.64)	205.33 (29.81)	1.518	4.98
15037108	1.043	151.33	13.61	1.010	25.62	0.812	2.57	(43.64)	220.08 (31.92)	1.622	5.32
15037110	1.043	151.33	13.65	1.010	25.62	0.812	2.57	(43.64)	220.08 (31.92)	1.618	5.31
15037112	1.043	151.33	5.21	1.012	23.92	0.758	2.40	(43.64)	228.91 (33.20)	1.743	5.72
16037102	1.043	151.33	5.26	1.012	24.98	0.792	2.50	(43.64)	228.63 (33.16)	1.747	5.73
16037107	1.043	151.33	22.03	1.267	32.18	1.020	3.22	52.06 (7.55)	267.24 (38.76)	1.494	4.90
16037110	1.043	151.33	13.96	1.268	31.10	0.986	3.12	(52.06)	297.10 (43.09)	1.609	5.28
16037113	1.043	151.33	7.47	1.268	29.50	0.935	2.96	(52.06)	311.99 (45.25)	1.704	5.59
16037116	1.043	151.33	7.23	1.269	31.10	0.986	3.12	(52.06)	321.44 (46.62)	1.713	5.62
16037125	1.043	151.33	9.91	1.504	28.74	0.911	2.88	(63.71)	369.49 (53.59)	1.628	5.34
16037127	1.043	151.33	9.89	1.516	28.39	0.900	2.85	(63.71)	375.84 (54.51)	1.625	5.33
16037123	1.043	151.33	14.84	1.518	31.48	0.998	3.16	(63.71)	359.43 (52.13)	1.551	5.09
16037129	1.043	151.33	12.14	1.518	29.34	0.930	2.94	(63.71)	366.11 (53.10)	1.585	5.20
16037119	1.043	151.33	22.86	1.518	32.97	1.045	3.30	63.71 (9.24)	337.85 (49.00)	1.420	4.66
16037121	1.043	151.33	14.77	1.543	30.26	0.959	3.03	(63.71)	360.67 (52.31)	1.536	5.04

TABLE 30

Test section	code number	31F annulus inner	type of heating mode	material	type material	outer diameter mm (in)	length mm (in)	total number	pitch mm (in)	distance from heater end mm (in)	configuration
Inner rod			7.95 (0.313) stainless steel	0.51 (0.02) stainless steel	Spacer						cylindrical Degussit Al 23 0.76 (0.03) 12.7 (0.5) 18 (6x3) 152.4 (6.0) 76.2 (3.0) and longitudinally in line
Shroud			9.5 (0.374) stainless steel	0.46 (0.018) stainless steel	Burnout detector						Resistance type and thermopile
Heater resistance (at 20 C) ohm			0.06		Heater Length mm (in)						914 (36)
Axial heat flux profile			Uniform		Distance between pressure taps mm (in)						990 (39)

Run number	Inlet Pressure MPa	Inlet Pressure psia	Inlet Subcooling kJ kg ⁻¹	Inlet Subcooling Btu lb ⁻¹	Mass Velocity kg s ⁻¹ m ⁻² x 10 ⁻³	Mass Velocity lb h ⁻¹ ft ⁻² x 10 ⁻⁶	Burnout Flux kW m ⁻²	Burnout Flux Btu h ⁻¹ ft ⁻² x 10 ⁻⁴	Exit Quality	Power kW	Zero Power kPa	With Power kPa	Boiling Length m	Boiling Length ft
19057118	1.043	151.33	13.86	5.96	1.024	0.755	69.50	2.203	0.487	1.59	(22.61)	78.46	11.379	0.741
19057117	1.043	151.33	13.84	5.95	1.024	0.755	70.19	2.225	0.493	1.60	(22.61)	79.07	11.468	0.744
19057114	1.043	151.33	5.35	2.30	1.024	0.755	64.83	2.055	0.517	1.48	(22.61)	86.37	12.527	0.841
19057113	1.043	151.33	5.35	2.30	1.024	0.755	61.70	1.956	0.491	1.41	22.61	85.76	12.438	0.838
19057122	1.043	151.33	21.91	9.42	1.027	0.757	77.29	2.450	0.485	1.76	(22.61)	74.35	10.784	0.668
19057121	1.043	151.33	21.77	9.36	1.027	0.757	77.35	2.452	0.487	1.77	(22.61)	74.35	10.784	0.668
18057114	1.043	151.33	15.12	6.50	1.253	0.924	77.07	2.443	0.429	1.76	(27.37)	98.84	14.336	0.704
18057115	1.043	151.33	15.14	6.51	1.253	0.924	77.45	2.455	0.431	1.77	(27.37)	99.30	14.402	0.707
18057110	1.043	151.33	5.63	2.42	1.257	0.927	68.90	2.184	0.451	1.57	(27.37)	115.87	16.806	0.826
18057111	1.043	151.33	5.35	2.30	1.257	0.927	69.59	2.206	0.458	1.59	(27.37)	117.09	16.983	0.832
18057105	1.043	151.33	22.68	9.75	1.257	0.927	84.32	2.673	0.415	1.93	(27.37)	91.85	13.321	0.628
18057107	1.043	151.33	22.59	9.71	1.257	0.927	82.87	2.627	0.406	1.89	27.37	90.78	13.166	0.622
18057119	1.043	151.33	14.56	6.26	1.731	1.276	92.40	2.929	0.380	2.11	39.23	153.0	22.189	0.683
18057118	1.043	151.33	14.58	6.27	1.731	1.276	92.34	2.927	0.379	2.11	39.23	151.46	21.968	0.683
19057108	1.043	151.33	6.00	2.58	1.733	1.278	82.37	2.611	0.404	1.88	39.99	177.02	25.674	0.808
19057107	1.043	151.33	6.02	2.59	1.733	1.278	82.78	2.624	0.406	1.89	39.99	177.02	25.674	0.808
19057105	1.043	151.33	22.24	9.56	1.735	1.279	99.97	3.169	0.352	2.28	39.99	135.34	19.630	0.585
19057104	1.043	151.33	22.14	9.52	1.735	1.279	99.87	3.166	0.352	2.28	39.99	136.26	19.762	0.588

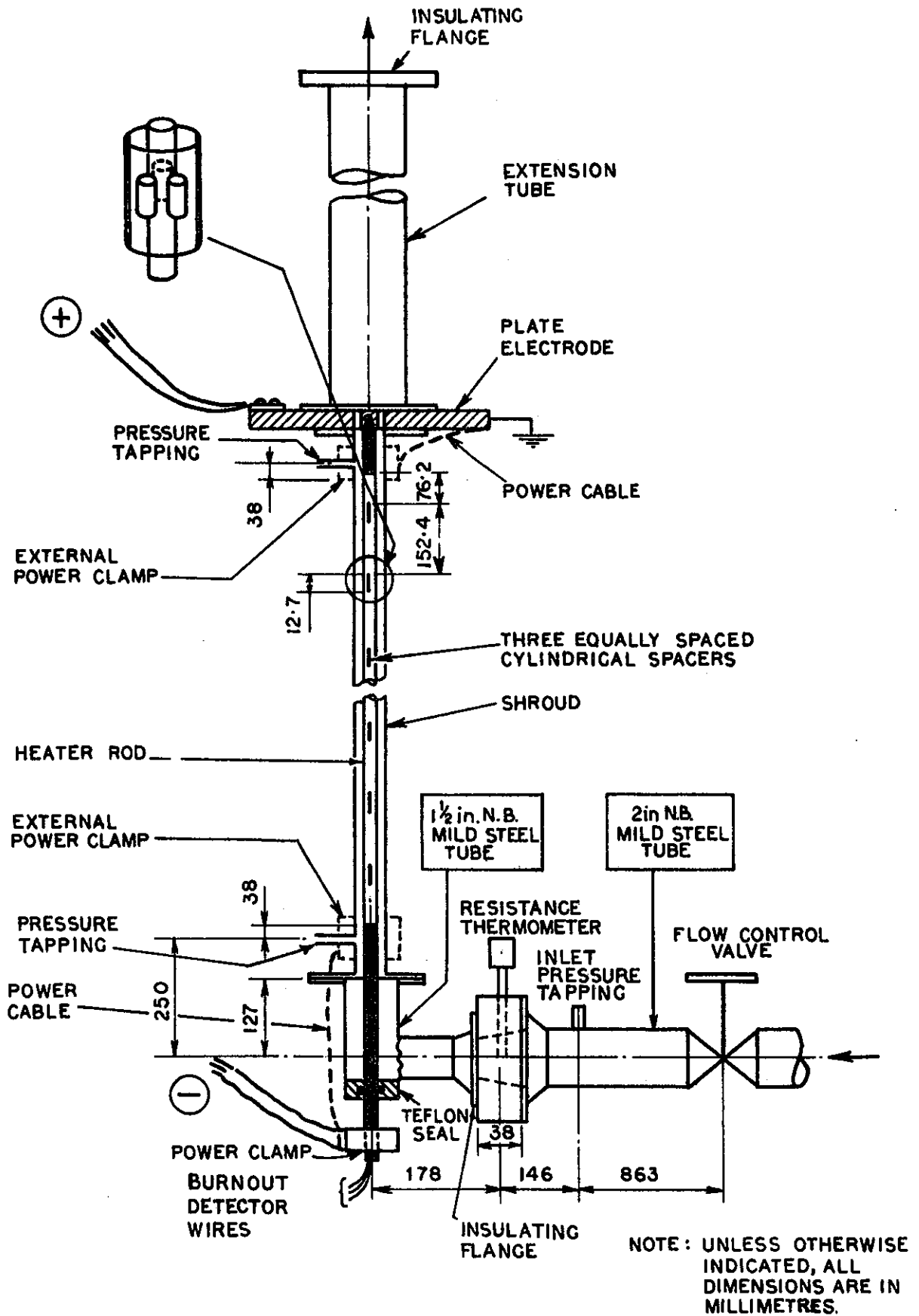


FIGURE 1. TYPICAL TEST SECTION ASSEMBLY IN THE RIG

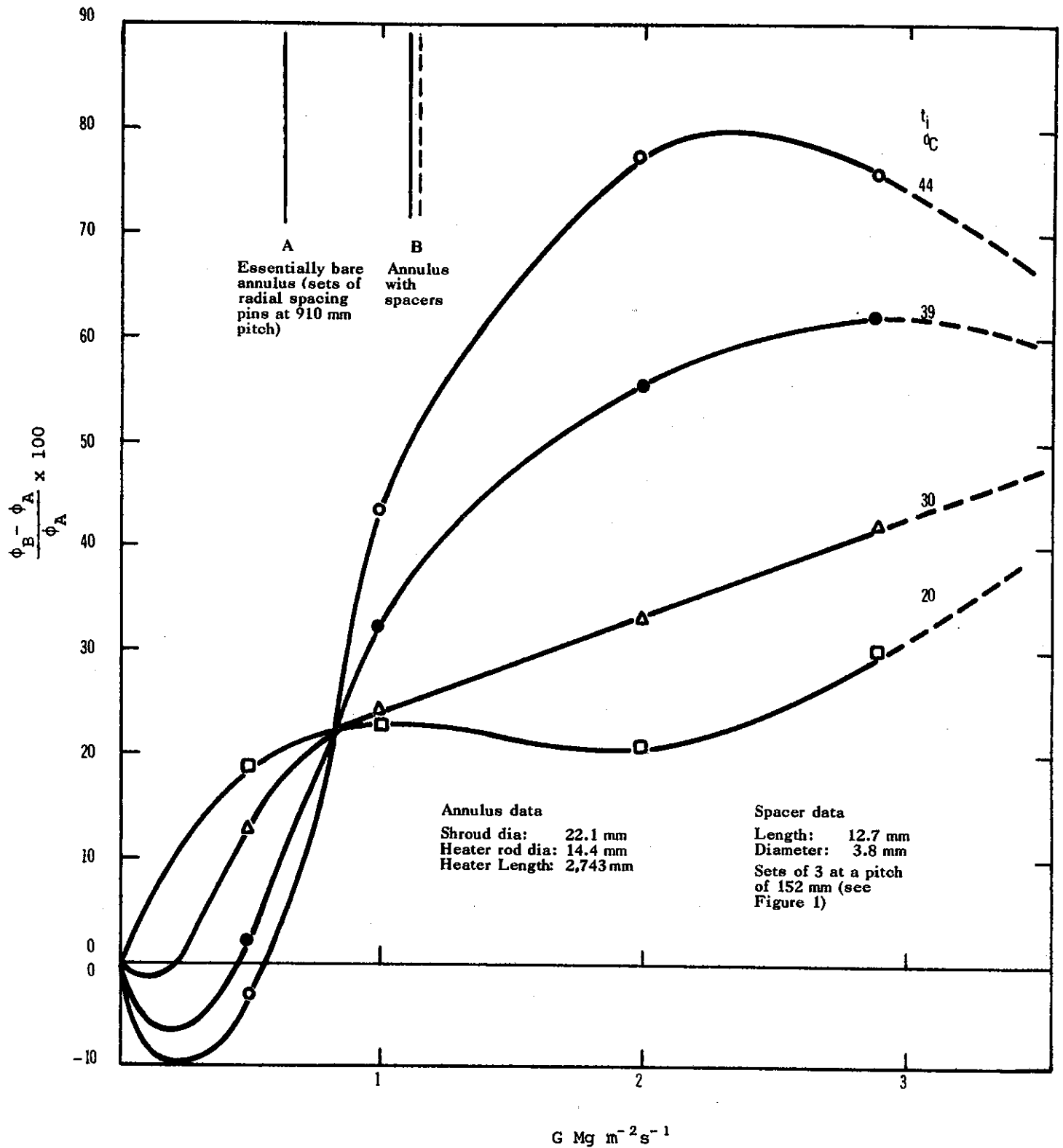


FIGURE 2. EFFECT OF SPACERS ON BURNOUT HEAT FLUX IN AN ANNULUS

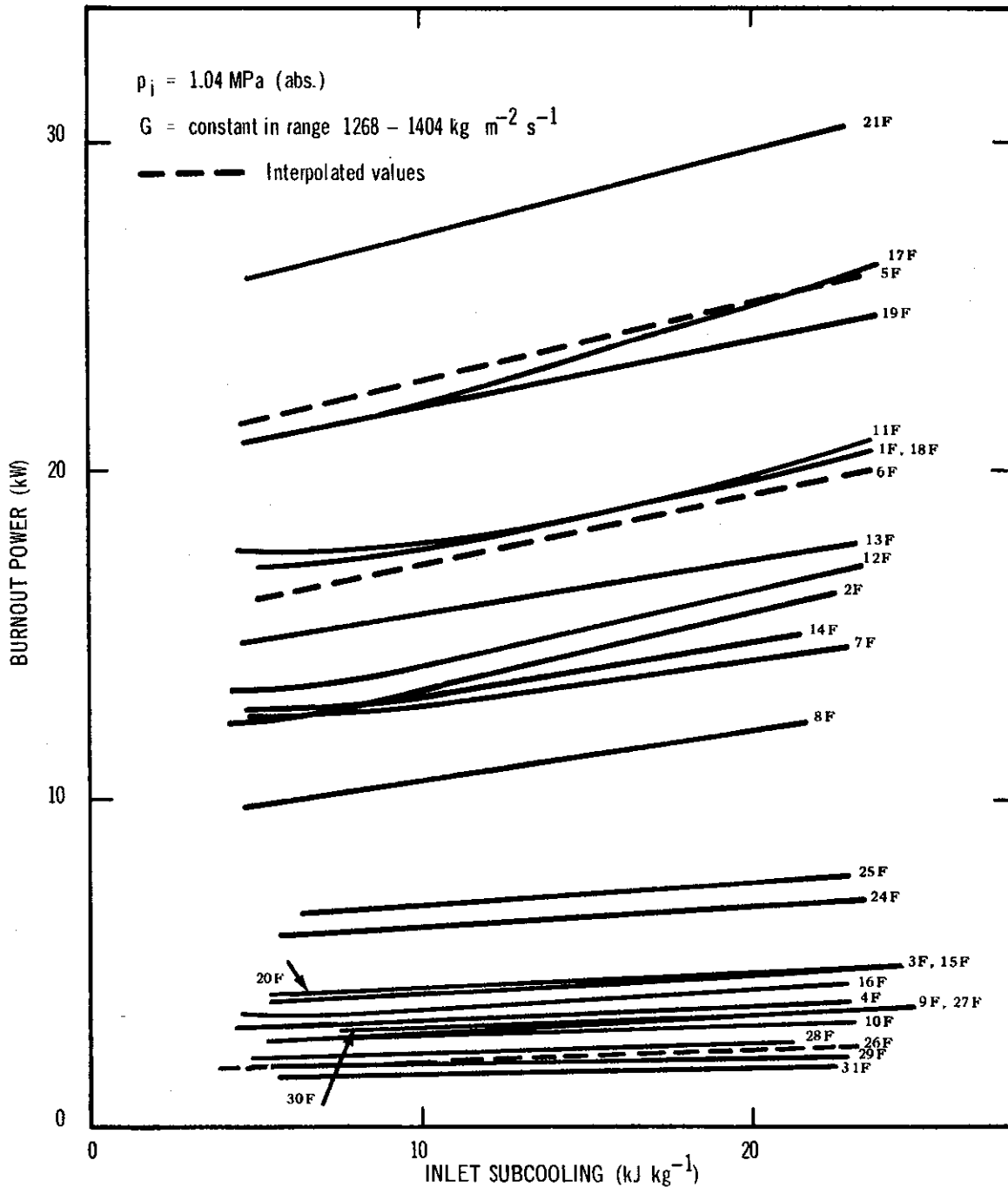


FIGURE 3. BURNOUT POWER VARIATION WITH INLET SUBCOOLING FOR ANNULUS TEST SECTIONS COOLED BY UPFLOW OF FREON-12

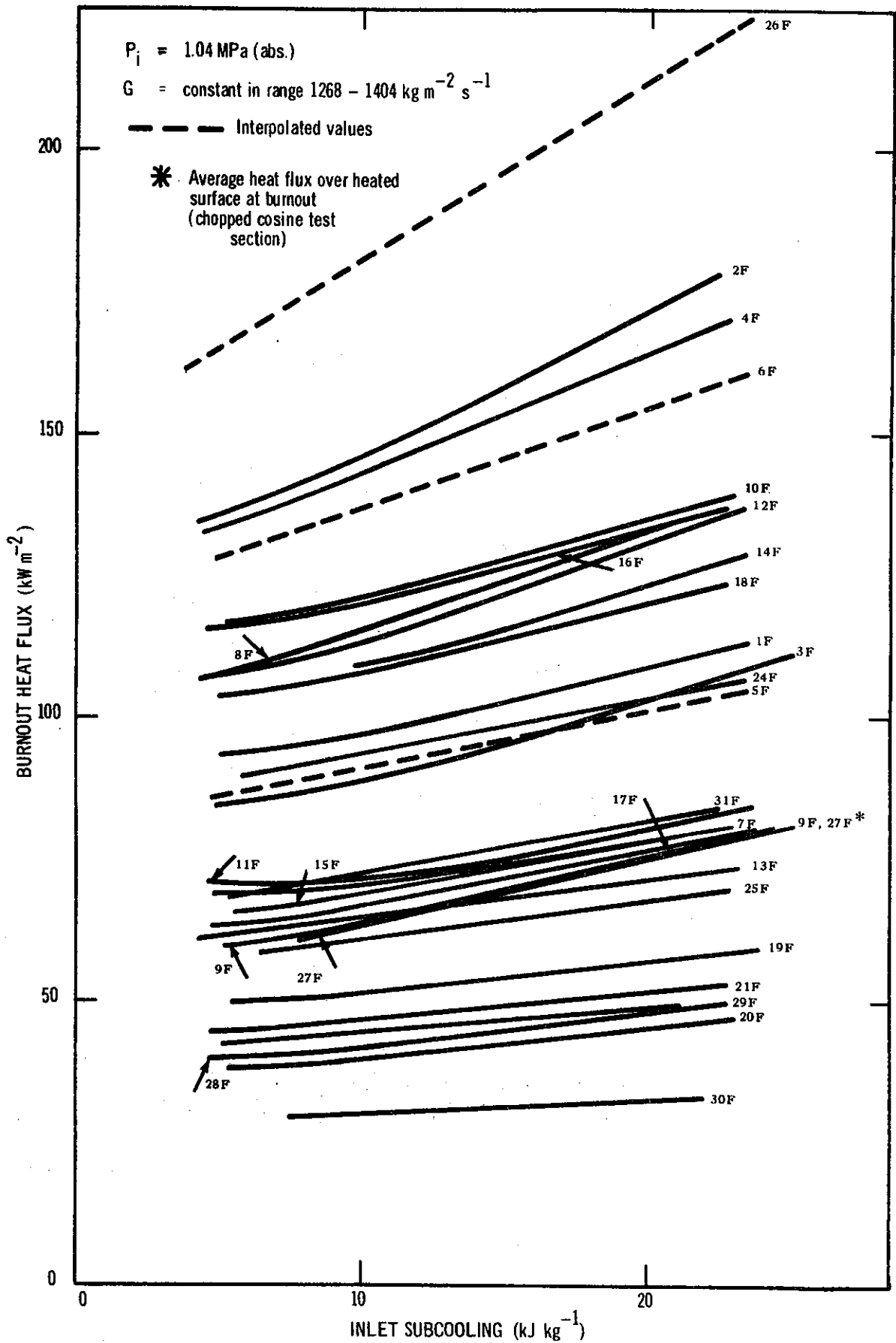
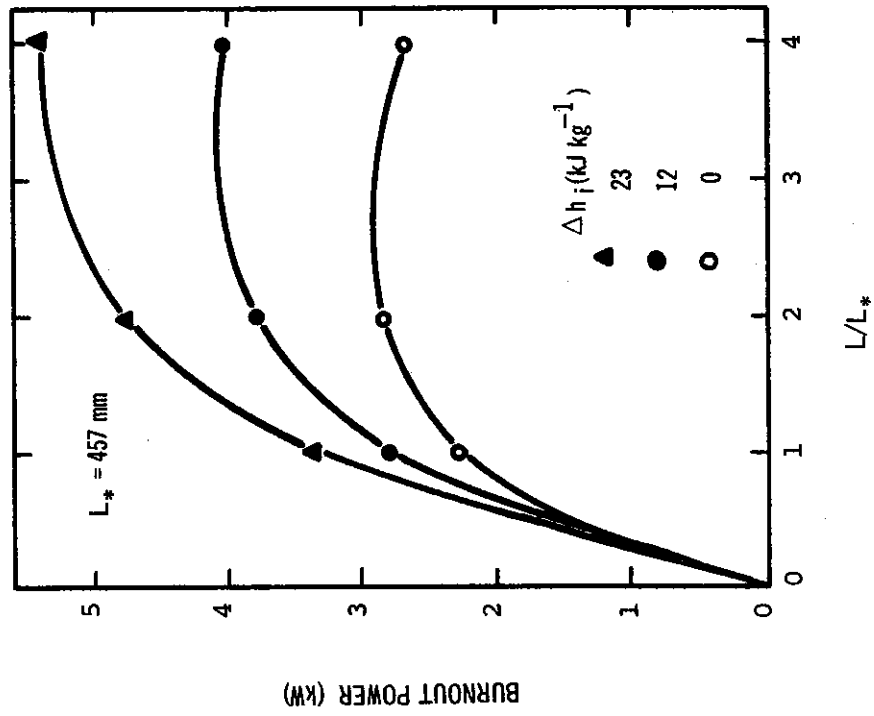
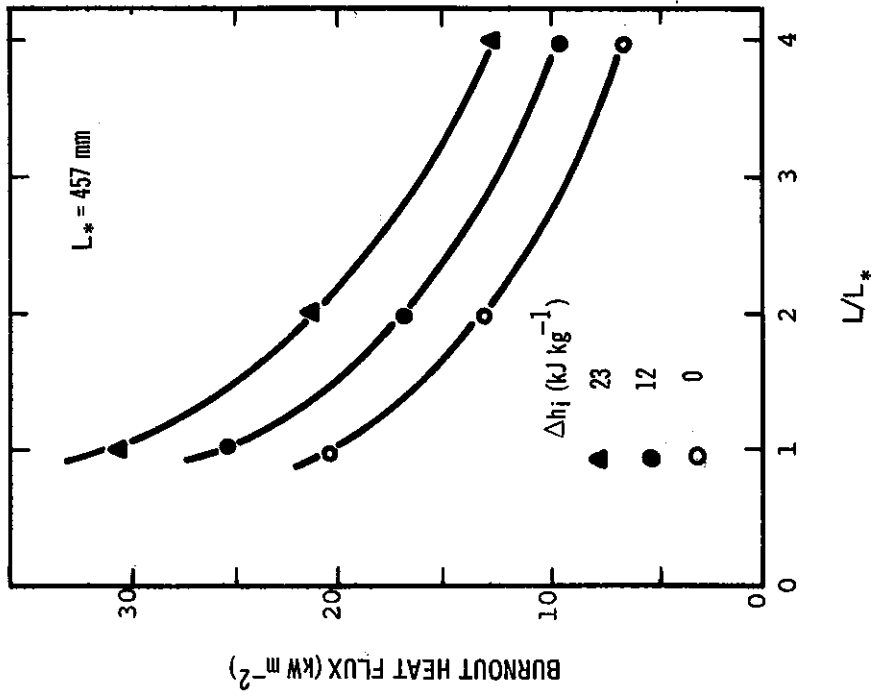


FIGURE 4. BURNOUT HEAT FLUX VARIATION WITH INLET SUBCOOLING FOR ANNULUS TEST SECTIONS COOLED BY UPFLOW OF FREON-12

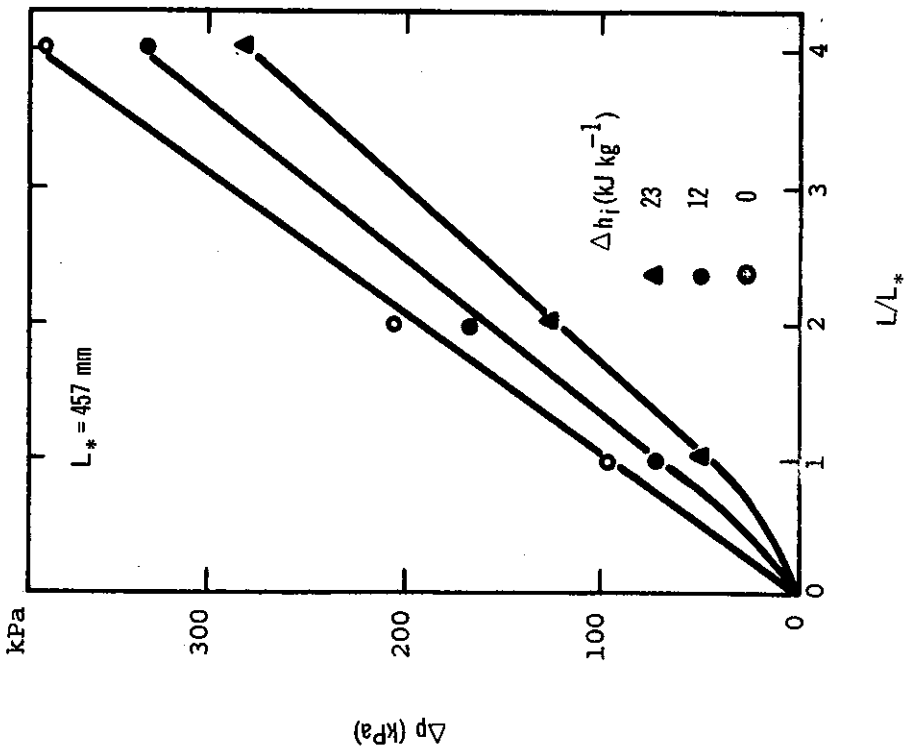


(a) VARIATION OF BOP WITH HEATED LENGTH
AT MASS VELOCITY OF $2.7 \times 10^3 \text{ kg m}^{-2} \text{ s}^{-1}$

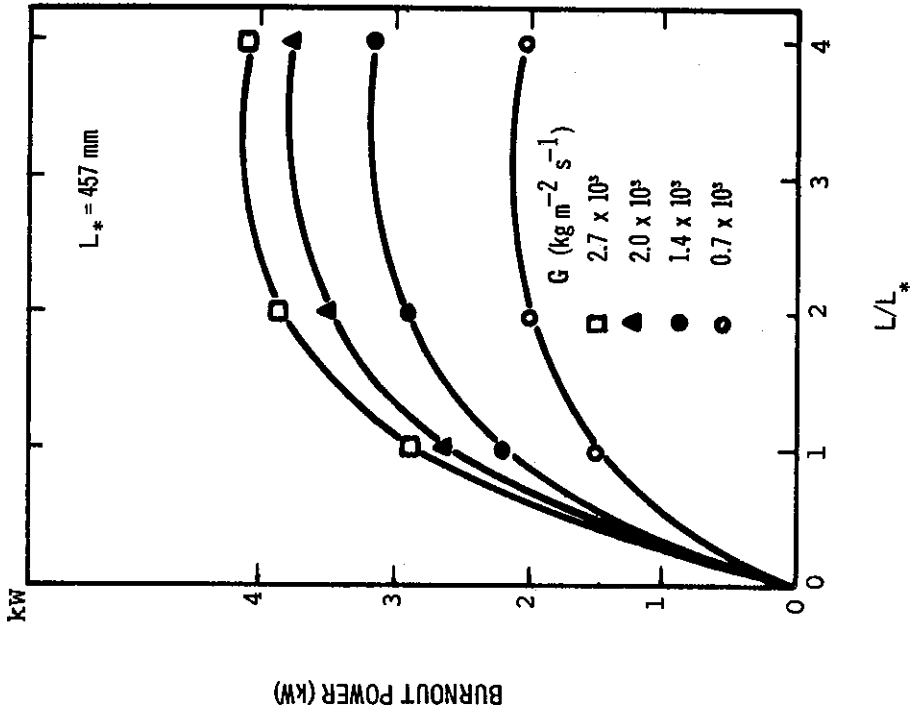


(b) VARIATION OF BHF WITH HEATED LENGTH
AT MASS VELOCITY OF $2.7 \times 10^3 \text{ kg m}^{-2} \text{ s}^{-1}$

FIGURE 5. THE EFFECT OF CHANGE IN HEATED LENGTH ON BURNOUT AND TEST SECTION PRESSURE DROP (TEST SECTIONS 9F, 10F, 26F)

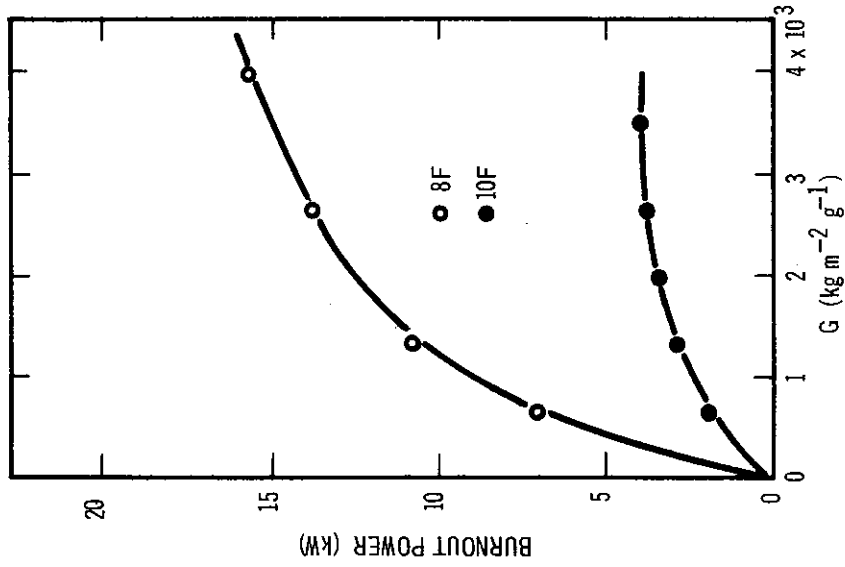


(c) VARIATION OF TEST SECTION PRESSURE DROP WITH HEATED LENGTH AT MASS VELOCITY OF $2.7 \times 10^3 \text{ kg m}^{-2} \text{ s}^{-1}$

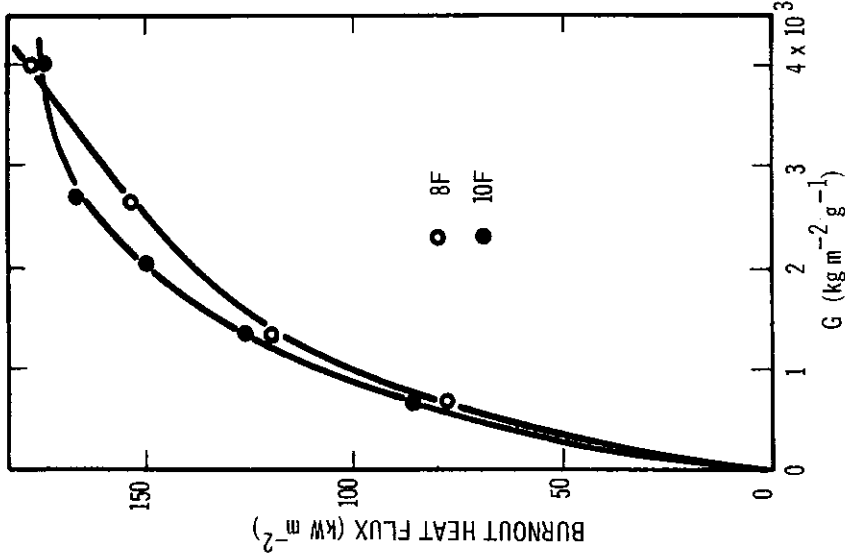


(d) VARIATION OF BOP WITH HEATED LENGTH AT INLET SUBCOOLING OF 12 kJ kg^{-1}

FIGURE 5. (contd.)



(a) VARIATION OF BURNOUT POWER WITH MASS VELOCITY AT $\Delta h_j = 12 \text{ kJ kg}^{-1}$ AND $L/D = \text{CONSTANT}$



(b) VARIATION OF BURNOUT HEAT FLUX WITH MASS VELOCITY AT $\Delta h_j = 12 \text{ kJ kg}^{-1}$ AND $L/D = \text{CONSTANT}$

FIGURE 6. THE EFFECT OF CHANGE IN ANNULUS SIZE ON BURNOUT AT L/D CONSTANT (TEST SECTIONS 8F, 10F)

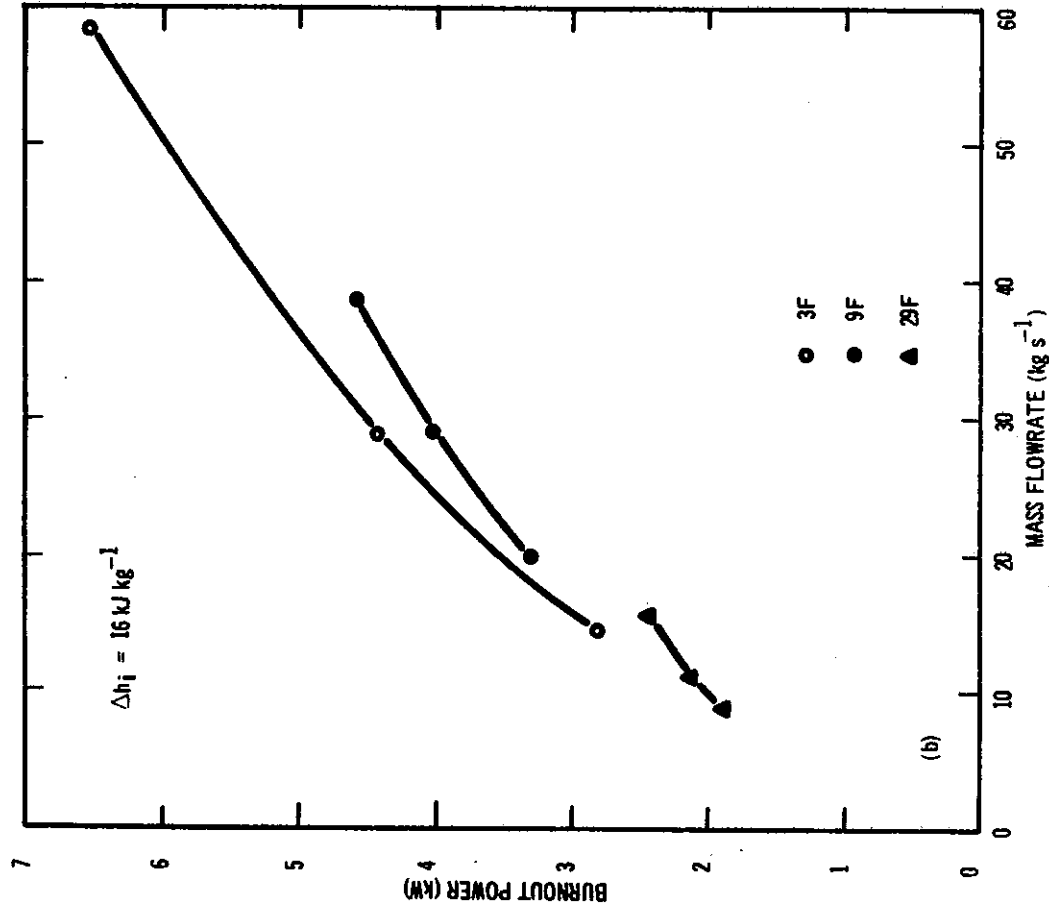
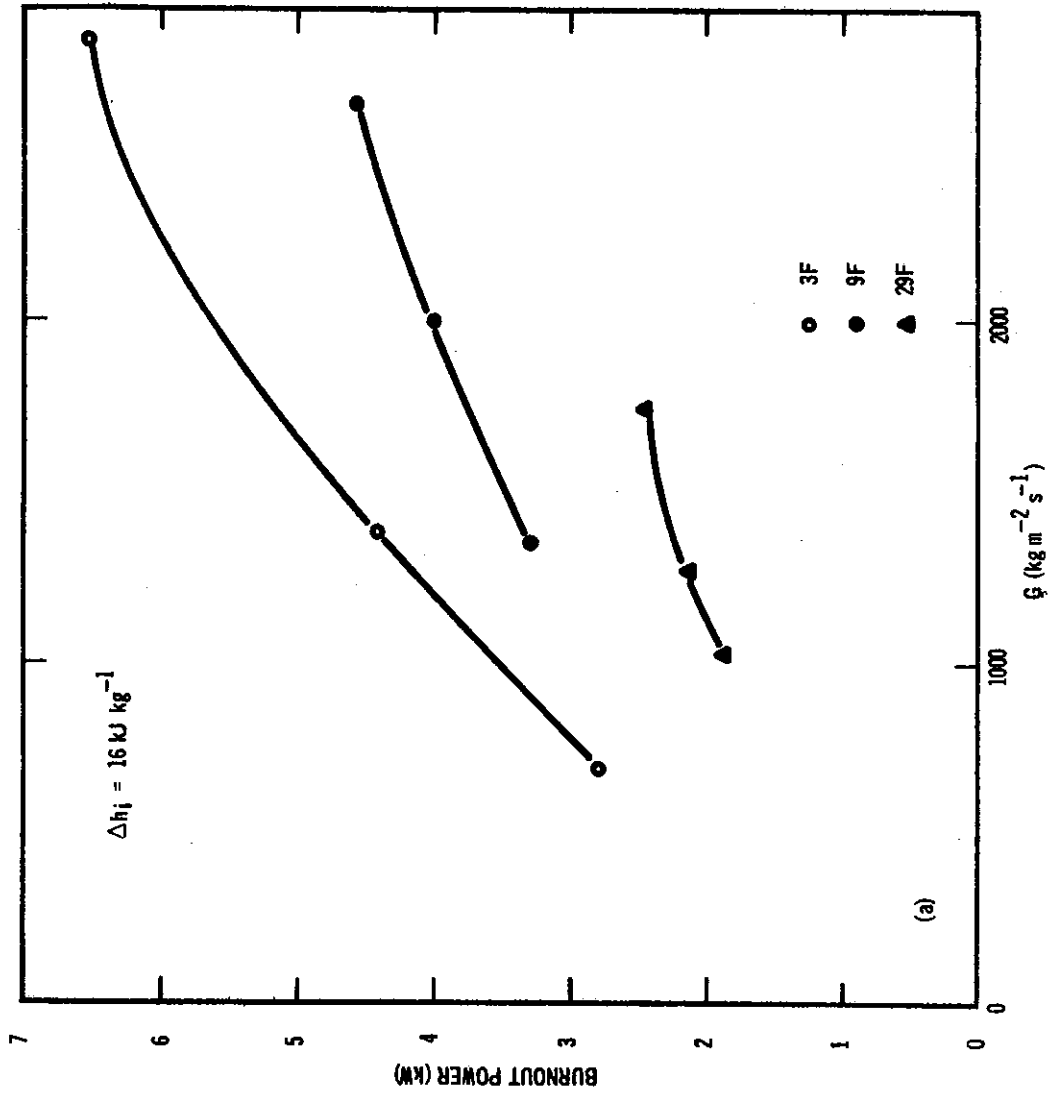


FIGURE 7. THE EFFECT OF CHANGE IN SHROUD DIAMETER ON BURNOUT
(TEST SECTIONS 3F, 9F, 29F)

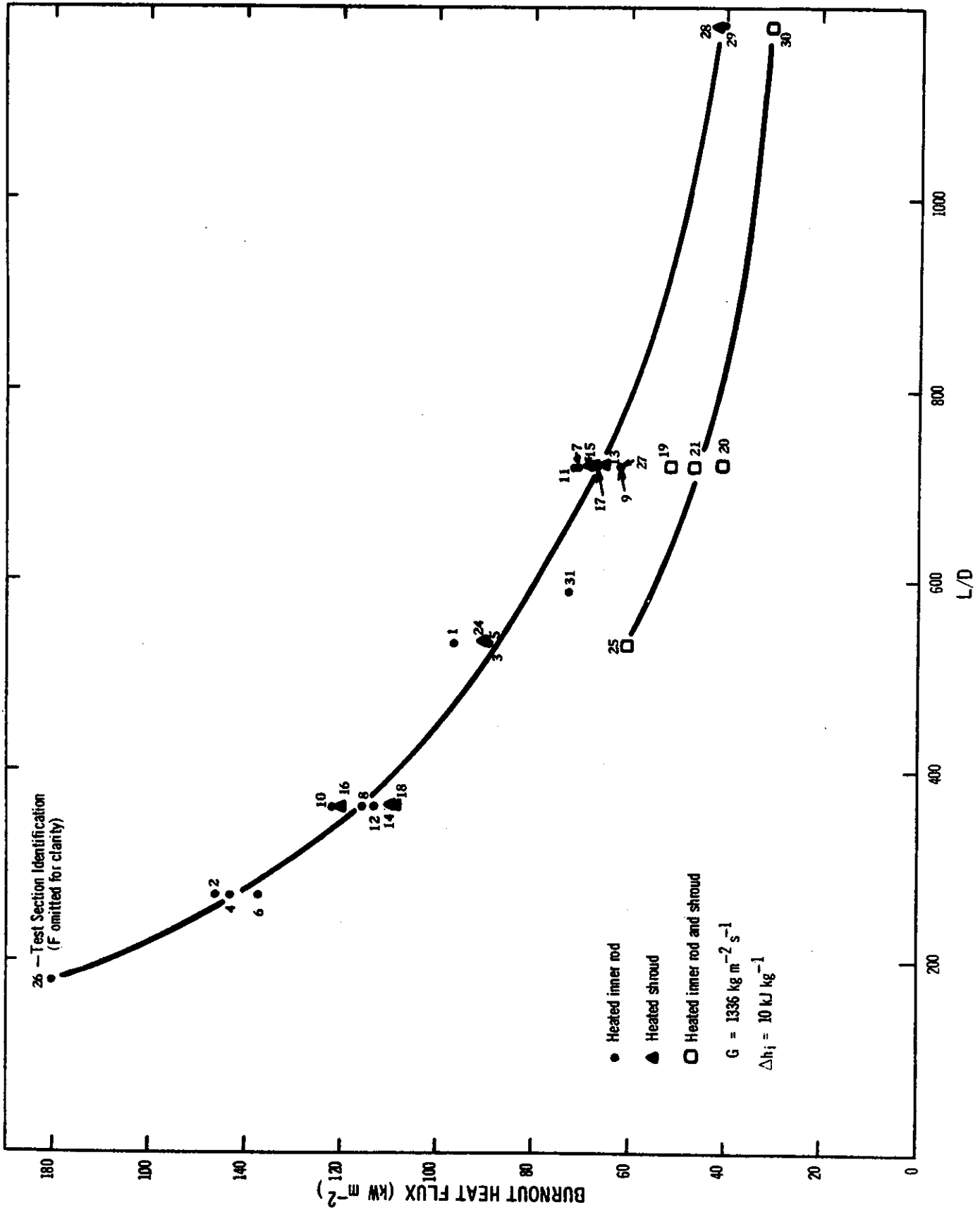


FIGURE 8. VARIATIONS OF BHF WITH L/D FOR ALL 29 TEST SECTIONS

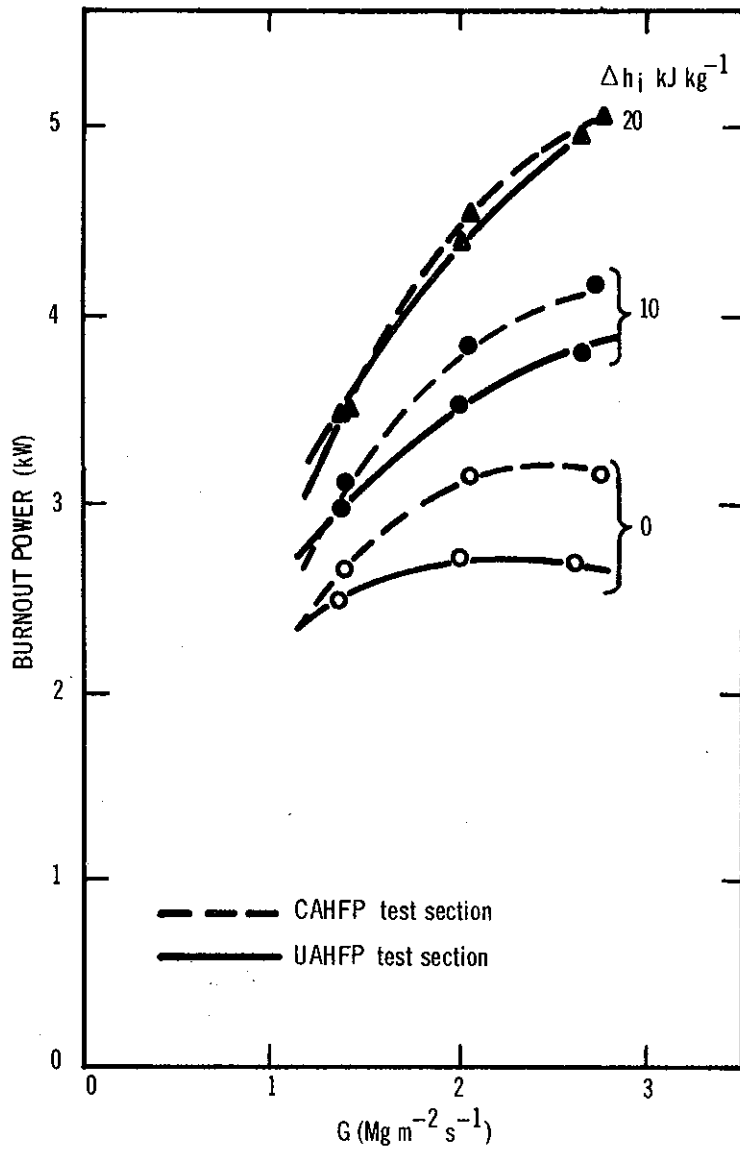


FIGURE 9. BOP VARIATION WITH MASS VELOCITY FOR COSINE (27F) AND UNIFORM HEAT FLUX PROFILE (9F) TEST SECTIONS

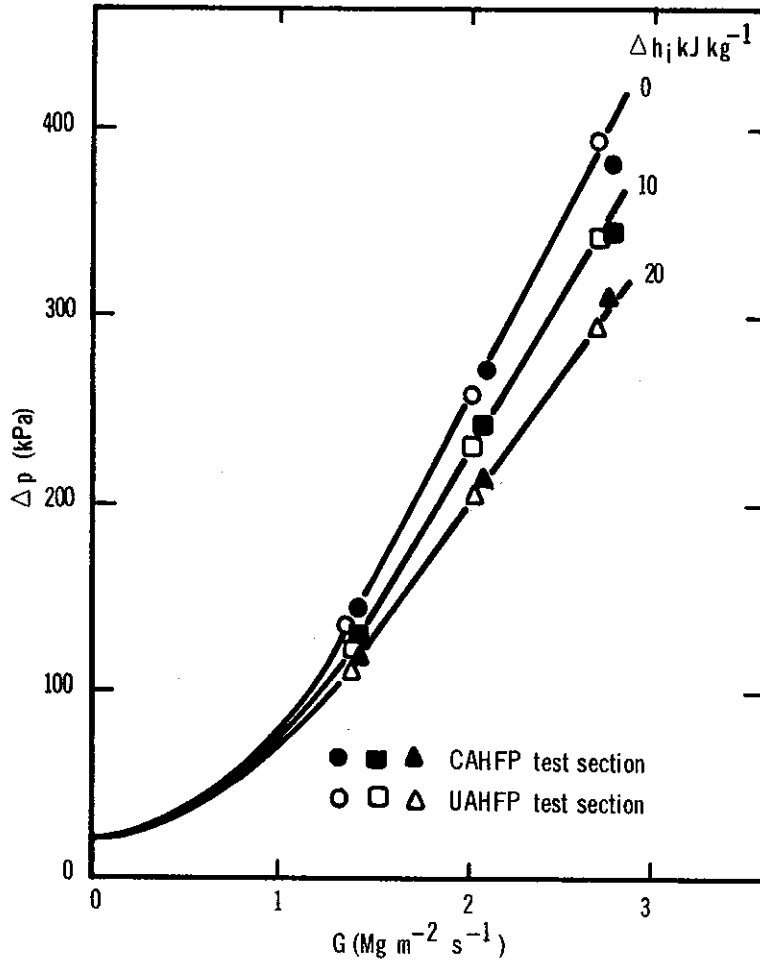


FIGURE 10. BURNOUT STATIC PRESSURE VARIATIONS WITH MASS VELOCITY FOR COSINE (27F) AND UNIFORM HEAT FLUX PROFILE (9F) TEST SECTIONS

