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ENGINEERING REPORT

HEAT AND SMOKE RELEASE RATE OF SEVEN
SEAT CUSHION CONFIGURATIONS WITH
FIRE BLOCKING LAYERS

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This report summarizes work performed at Douglas Aircraft Company for the FAA NASA-AIA round robin test.

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ABSTRACT

Seven seat cushion configurations were tested in a FAA-NASA-AIA round robin test program.

Materials were tested in an Ohio State University HRR chamber at 2.5 and 5.0 w/cm² heat flux. Heat and smoke release were measured, integrated and plotted. Fire blocking material used in the seat configurations showed different degrees of fire resistance during the tests. Vonar-3 showed the best results in delaying the ignition of foam and reducing heat release. However, all the total smoke release was higher than the baseline seat configuration without using fire blocking materials.

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I

INTRODUCTION

A round robin test program was initiated to compare data obtained on the same seat configurations representing various fire blocking combinations. The configurations were tested by several aircraft companies and agencies using their individual test procedures. Results were to be compared as the first step toward development of standardized tests.

The objective of this work was to evaluate the fire blocking performance in seven seat cushion configurations. As part of FAA-NASA-AIA round robin test program, seven seat cushion configurations were tested in the Ohio State University Heat Release Rate calorimeter chamber (OSU-HRR) at 2.5 W/cm^2 and 5.0 W/cm^2 for ten minutes.

The heat release rate and smoke release rate data were taken and plotted with a Hewlett Packard Data Acquisition Computer System. The flame spread, time of the fabric and foam involvement were observed and recorded. The heat and smoke release at 1.5, 3, 5 and 10 minute intervals were integrated, charted and compared.

II

MATERIALS AND EQUIPMENT

The identity of materials used in this test are listed in Table I. Seat cushions were constructed as shown in Table II. Wool-nylon, a decorative upholstery, with a urethane foam cushion was the baseline configuration. The materials were tested in the Douglas (modified) version of the Ohio State University Rate of Heat Release calorimeter (OSU-HRR). (See Figure 1.) The basic OSU-HRR calorimeter, and its operation, is described in Ref. 1 & 2. In its regular mode of operation, both heat and smoke evolution rates are measured as a test material burns within the apparatus chamber. Air flowing through the chamber is heated by the net heat of combustion released from the test sample. A three-junction thermocouple connected in series and located in the chimney forms a differential thermopile (TP) temperature measurement device with the series-connected three junction-thermocouples located in the cold air entering the bottom of the OSU-HRRF chamber. Quantitative measurements were calculated with respect to sample burn time normalized to kW/m^2 for $25.4 \text{ by } 25.4 \text{ cm}$ ($10 \times 10 \text{ in.}$) samples. The OSU-HRRF was calibrated by measuring the TP response for the known heating rate established by burning in the chamber natural gas of known heat output. The TP output signal (millivolts) was recorded over the entire burn time by a Hewlett Packard Automatic Data Acquisition System (HP-ADA). A smoke photometer located at the chimney outlet measured optical density changes as the sample generated smoke during a test. This was also recorded with the HP-ADAS. A specially modified, lightweight sample holder of low thermal capacitance was used to reduce heat absorption by the holder immediately following injection of the mounted sample into the OSU-HRR chamber. Samples were stored prior to testing in a laboratory atmosphere varying from 38- to 45-percent relative humidity.

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The electrically-powered Glowbar[®] radiant panel heating source was adjusted to the required thermal flux using a Hycal[®] Radiometer-Calorimeter and allowed to equilibrate to a constant level with air flowing through the chamber. In most tests, baseline-recorded temperature variations (noise) differentially recorded between the air input temperature and the exit stack of the OSU-HRR, were observed to hold within ± 0.5 division of chart (equivalent to approximately $1 \pm \text{kW/m}^2$ heat release). Approximate blackbody temperatures corresponding to each heat flux were: 2.5 W/cm^2 990°F (532°C); and 5 W/cm^2 , 1280°F (693°C). A mass loss transducer was used to determine mass burning rates.

III

PROCEDURE

The procedural steps for running the OSU-HRR are as follows:

1. Turn on and adjust the main air supply regulator for the OSU-HRR chamber to the selected airflow ($60 \text{ ft}^3/\text{min}$).
2. Turn on electrical power to the OSU-HRR Glowbar[®] radiant panel and adjust power input to selected radiant heat flux level (2.5 or 5.0 W/cm^2) as measured by standardized calorimeter. Ignite the internal chamber pilot light.
3. Switch on the electrical power to MLT unit and the smoke photometer.
4. Allow $1\text{--}1.5$ hours for warm up time.
5. Cut samples to size (10×10 inches) and mount in sample holder.
6. Turn strip chart recorder on and monitor readings from the DTP. Recorded (and equilibrated) DTP OSU-HRR baseline should not vary over a period of $\pm$ minutes by more than ± 0.02 millivolts.
7. The ADAS (HP3052, HP9885M and HP9825B) is initialized (see Figure 2) and the data channels check out to determine the instruments are operational.
8. The smoke photometer is calibrated at this time by adjusting its output using standard neutral density filters to set the span in millivolts corresponding to its calibration curve.

9. After the airflow rates have been adjusted accurately to the selected values (e.g., 56.32 ft³/min through the OSU-HRR chamber and 3.68 Ft³/min through the hold chamber of MLT), press "10 Data Aquisition Program" special funtion key and enter the following (see Figure 3):

- | | |
|-----------------------------|-------------------------------------|
| (a) Run no. | (g) Airflow rates, CFM |
| (b) Sample name | (h) Inlet air temp. °C |
| (c) Date | (i) Sample area, in ² |
| (d) Floppy disk no. | (j) Heat flux, W/cm ² |
| (e) Disk run no. | (k) Sample wt. grams |
| (f) Length of test, minutes | (l) MLT sensitivity factor, mv/100g |

10. Start the strip chart recorder and continue ADAS program.

Check ADAS baseline data printed out on the 9825B tape. Make last adjustments to smoke photometer span calibration points (millivolts).

11. Load sample/holder/injection mechanism assembly into the OSU-HRR hold chamber, clamp the seal door in place with radiation door still closed. Immediately turn the hold chamber air cooling valve to divert this airflow (3.67 ft³/min) through the MLT.
12. After one minute the baseline strip chart recorder will show recovery of analog baseline, continue the data aquisition with the ADAS to record all baseline into computer 9855M disk memory.
13. When the baseline scans are completed, open the radiation doors immediately and inject the sample into the inner burn chamber, closing the radiation doors at the same time to protect the MLT unit from radiant heat.
14. Immediately upon completing step 13, start the data aquisition mode on the ADAS controller. This is time zero for the burn test. Start the digital electronic time at the same moment.
15. After the burn test is completed, remove the sample/hold/injection mechanism from the OSU-HRR, vacuum clean the ashes, spalling off the burn specimen residue from the hold chamber and the bottom of the inner OSU-HRR chamber.

CAUTION: Take care to avoid contact with the hot globars when vacuuming ashes from the chamber and the bottom of the inner OSU-HRR chamber.

16. Approximately 30 to 40 minutes after step 15, is completed, the DTP OSU-HRR baseline will reestablish. Repeat run can be started again.

Each seat configuration was tested in triplicate at heat fluxes of 3.5 and 5.0 W/cm². Samples were prepared by cutting the urethane foam (1/2" thick) and fire blocking materials to the size of 10" x 10". The decorative upholstery was cut to the size of 12" x 12", so it could be wrapped around the edge of the sample. A drip-pan was attached to the bottom of the sample holder to prevent the melted urethane foam from dripping to the bottom of the test chamber. Total airflow used in these tests was 60 CFM.

IV

RESULTS

The results are charted in Figures 4 through 11. Figures 4 and 5 were for "sample ignition time." Figures 6 and 7 were for "integrated heat release at 1.5, 3, 5 and 10 minutes." Figures 8 and 9 were for "integrated smoke release at 1.5, 3, 5 and 10 minutes." Figures 10 and 11 show the "total heat and smoke release."

The typical heat and smoke release curves of each sample at each heat flux were plotted and shown in Figures 12 through 39.

Ignition time of the samples (front surface and back surface), char yield, maximum peak of heat and smoke release, and integration of heat and smoke release at 1.5, 3, 5 and 10 minutes were summarized in Table 111.

V

DISCUSSION

The test condition such as airflow rate, the ratio of airflow which flows across the test sample, the length of test time, the thickness and size of each component used in the sample, the length of time when the sample was in the holding chamber, the test chamber cool down time between tests, are all very important variables and have a critical impact on the test results. Changing of test conditions could change the results significantly. Also it might cause difficulties in comparing results from two different test conditions.

VI

CONCLUSION

During all the tests, the samples were burned completely in less than 10 minutes. The fire started on the front surface within 3 to 6 minutes (see Figures 4 and 5). The fire started at the back of surface of the samples within 5 to 300 seconds (see Figures 6 and 7). The heat release rate and time to ignition of the back surface of the sample varied due to the different fire blocking materials. At a heat flux of 2.5 W/cm², the

heat release rate and total heat release of seat configurations #2 and #8 were also the lowest compared to all the other seat configurations except seat configuration #1. The seat configuration #1 (as a baseline) without using any fire blocking materials had the lowest mass. However, the total smoke release of all the seat configurations were much higher than the seat configuration #1. Higher mass and fire retardent chemicals in all the seat configurations with fire blocking layer could have contributed to this result.

VII

REFERENCES

1. ASTM E.5.020.03, Heat Release Rate, Test Methods, "Draft of a Test for Heat and Visible Smoke Release Rates in Materials and Products," Revised, March 18, 1977.
2. E. E. Smith, "Measuring Rate of Heat, Smoke, and Toxic Gas Release," Fire Tech. 8,237, 1972.

TABLE I
MATERIAL SOURCES

NO.	MATERIAL	SOURCE
17	#2043 urethane foam, fire-retarded (FR), 2.0 lb/ft ³ , 43 11.D	North Carolina Foam Ind. P. O. Box 1112 Mount Airy, NC 27030
4	Urethane foam, non-fire retarded (NF), 1.4 lb/ft ³ , 24-35 11.D	CPR Div. of Upjohn Torrance, CA (213) 320-3550
9	Vonar-3, 3/16 inch thick with Osnaburg cotton scrim, 23.5 oz/yd ²	Chris Craft Industries 1980 East State Street Trenton, NJ 08619
129	Norfab 11HT26-Aluminized, 11.3 oz/yd ² aluminized one side only	Amatex Corporation 1032 Stanbridge St. Norristown, PA 19404 (215) 277-6100
101	Gentex preox (celiox), 12.6 oz/yd ² , aluminized one side only	Gentex Corporation Main Street P. o. Box 315 Carbondale, PA 18407
5	Wool nylon, 0.0972 lb/ft ² 90% wool/100% nylon, R76423 sun eclipse, azure blue 78-3080 (ST7427-115, color 73/3252)	Collins and Aikem P. O. Box 5000 Albemarle, NC 28001
2	Same as #9 except 2/16 inches thick, 19.9 oz/yd ²	Same as #9
20	LS-200 foam, 3/8 inch thick, 33.7 oz/yd ² , LS-200 foam, 3-4 inches thick	Toyad Corporation 21 Plant Road Latrobe, PA 15650 (412) 537-7754

TABLE 11

SEAT CUSHION CONFIGURATIONS FOR FIRE TEST METHODS EVALUATION

CONFIGURATION	DECORATIVE UPHOLSTERY	FIRE-BLOCKING LAYER	FOAM	COMMENTS
1	Wool-Nylon	None	FR Urethane	Baseline
2	"	Vonar - 3	"	Cotton Scrim
4	"	3/8" - LS-200	"	
5	"	Celiox 101	"	
6	"	Norfab 11Ht-26-AL	"	
8	"	Vonar - 3	NF Urethane	Cotton Scrim
9	"	^F Norfab 11HT-26-AL	NF Urethane	

TABLE III
SUMMARY OF SEVEN SEAT CONFIGURATIONS FIRE TEST DATA

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	FRONT FIRE START @ sec	BACK FIRE START @ sec	FLAME COMPLETE OUT @ sec	MAX HEAT Kw/m ² @ sec	INTEGRATED HEAT RELEASE - Kw-min./m ²				MAX SMOKE ssu/m ² @ sec	INTEGRATED SMOKE RELEASE SSU/m ²				SAMPLE WEIGHT GRAMS	CHAR YIELD WT. %
						1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0		
Wool-Nylon/ none/ FR Urethane Run #12582	2.5	-	53	251	64 (73)	33	87	123	141	24.5 (58)	9.7	22.3	25.1	27.2	63.4	5
Run #12682	2.5	5	53	231	83.4 (59)	54	104	141	160	39.4 (52)	13.6	21.1	23.3	25.4	-	-
Run #10682	2.5	4	58	190	79 (40)	69	116	137	152	24 (34)	12.2	16.4	17.2	18.6	66.6	12
Average	2.5	5	55	231	75 (57)	52	102	134	151	29 (48)	11.8	20	22	24	65	8.5
Wool-Nylon/ Vonar-3/ FR Urethane Run #10882	2.5	5	370	633	37 (48)	27	30	30	98	22 (414)	2.1	2.7	8.1	44.7	169	29.9
Run #10982	2.5	5	268	520	37 (55)	28	36	47	135	53 (302)	2.1	4.7	22	73.9	150	26.7
Run #12882	2.5	5	263	495	36 (50)	27	32	46	142	54 (306)	2.7	4.5	27	79	159.6	23
Average	2.5	5	300	549	37 (51)	27	33	41	125	43 (340)	2.3	4.0	19	66	159.5	26.5
Wool-Nylon/ 3/8" LS200/ FR Urethane Run #11082	2.5	3	164	410	44 (202)	29	35	104	186	54 (207)	2.3	4.5	65	76	153	25
Run #11182	2.5	5	164	400	53 (213)	31	38	116	202	62 (202)	2.5	5.4	70	80	164	25.5
Run #11282	2.5	8	173	330	43 (231)	32	38	105	188	42 (223)	1.7	2.7	57	70	155	24
Average	2.5	5	167	380	47 (216)	31	37	108	192	53 (210)	2.2	4.2	64	75	157.3	25

TABLE III (Cont'd)

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	FRONT FIRE START @ sec	BACK FIRE START @ sec	FLAME COMPLETE OUT @ sec	MAX HEAT Kw/m ² @ sec	INTEGRATED HEAT RELEASE - Kw-min./m ²				MAX SMOKE ssu/m ² @ sec	INTEGRATED SMOKE RELEASE SSU/m ²				SAMPLE WEIGHT GRAMS	CHAR YIELD WT. %
						TIME INTERVAL - minutes					TIME INTERVAL -minutes					
						1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0		
Wool-Nylon/ Celiox 101/ FR Urethane Run #11382	2.5	6	69	260	62 (84)	46	106	161	202	27.7 (87)	11	23	27	31	99.2	12.5
Run #11482	2.5	5	64	270	57 (87)	46	108	146	176	23 (83)	9.6	22	24	26	96.7	16
Run #11582	2.5	7	67	320	60 (91)	45	99	157	204	29 (93)	7.3	21	26	27	97.6	-
Average	2.5	6	66	283	60 (87)	46	104	155	194	27 (27)	9.3	22	26	28	97.8	14.3
Wool-Nylon/ Norfab 11HT-26-A1/ FR Urethane Run #11682	2.5	5	69	249	70 (92)	49	126	172	213	31 (81)	16	40	41	43	103	15.3
Run #11782	2.5	7	73	255	67 (122)	36	119	173	225	35 (97)	14	44	53	62	110	4.1
Run #11882	2.5	6	61	261	74 (86)	53	134	182	228	49 (77)	24	53	59	67	103	14.2
Average	2.5	6	68	255	70 (100)	46	126	176	222	38 (85)	18	46	51	57	105.3	11.2
Wool-Nylon/ Vonar-3/ NF Urethane Run #11982	2.5	5	336	602	38 (51)	29	34	37	97	37 (355)	4.2	12.0	28.9	96	150	26.3
Run #12082	2.5	5	280	580	39 (51)	29	35	41	109	47 (302)	9.2	19.5	40.8	96	142	16.9
Run #15182	2.5	5	198	466	39 (52)	30	39	72	129	46 (208)	6	12	69	87	140	20.4
Average	2.5	5	238	549	39 (51)	30	36	50	112	43 (288)	6.5	14.5	46	93	144	21.1

TABLE III (Cont'd)

SAMPLE IDENTIFICATION	HEAT FLUX W/cm^2	FRONT FIRE START @ sec	BACK FIRE START @ sec	FLAME COMPLETE OUT @ sec	MAX HEAT Kw/m^2 @ sec	INTEGRATED HEAT RELEASE - $Kw-min./m^2$				MAX SMOKE ssu/m^2 @ sec	INTEGRATED SMOKE RELEASE SSU/m^2				SAMPLE WEIGHT GRAMS	CHAR YIELD WT. %
						1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0		
Wool-Nylon/ Norfab 11HT-26-A1/ NF Urethane Run #12282	2.5	5	50	220	63 (73)	50	114	153	187	37 (71)	17.9	33.4	34.7	37.2	96.7	10.2
Run #12382	2.5	5	65	170	54 (109)	42	107	145	177	29 (85)	16	35.4	36.5	38.1	97.1	16.4
Run #12482	2.5	6	59	180	54 (117)	40	102	144	180	34 (80)	17	32	34.2	37.4	97.6	14.9
Average	2.5	5	58	190	57 (100)	44	108	147	181	33 (79)	17	33.6	35	37.6	97.1	13.8
Wool-Nylon/ None/ FR Urethane Run #12982	5.0	3	17	180	77 (30)	62	108	127	129	45 (20)	17	26	27	30	67.4	7.1
Run #13082	5.0	3	14	187	80 (28)	70	118	140	153	46 (22)	17	24	25	26	65.6	-
Run #13182	5.0	3	17	171	74 (29)	66	113	130	134	47 (23)	20	26	26	29	65.6	6.8
Average	5.0	3	16	179	77 (29)	66	113	132	138	46 (22)	18	25	26	28	66.2	7.0
Wool-Nylon/ Vonar-3/ FR Urethane Run #13282	5.0	4	100	260	55 (22)	46	97	141	182	84 (121)	22	84	97	100	-	-
Run #13382	5.0	3	61	261	61 (109)	53	117	158	192	118 (106)	28	108	115	117	145.9	16.6
Run #13482	5.0	3	90	269	55 (23)	46	90	130	164	75 (120)	22	71	83	85	142.6	13.6
Average	5.0	3	83	263	57 (51)	48	107	143	179	92 (116)	24	88	98	101	144.1	15.1

TABLE III (Cont'd)

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	FRONT FIRE START @ sec	BACK FIRE START @ sec	FLAME COMPLETE @ sec	MAX HEAT Kw/m ² @ sec	INTEGRATED HEAT RELEASE - Kw-min./m ²				MAX SMOKE ssu/m ² @ sec	INTEGRATED SMOKE RELEASE SSU/m ²				SAMPLE WEIGHT GRAMS	CHAR YIELD WT. %
						1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0		
Wool-Nylon/ 3/8" LS200/ FR Urethane Run #14882	5.0	3	85	270	64 (123)	49	113	161	201	87 (117)	23	80	92	94	159.1	17.4
Run #14982	5.0	3	78	275	61 (115)	49	114	162	201	109 (112)	24	102	114	118	161.6	11.0
Run #15082	5.0	2	80	265	64 (115)	50	118	164	201	110 (107)	31	110	122	133	158.2	12.3
Average	5.0	3	81	270	63 (117)	49	115	162	201	102 (113)	26	97	109	115	159.6	13.6
Wool-Nylon/ Celiox 101/ FR Urethane Run #13582	5.0	3	27	172	68 (55)	74	131	166	204	41 (25)	30	43	46	54	98.2	3.9
Run #13682	5.0	3	30	173	58 (75)	28	90	133	191	36 (69)	26	41	44	51	97.1	2.8
Run #13782	5.0	3	35	175	79 (57)	81	133	165	197	53 (30)	37	45	45	47	95.9	-
Average	5.0	3	31	173	68 (62)	61	118	155	197	43 (41)	31	43	45	51	97.1	-
Wool-Nylon/ Norfab 11H-26-A1/ FR Urethane Run #14182	5.0	3	34	170	78 (68)	82	141	175	200	58 (65)	47	56	57	60	106	6
Run #14282	5.0	3	32	170	73 (71)	80	142	178	209	56 (63)	48	60	62	68	106	11
Run #14382	5.0	3	32	160	75 (68)	83	139	171	196	67 (24)	51	60	61	63	102.3	15.2
Average	5.0	3	33	166	75 (69)	82	141	175	202	60 (51)	49	59	60	64	104.8	10.7

TABLE III (Cont'd)

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	FRONT FIRE START @ sec	BACK FIRE START @ sec	FLAME COMPLETE OUT @ sec	MAX HEAT Kw/m ² @ sec	INTEGRATED HEAT RELEASE - Kw-min./m ²				MAX SMOKE ssu/m ² @ sec	INTEGRATED SMOKE RELEASE SSU/m ²				SAMPLE WEIGHT GRAMS	CHAR YIELD WT. %
						1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0		
Wool-Nylon/ Vonar-3/ NF Urethane Run #13882	5.0	4	100	241	59 (22)	48	92	131	165	80 (115)	29	91	106	117	149	18.5
Run #13982	5.0	4	104	260	60 (23)	50	102	136	167	99 (114)	26	91	101	102	148.3	18.1
Run #14082	5.0	3	102	268	59 (22)	48	96	132	164	85 (125)	24	86	101	104	151	19.0
Average	5.0	4	102	256	59 (22)	49	97	133	165	88 (118)	26	89	103	107	149.4	18.5
Wool-Nylon/ Norfab 11HT-26-A1/ NF Urethane Run #124482	5.0	3	20	150	75 (63)	85	132	160	184	77 (21)	53	62	66	77	98.1	16.8
Run #14582	5.0	3	30	145	72 (66)	80	127	155	174	65 (24)	48	54	54	55	98	9.0
Run #14682	5.0	3	30	151	68 (63)	78	123	151	168	60 (31)	44	49	49	51	95.5	7.0
Average	5.0	3	26	149	72 (64)	81	127	155	175	67 (25)	48	55	56	61	97.2	10.9

HP AUTOMATIC DATA ACQ. SYSTEM

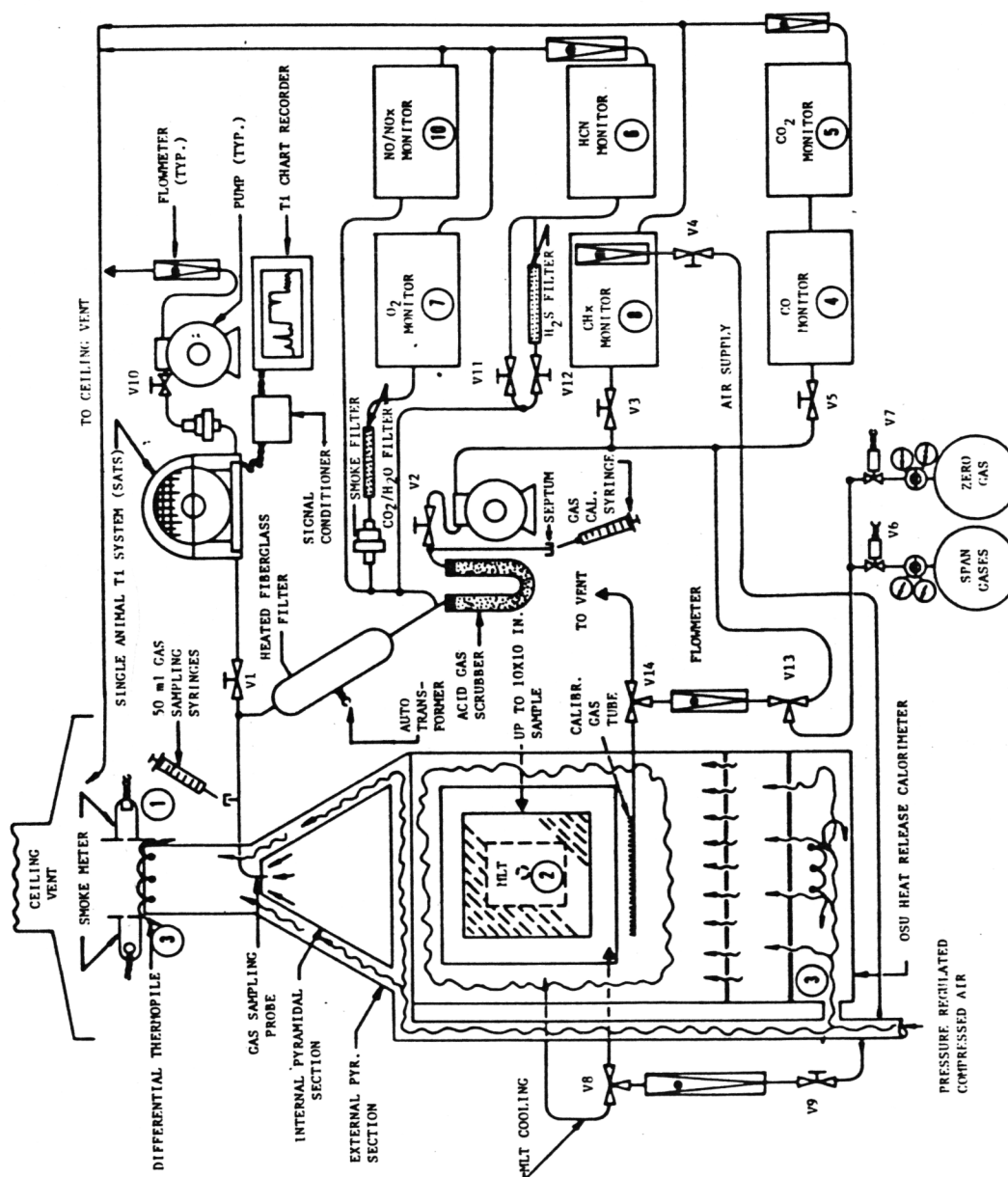
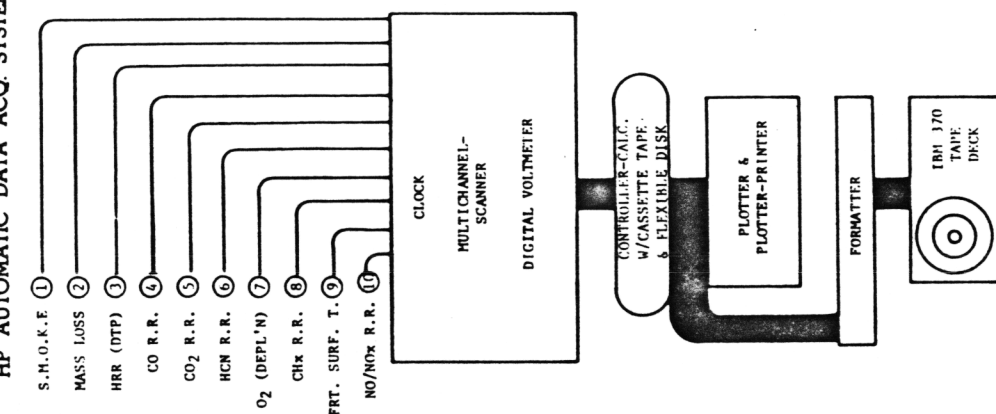


FIGURE 1. SCHEMATIC DIAGRAM OF THE COMBINED HAZARDS ANALYSIS SYSTEM

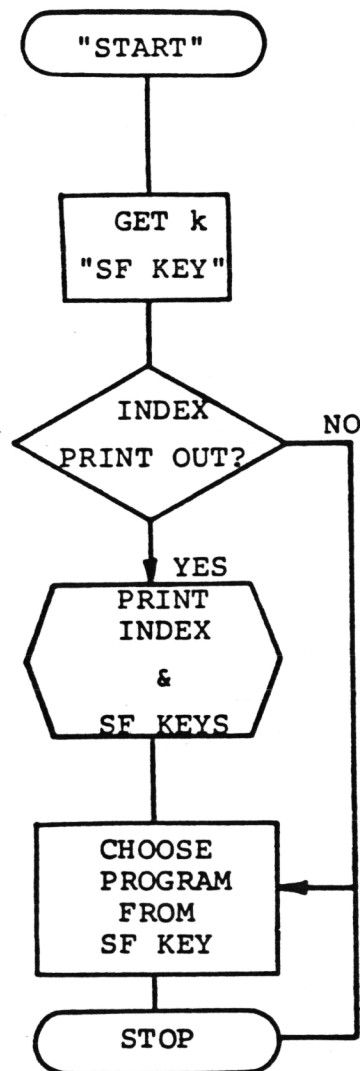


FIGURE 2. DATA AQUISITION COMPUTER PROGRAM PRELIMINARY SETUP

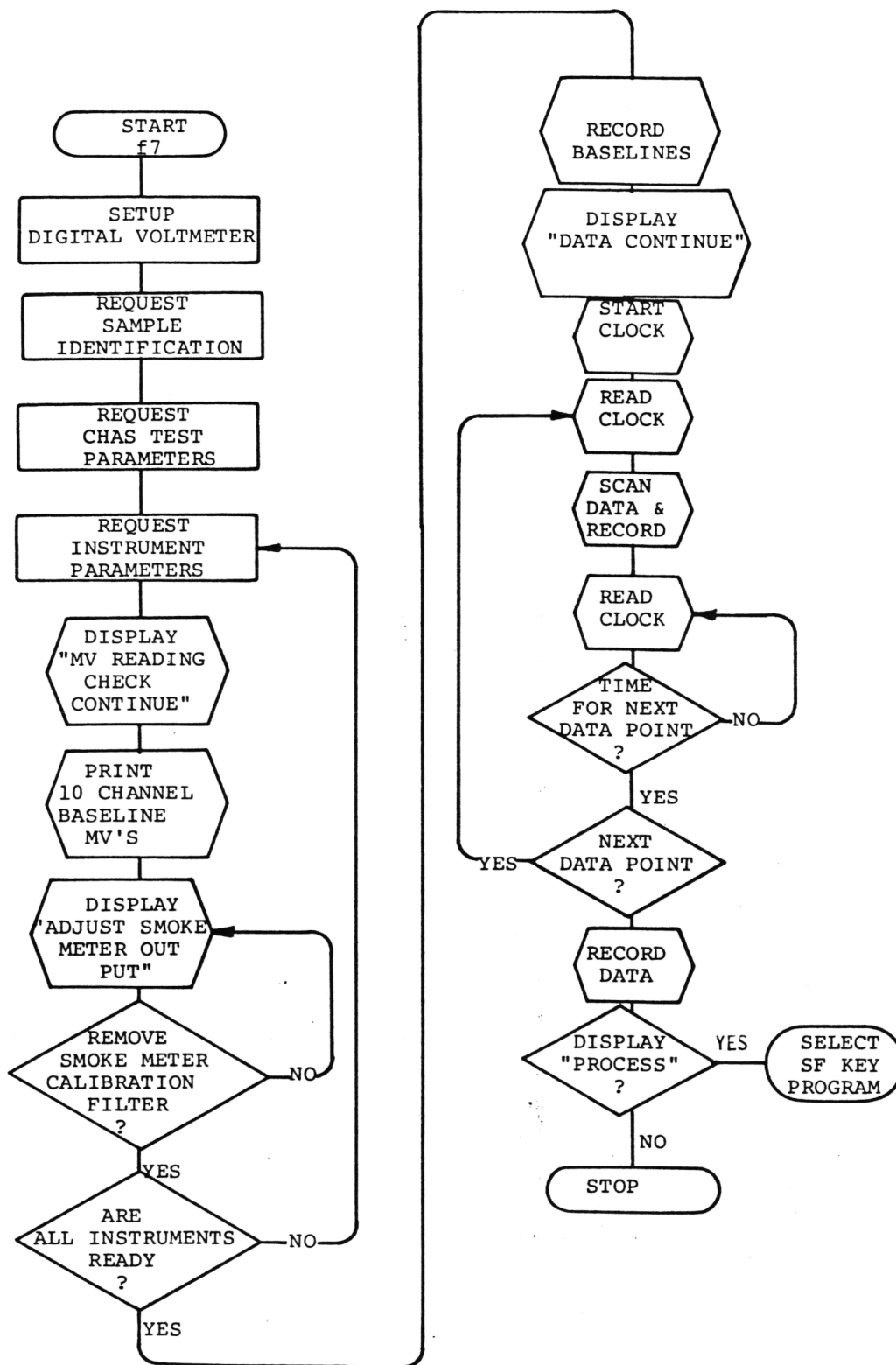


FIGURE 3. CHAS DATA ACQUISITION COMPUTER PROGRAM /

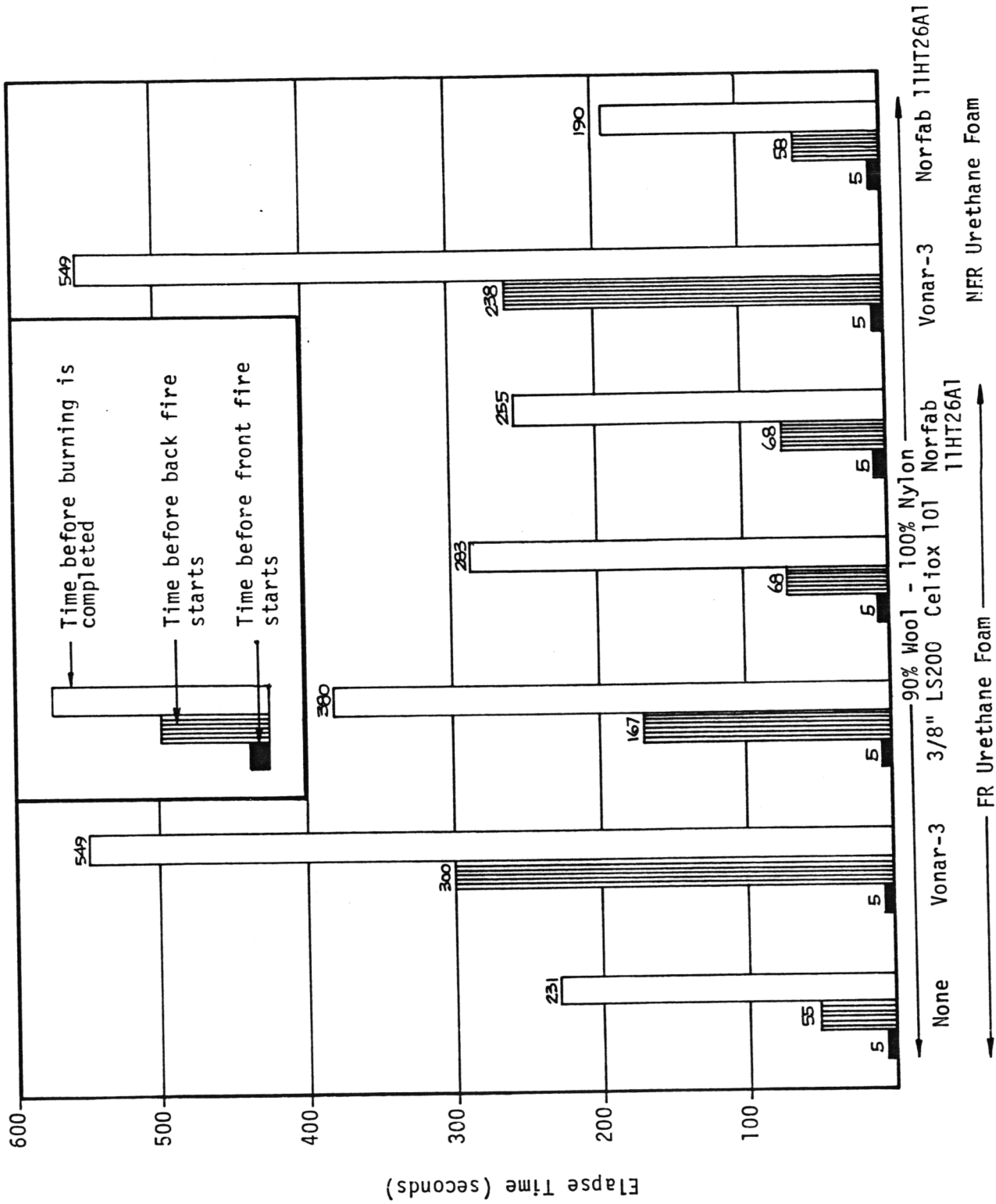


FIGURE 4. FIRE INVOLVEMENT OF SEVEN SEAT CUSHION CONFIGURATION AT 2.5 W/cm²

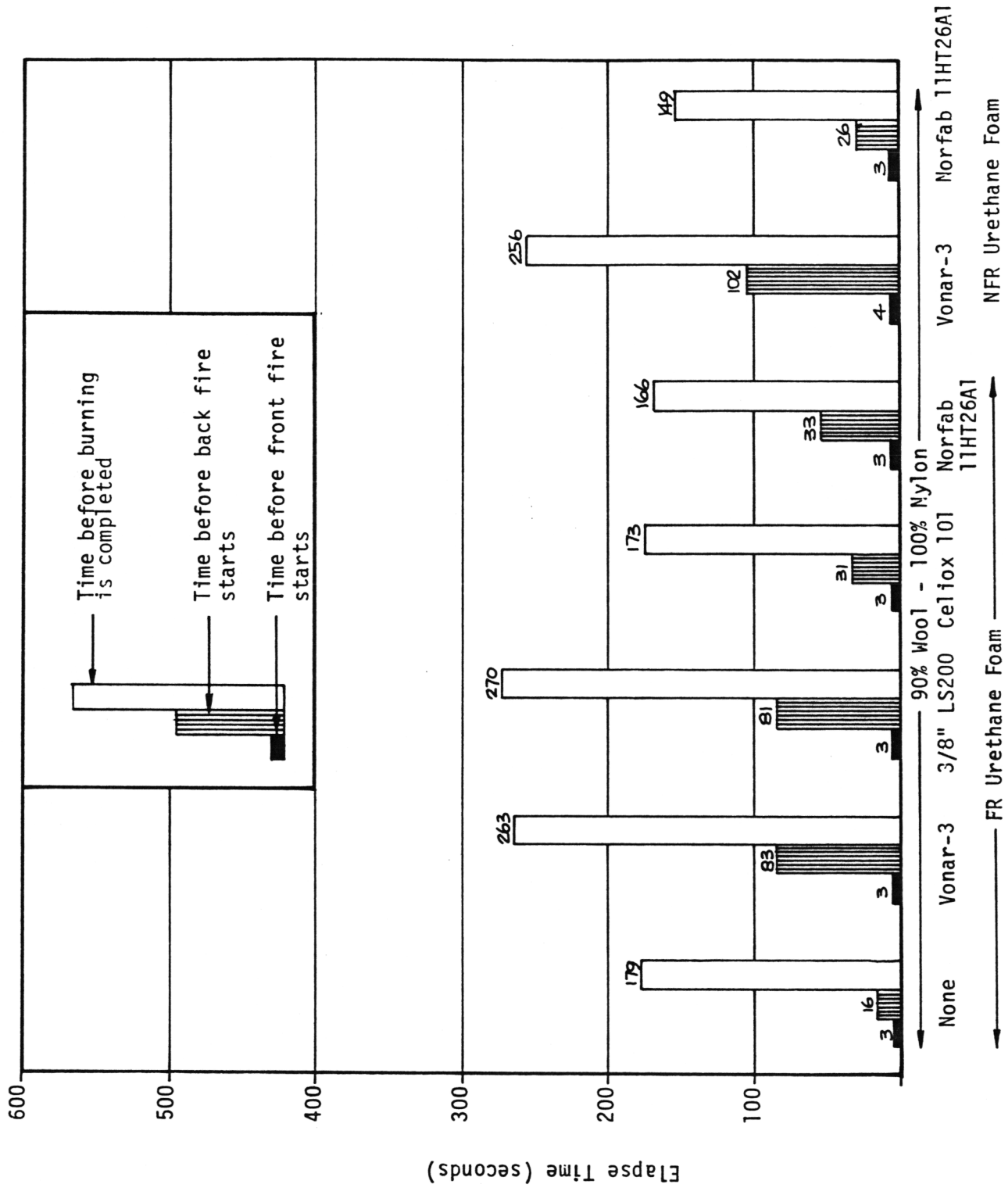


FIGURE 5. FIRE INVOLVEMENT OF SEVEN SEAT CUSHION CONFIGURATIONS AT 5.0 W/cm²

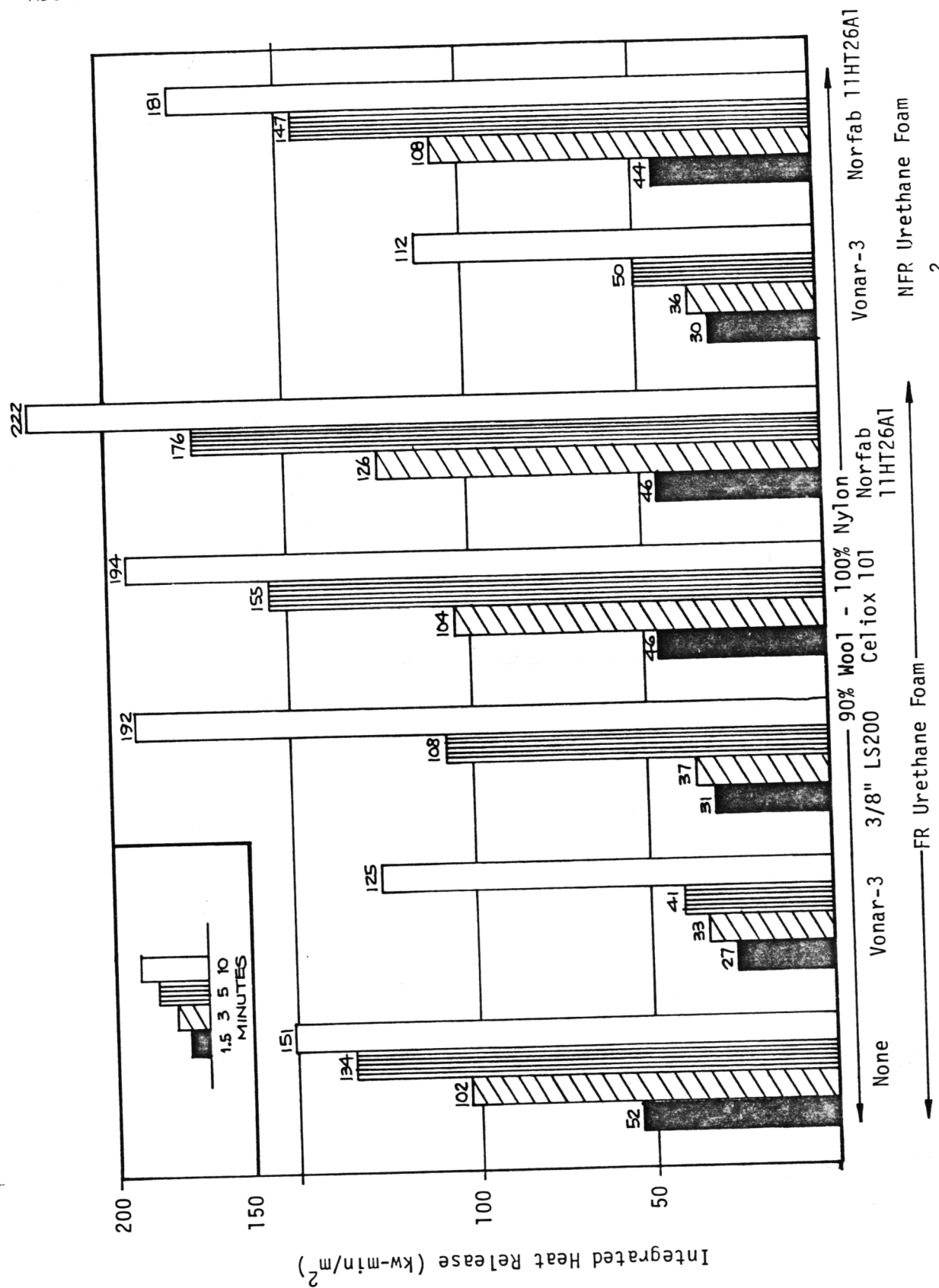
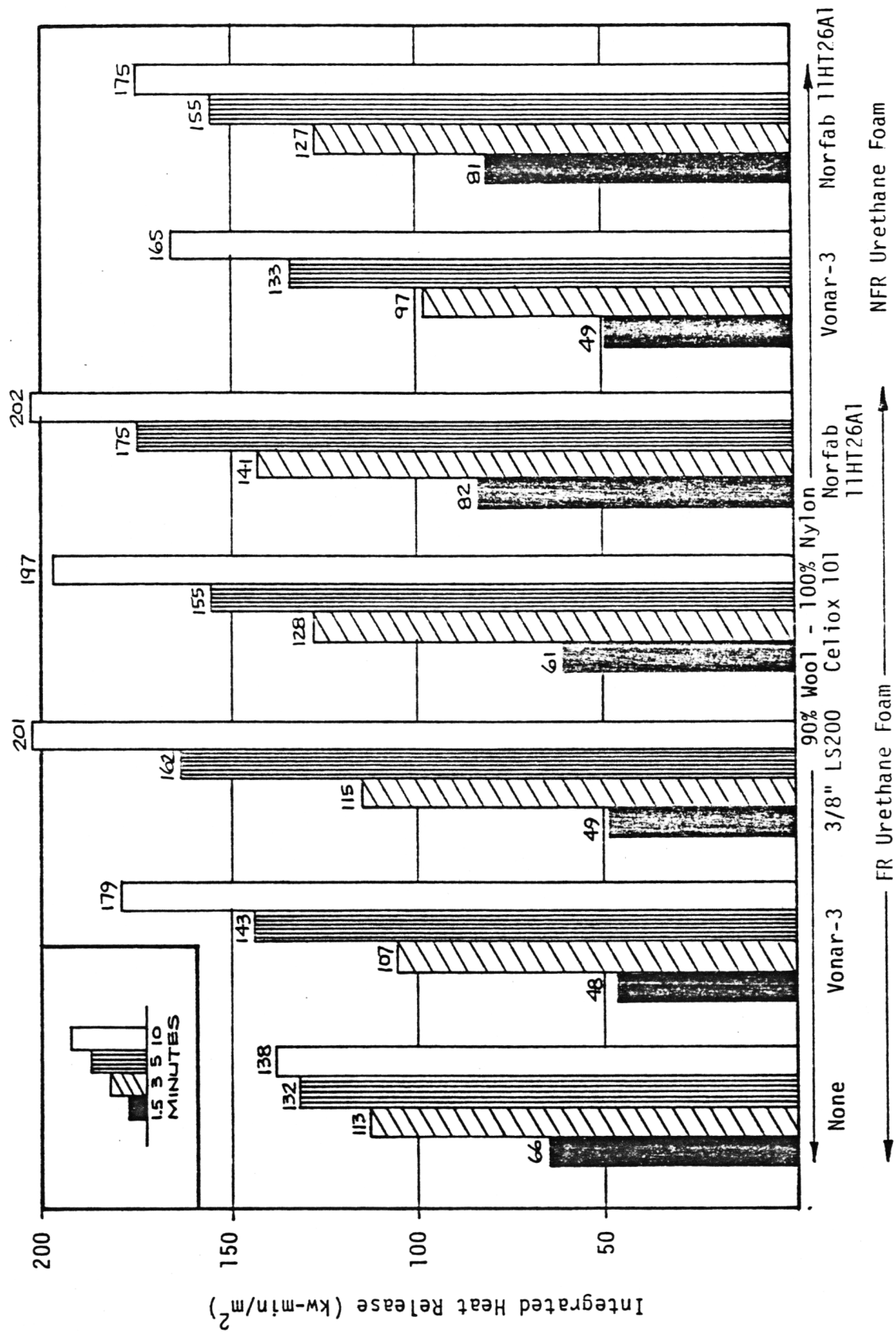


FIGURE 6. INTEGRATED HEAT RELEASE OF SEVEN SEAT CONFIGURATIONS AT 2.5 W/cm²

FIGURE 7. INTEGRATED HEAT RELEASE OF SEVEN SEAT CONFIGURATION AT 5.0 W/cm²

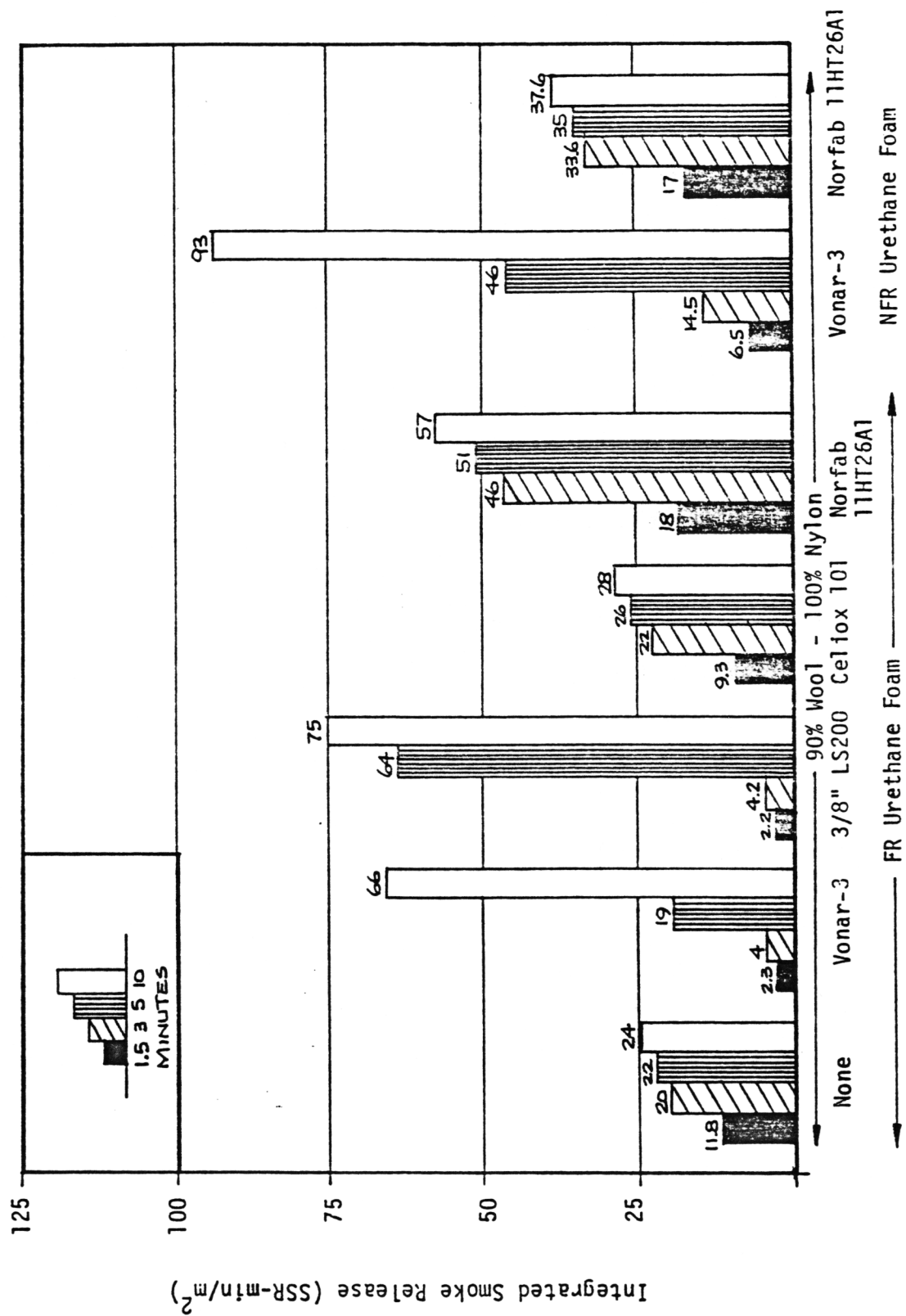


FIGURE 8. INTEGRATED SMOKE RELEASE OF SEVEN SEAT CONFIGURATIONS AT 2.5 W/cm²

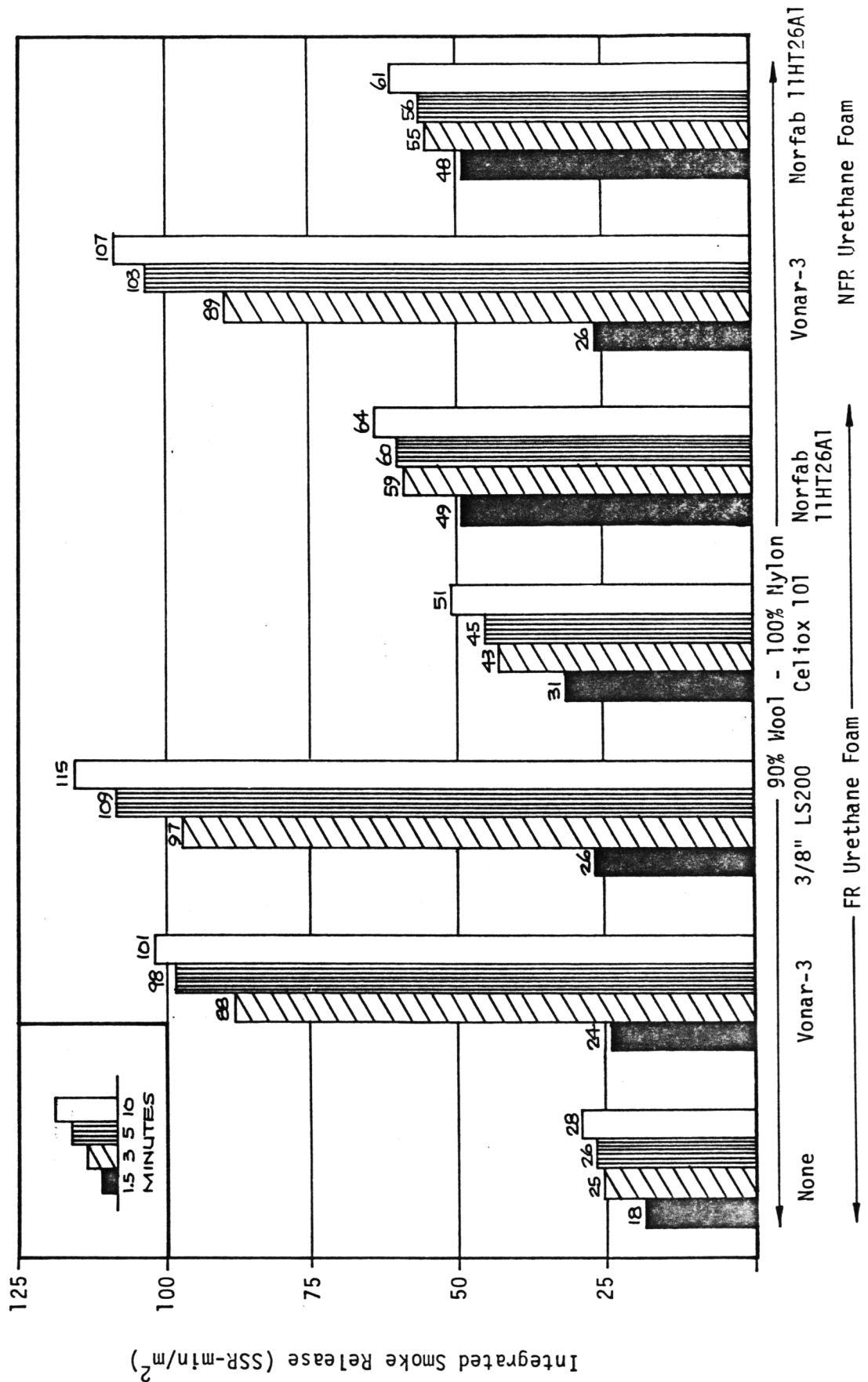


FIGURE 9. INTEGRATED SMOKE RELEASE OF SEVEN SEAT CONFIGURATIONS AT 5.0 W/cm²

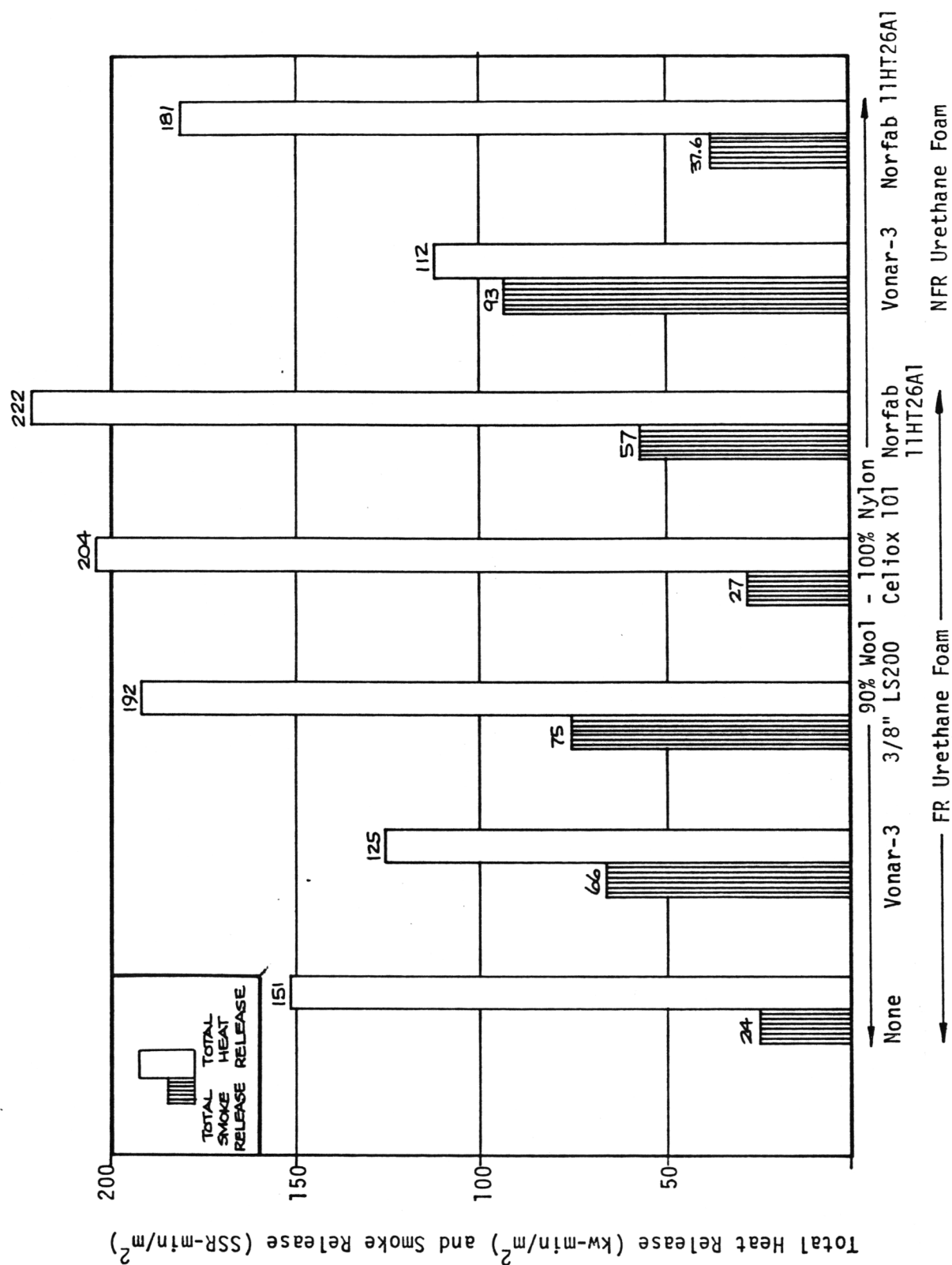


FIGURE 10. TOTAL HEAT RELEASE AND SMOKE RELEASE OF SEVEN SEAT CONFIGURATIONS AT 2.5 W/cm²

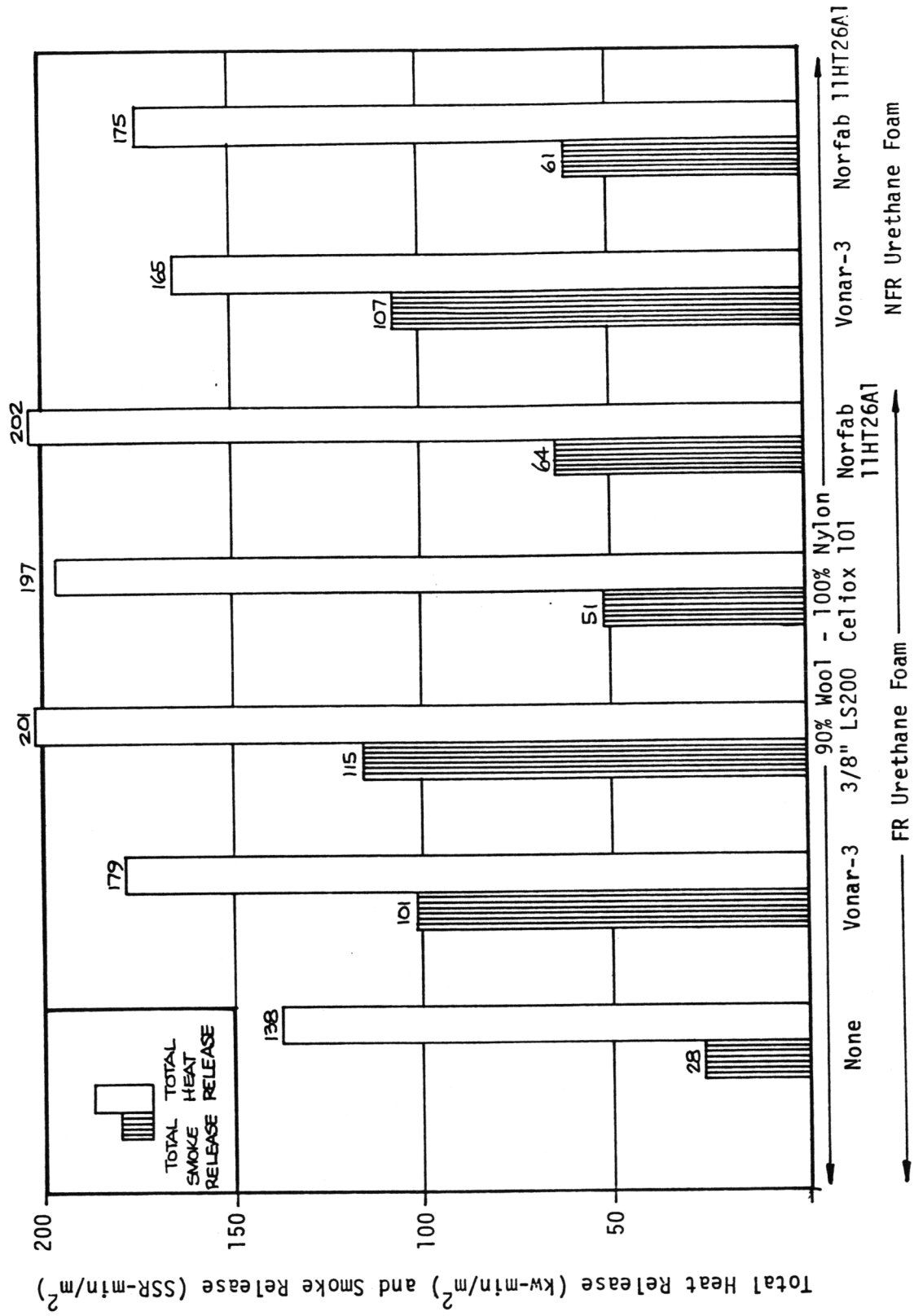


FIGURE 11. TOTAL HEAT RELEASE AND SMOKE RELEASE OF SEVEN SEAT CONFIGURATIONS AT 5.0 W/cm²

RUN# 12682
 WL-NY/F.R.U
 HEAT FLUX 2.5 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE
 (KW MIN/M²) MIN
 25.2 1
 53.9 1.5
 104.4 3
 141 5
 160 10
 MAX. PEAK AT 59 SEC
 83.39

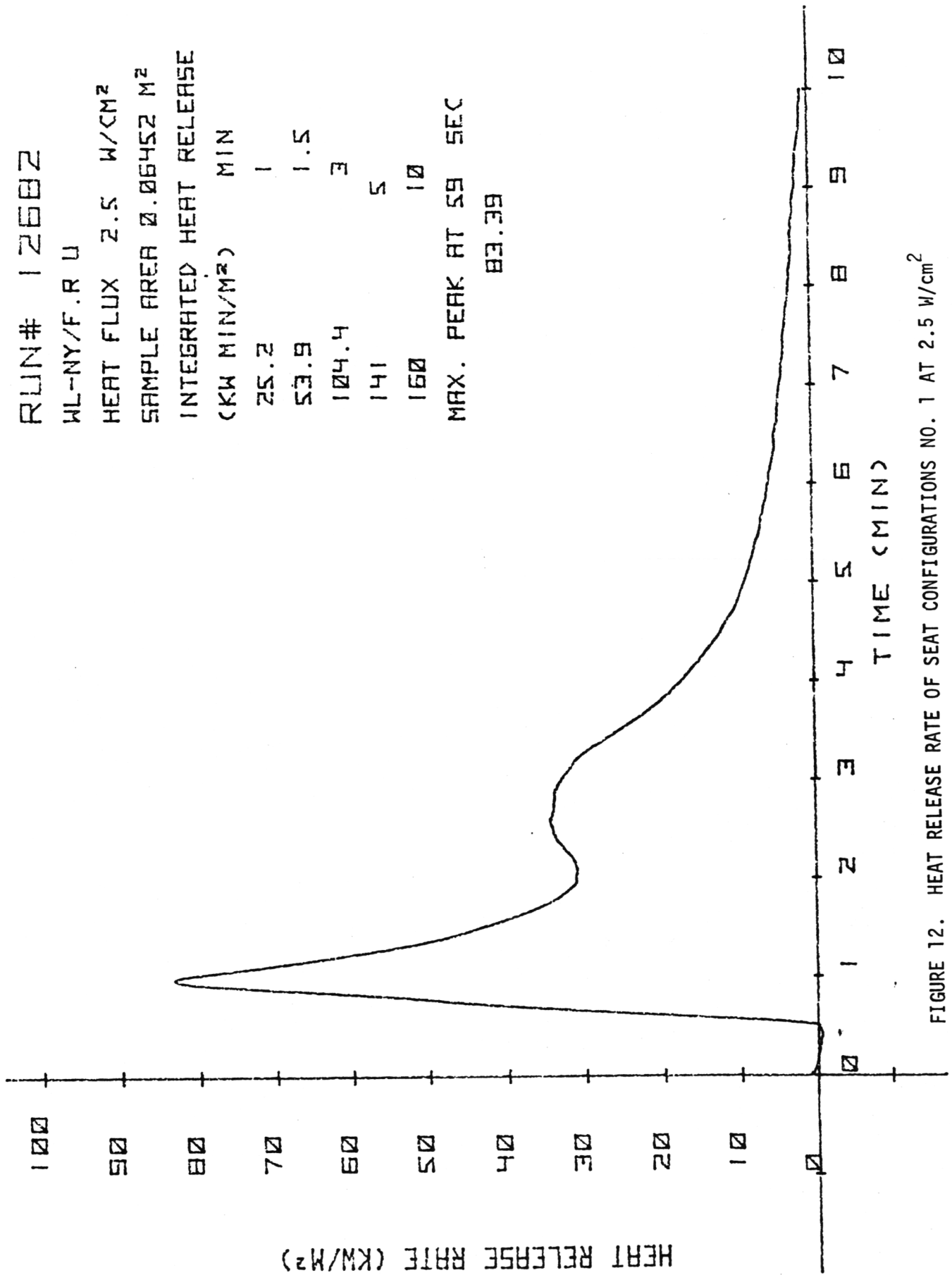


FIGURE 12. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 1 AT 2.5 W/cm²

RUN# 10982

WL-NY/V3/F.R.U

HEAT FLUX 2.5 W/CM²

SAMPLE AREA 0.06452 M²

INTEGRATED HEAT RELEASE

(KW MIN/M²) MIN

17.3	1
28.1	1.5
35.7	3
47	5
135	10

MAX. PEAK AT 55 SEC
37.21

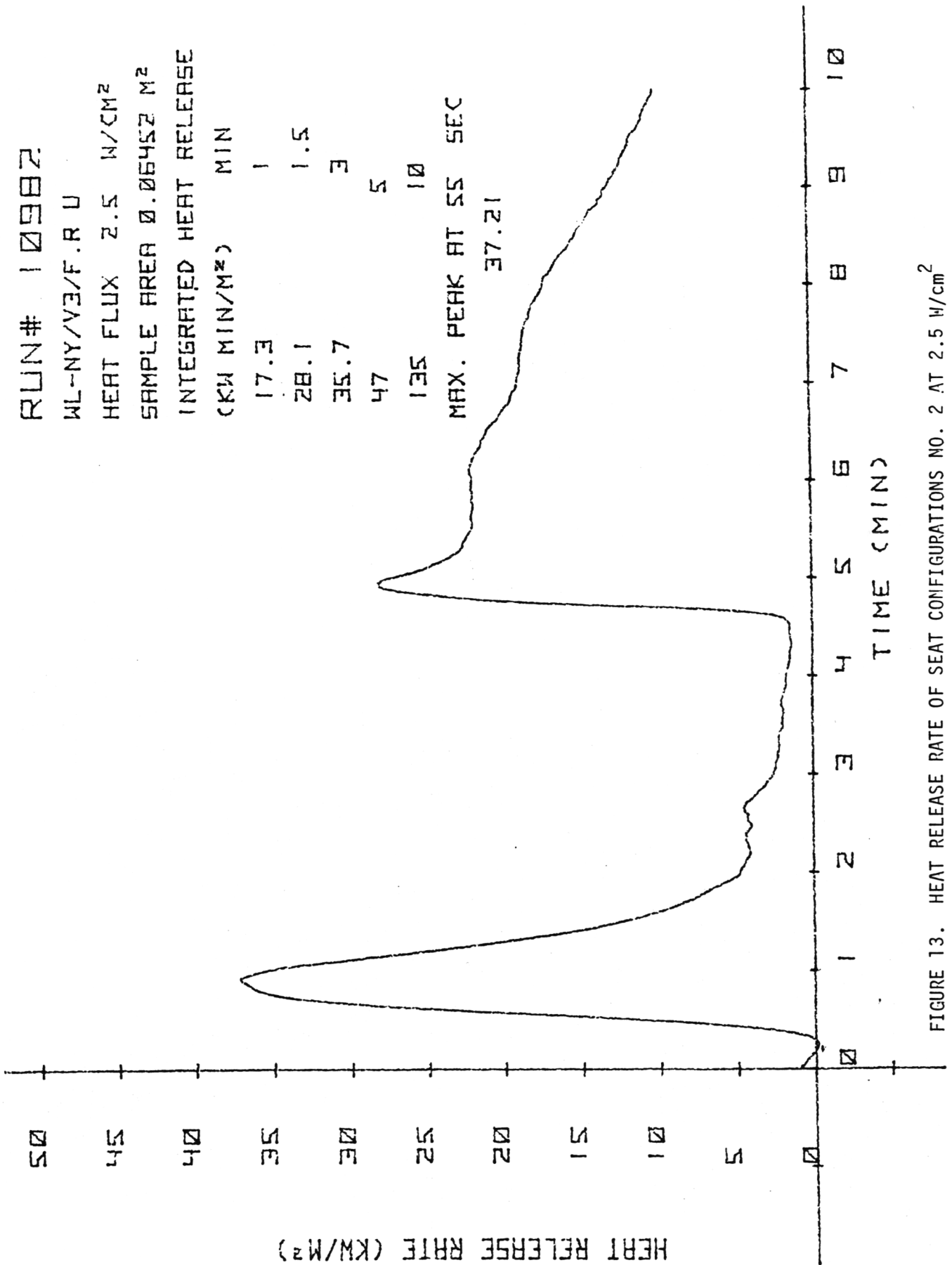


FIGURE 13. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 2 AT 2.5 W/CM²

RUN# 11282
 WL-NY/3/BL5/F.RU
 HEAT FLUX 2.5 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE

(KW MIN/M ²)	MIN
21.5	1
32.0	1.5
38.2	3
105	5
188	10

MAX. PEAK AT 231 SEC
 42.96

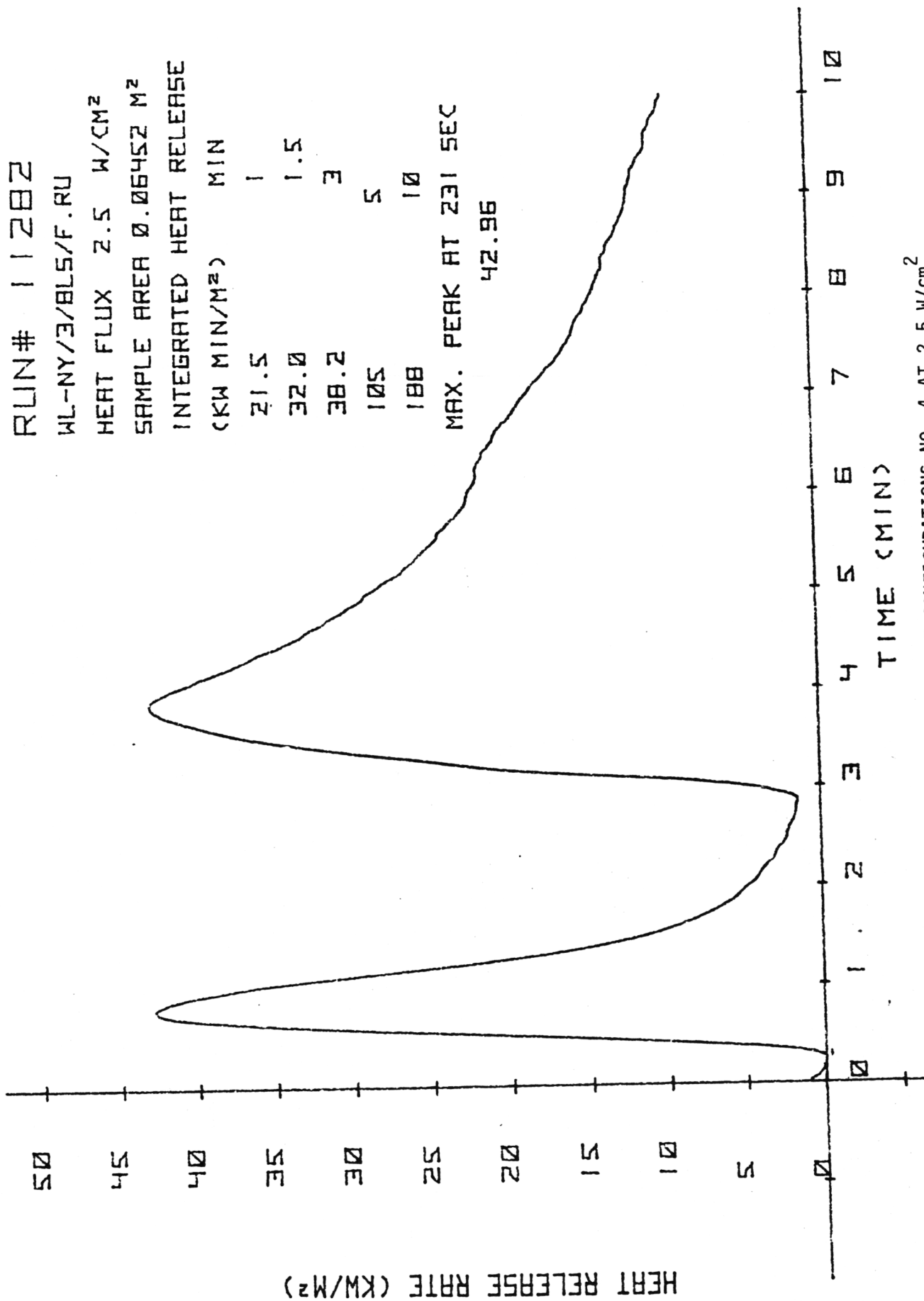


FIGURE 14. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 4 AT 2.5 W/cm²

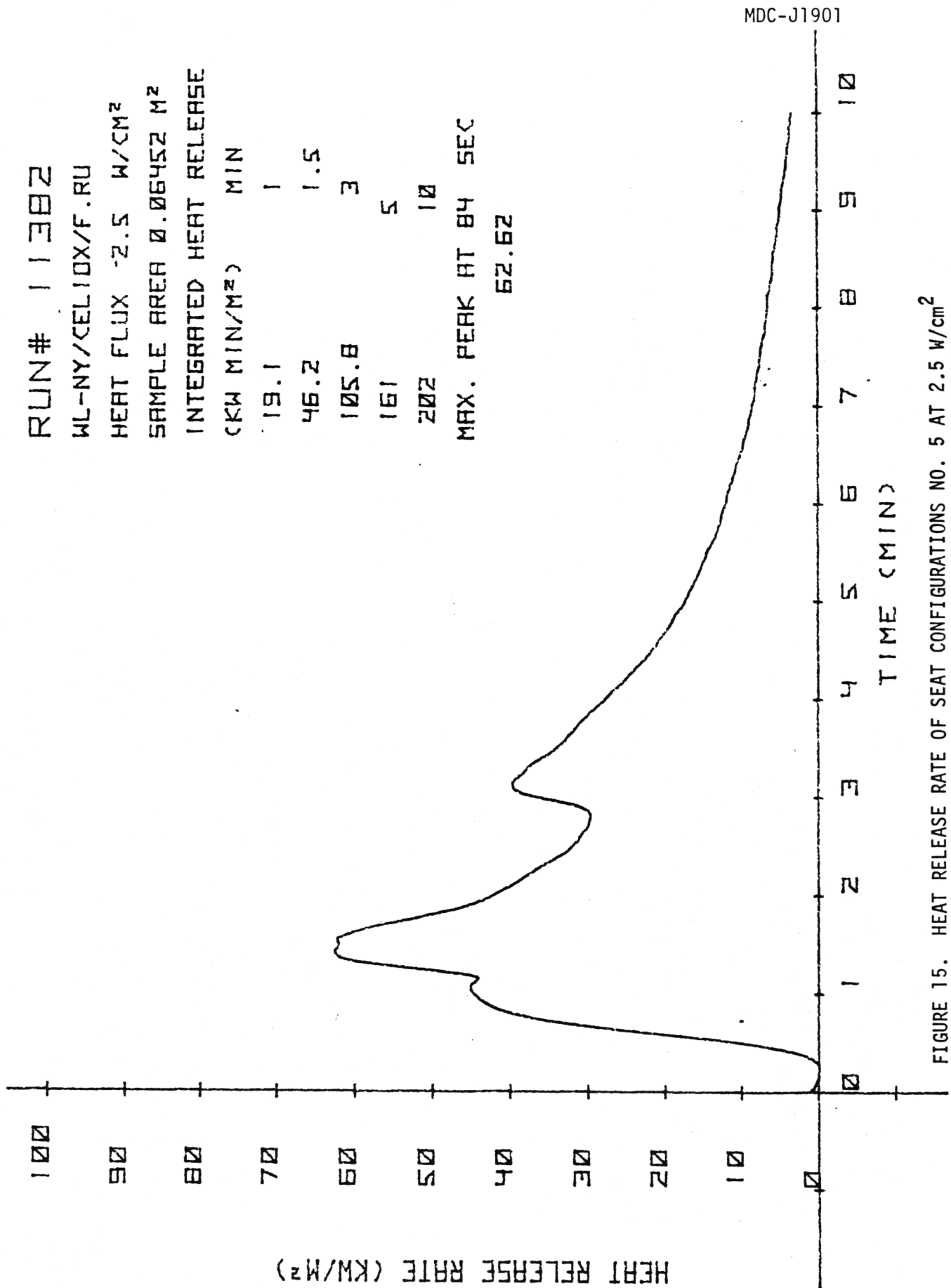


FIGURE 15. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 5 AT 2.5 W/cm²

RUN# 11682
 WL-NY/NORFAB/F.RU
 HEAT FLUX 2.5 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE
 (KW MIN/M²) MIN
 23.2 1
 49.6 1.5
 126.0 3
 172 5
 213 10
 MAX. PEAK AT 92 SEC
 70.12

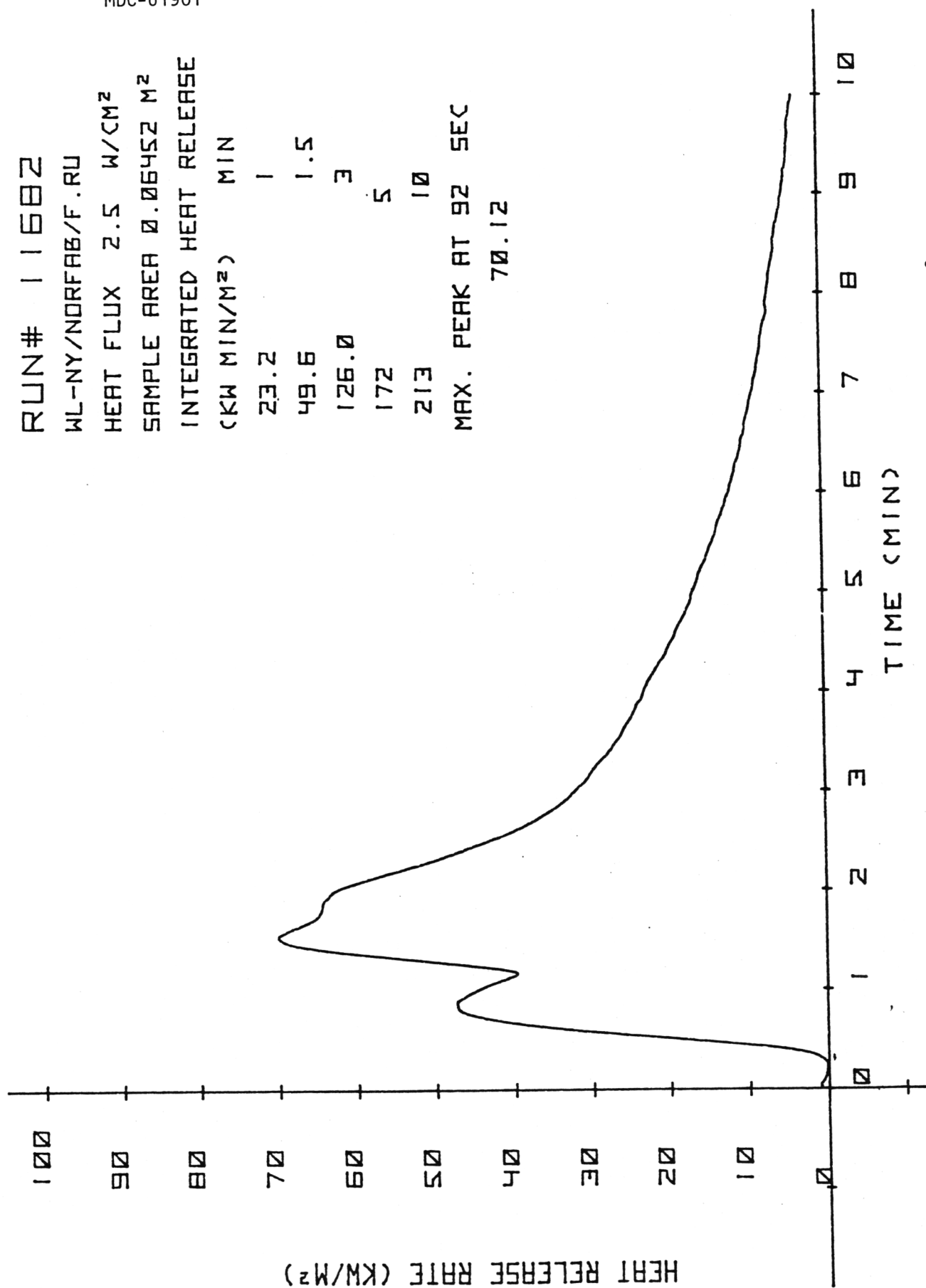
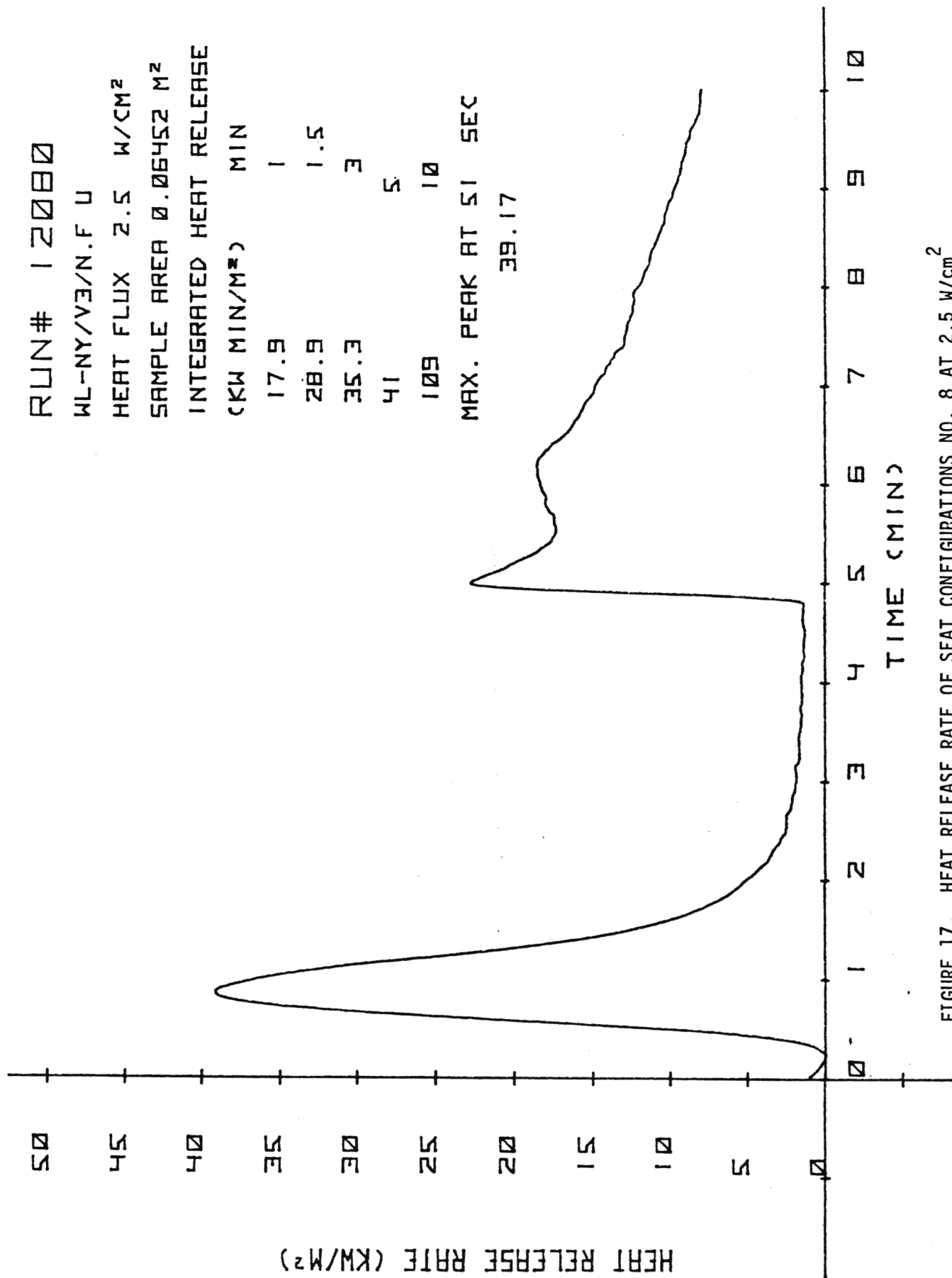


FIGURE 16. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 6 AT 2.5 W/cm²


 FIGURE 17. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 8 AT 2.5 W/cm²

RUN# 12382
 WL-NY/NORFAB/N.F.U
 HEAT FLUX 2.5 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE
 (KW MIN/M²) MIN
 18.8 1
 41.9 1.5
 106.8 3
 145 5
 177 10
 MAX. PEAK AT 109 SEC
 54.10

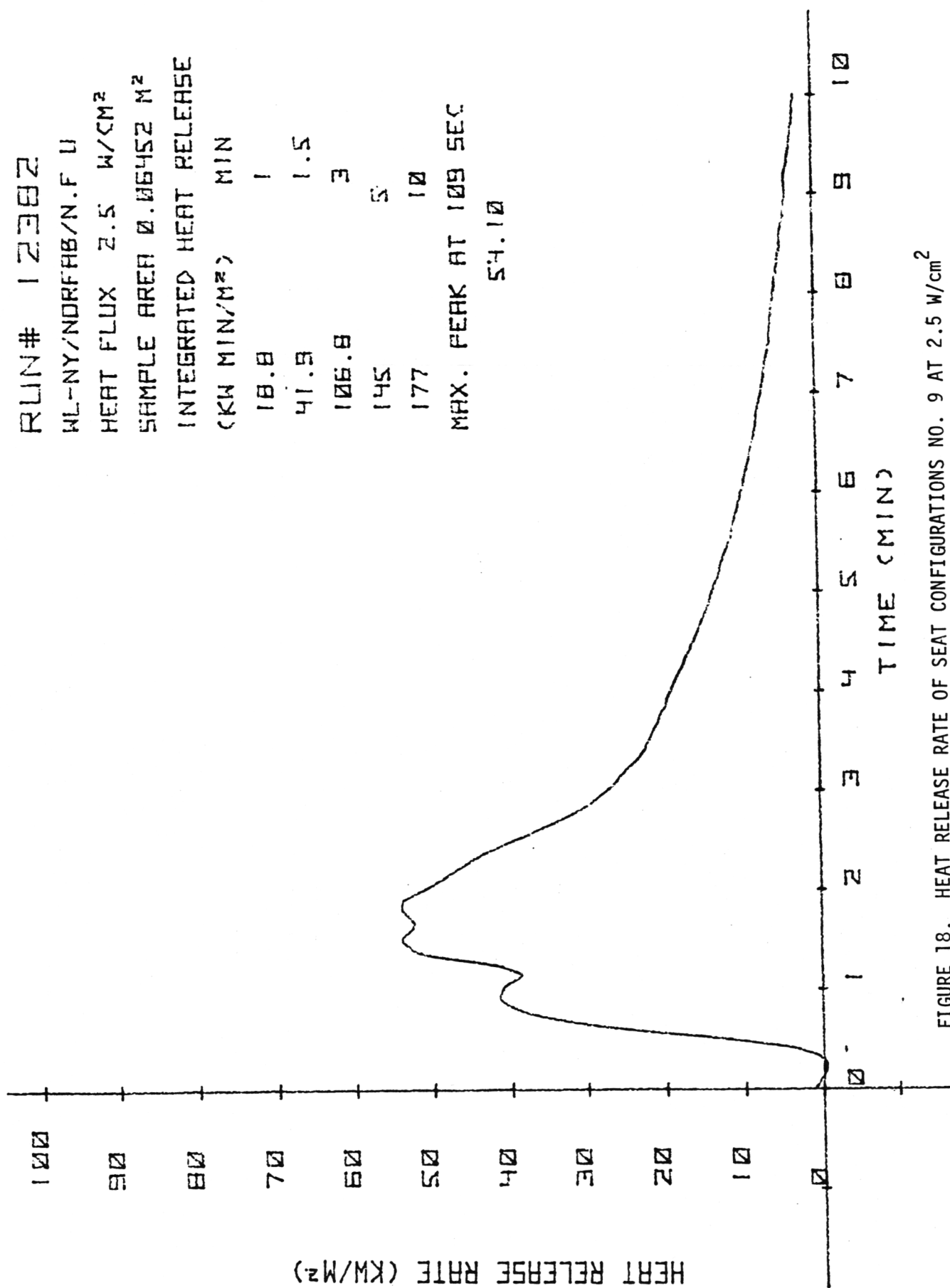


FIGURE 18. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 9 AT 2.5 W/CM²

RUN# 13182

WL-NY/F.R.U

HEAT FLUX 5.0 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED HEAT RELEASE

(KW MIN/M²) MIN

51.1 1

68.2 1.5

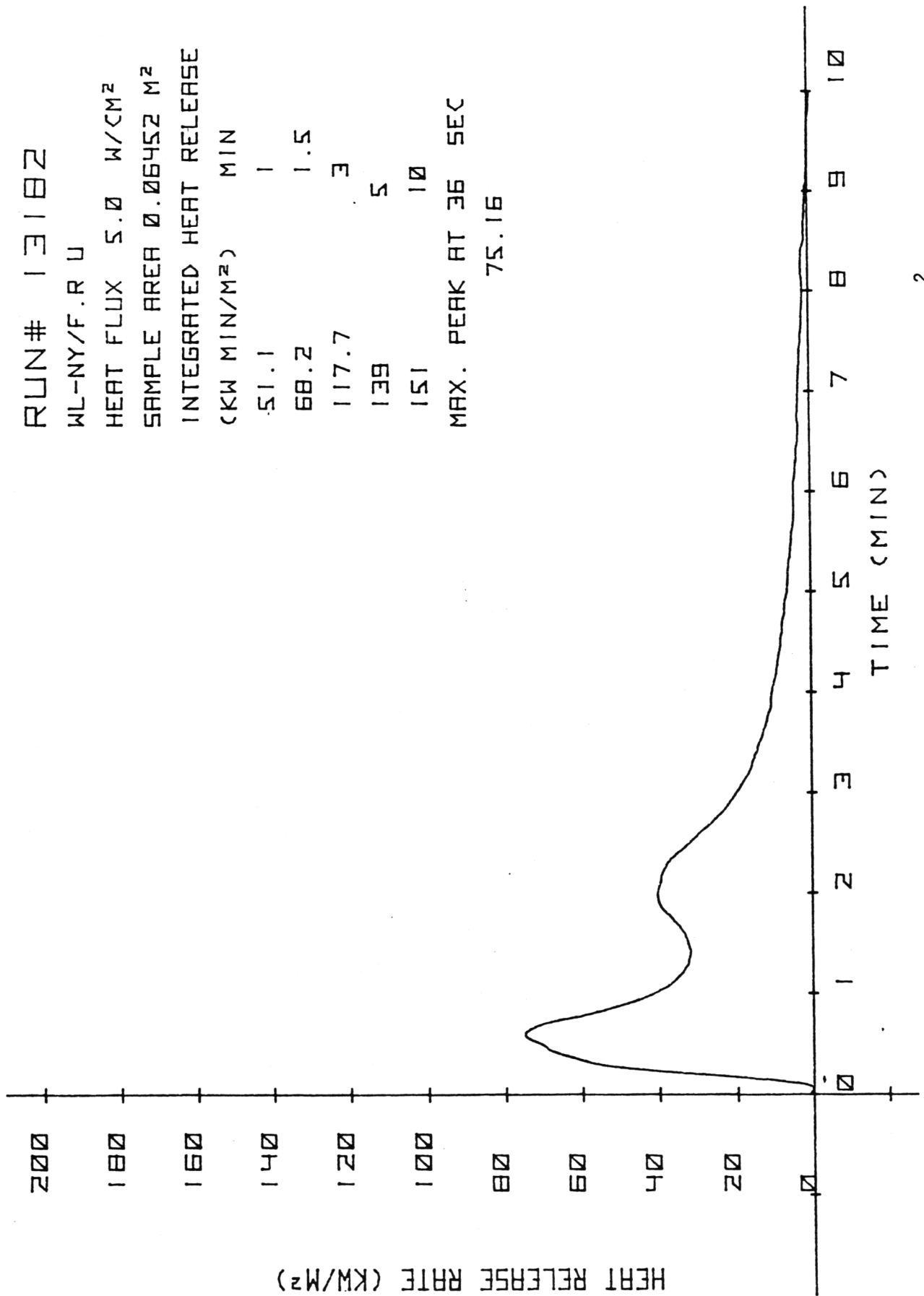
117.7 3

139 5

151 10

MAX. PEAK AT 36 SEC

75.16

FIGURE 19. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 1 AT 5.0 W/CM²

RUN# 13282
 WL-NY/V3/F.RU
 HEAT FLUX 5.0 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE
 (KW MIN/M²) MIN
 34.6 1
 46.1 1.5
 97.2 3
 141 5
 182 10
 MAX. PEAK AT 22 SEC
 55.42

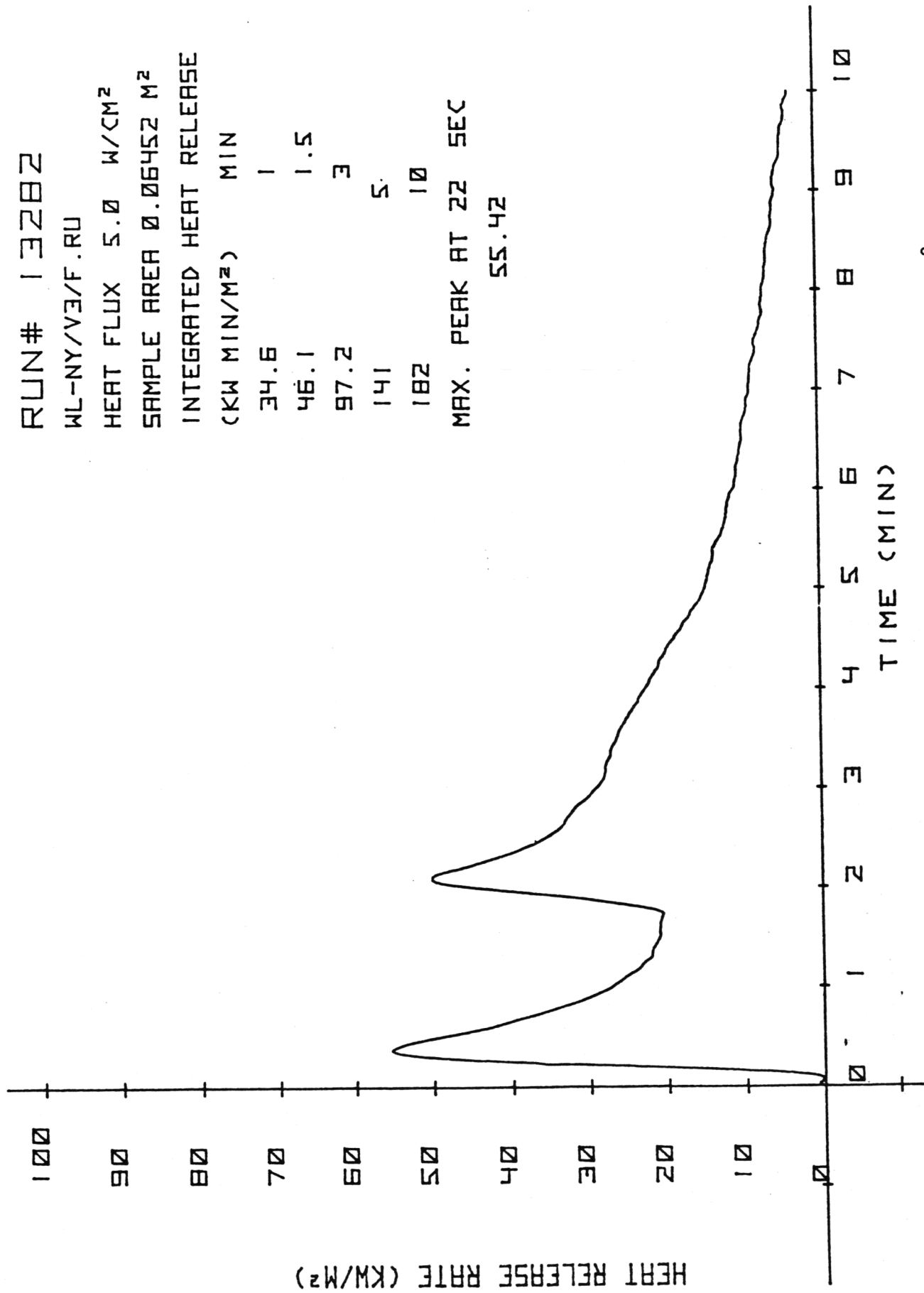


FIGURE 20. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 2 AT 5.0 W/cm²

RUN# 14982

WL-NY/LS200/F.RU

HEAT FLUX 5.0 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED HEAT RELEASE

(KW MIN/M²) MIN

36 1

49 1.5

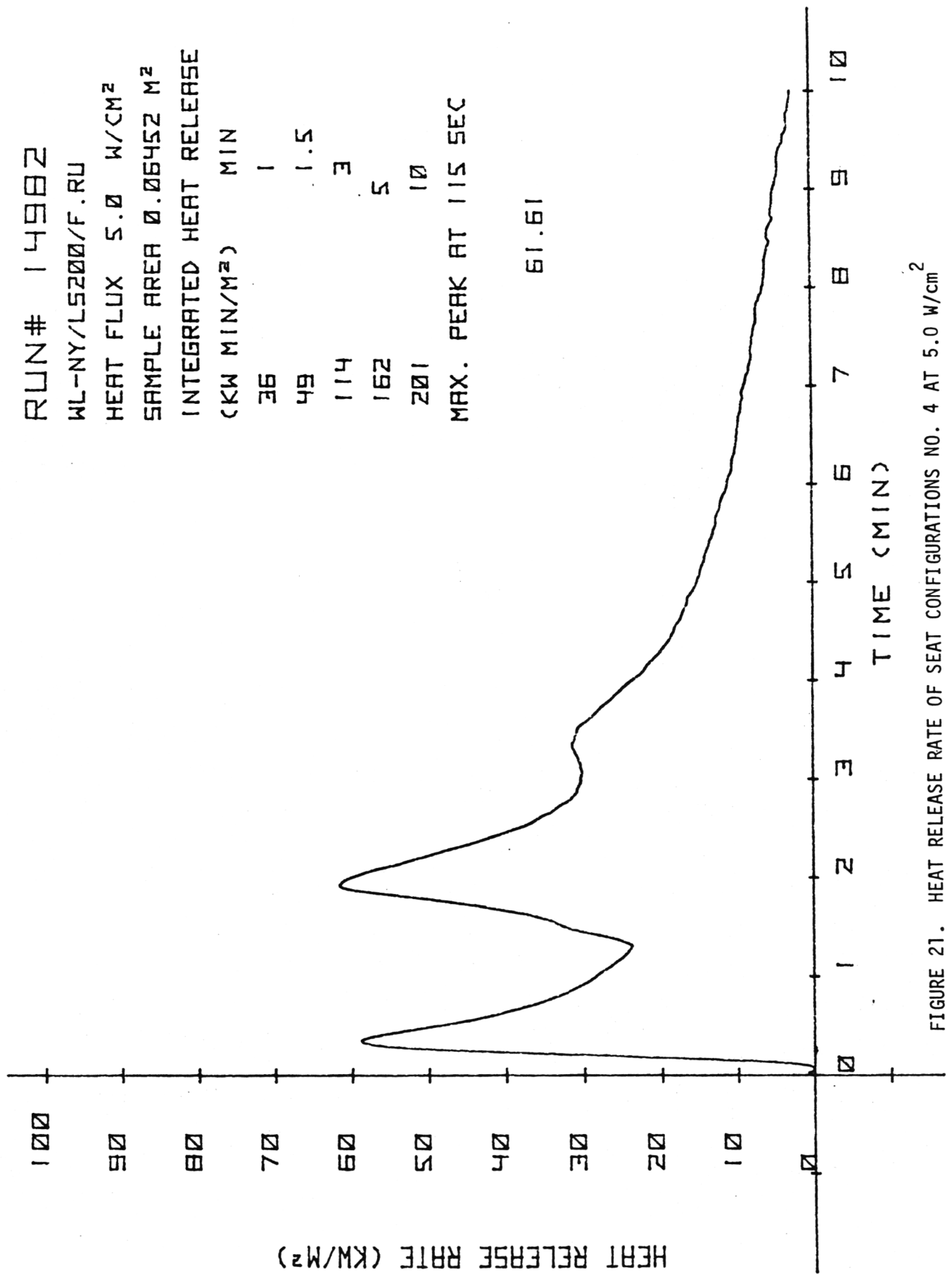
114 3

162 5

201 10

MAX. PEAK AT 115 SEC

61.61

FIGURE 21. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 4 AT 5.0 W/CM²

RUN# 13782
 WL-NY/CELOX/F.RU
 HEAT FLUX 5.0 W/CM²
 SAMPLE AREA 0.06452 M²
 INTEGRATED HEAT RELEASE
 (KW MIN/M²) MIN
 51.9 1
 80.7 1.5
 132.7 3
 165 5
 197 10
 MAX. PEAK AT 57 SEC
 79.48

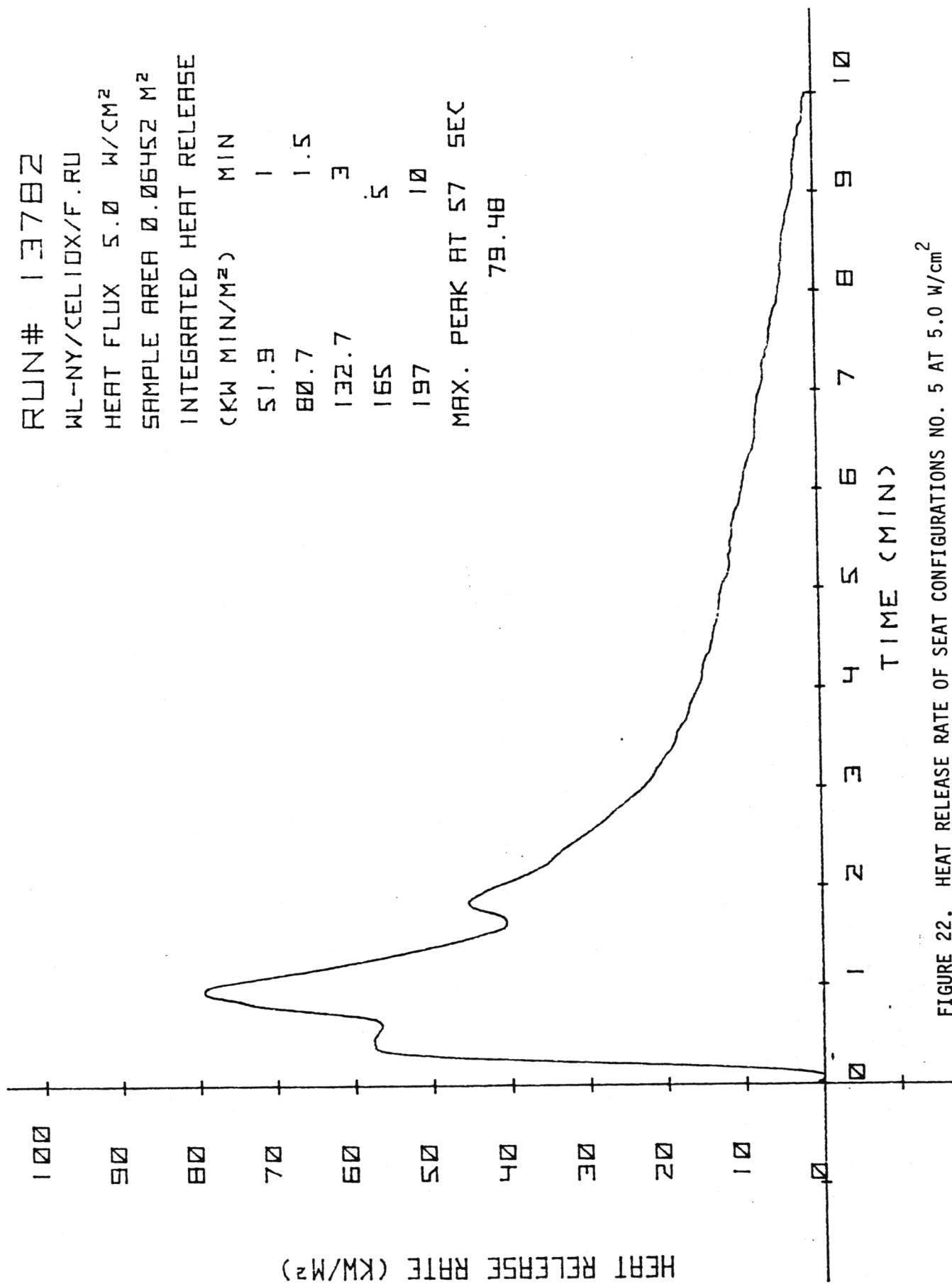
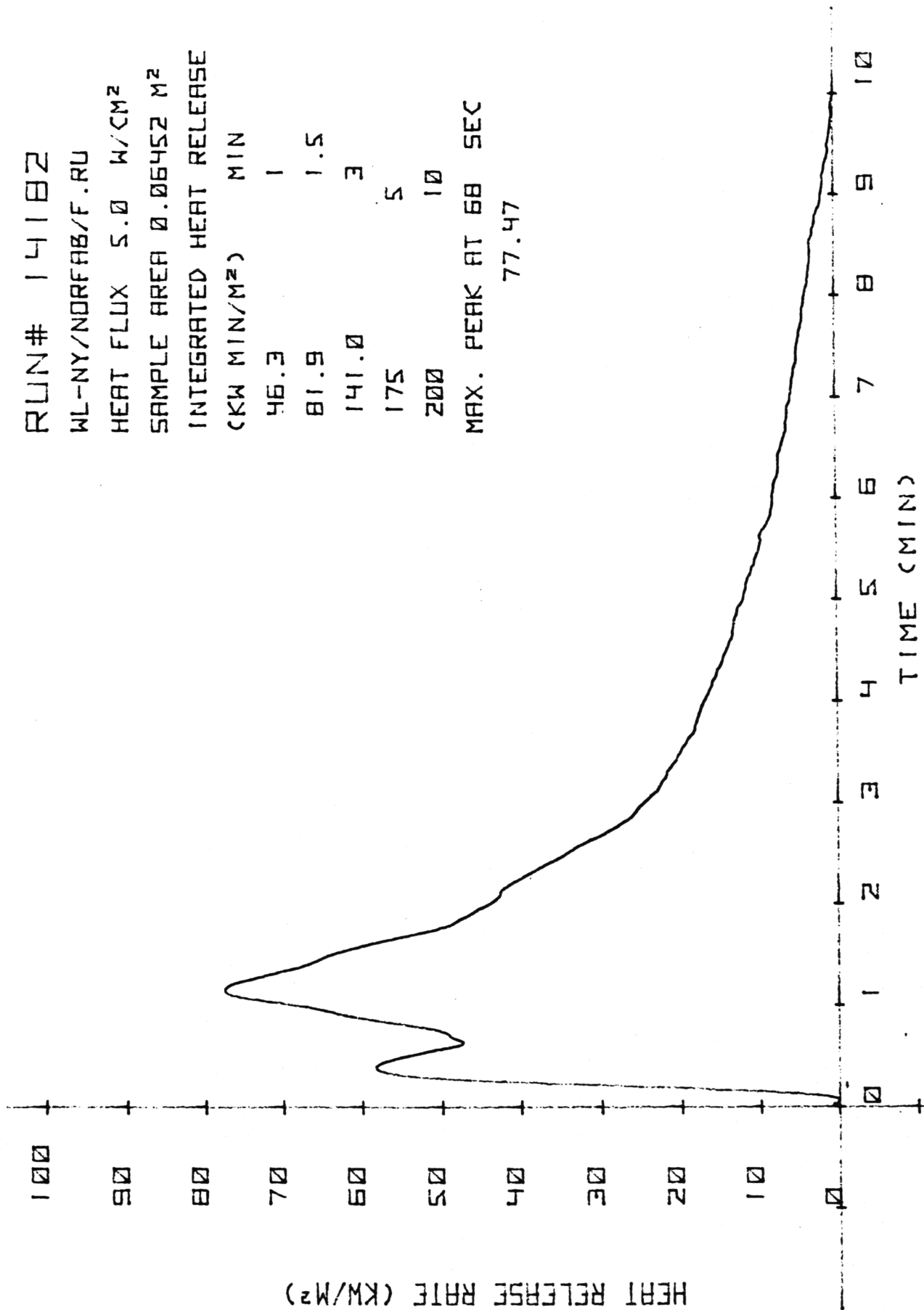


FIGURE 22. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 5 AT 5.0 W/CM²


 FIGURE 23. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 6 AT 5.0 W/cm²

RUN# 14082

WL-NY/V3/N.F.U

HEAT FLUX 5.0 W/CM²

SAMPLE AREA 0.06452 M²

INTEGRATED HEAT RELEASE

(KW MIN/M²) MIN

35.4 1

47.8 1.5

96.0 3

132 5

164 10

MAX. PEAK AT 22 SEC

58.38

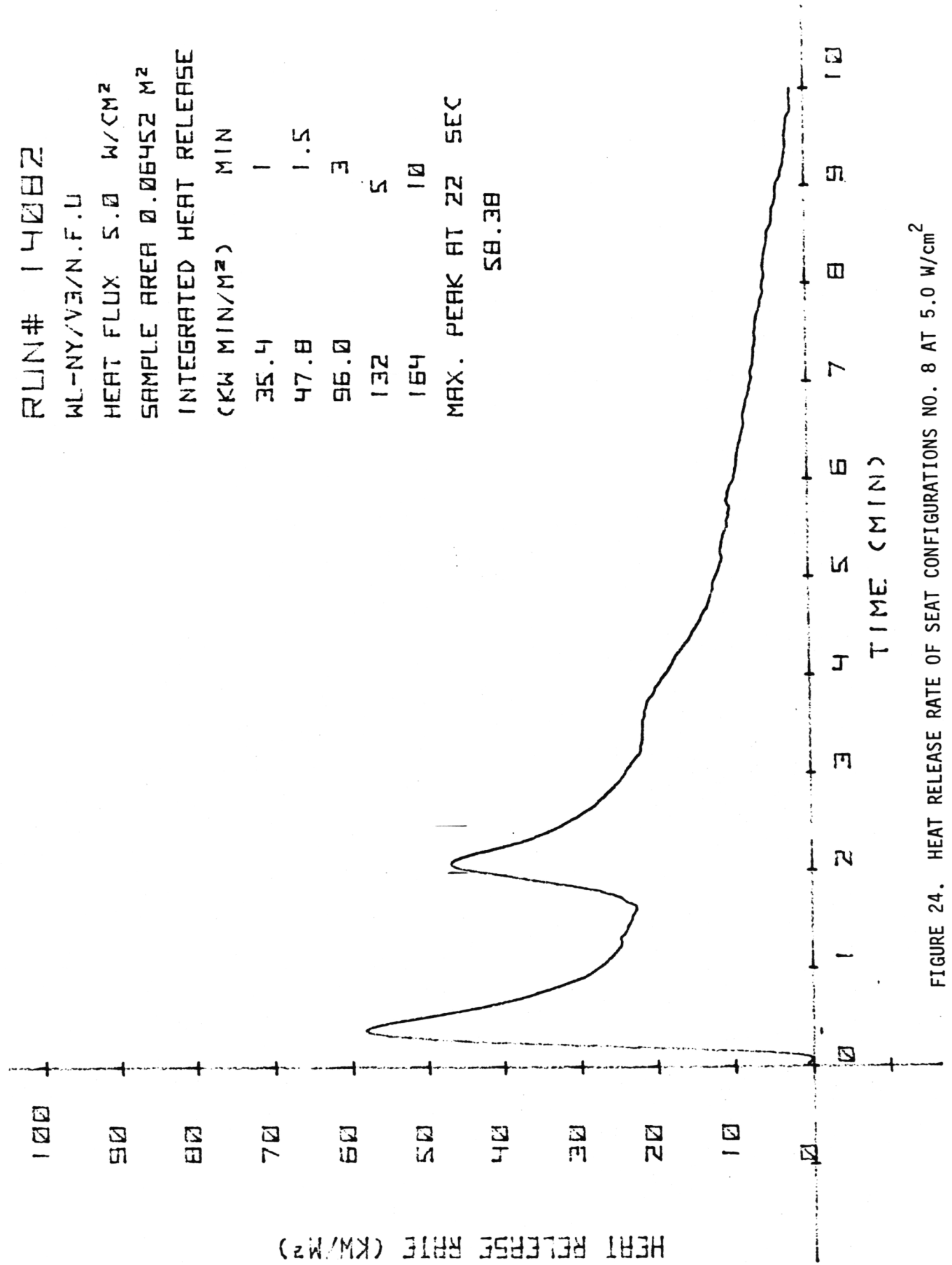


FIGURE 24. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 8 AT 5.0 W/CM²

RUN# 14582

WL-NY/NORFAB/N.FU

HEAT FLUX 5.0 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED HEAT RELEASE

(KW MIN/M²) MIN

47 1

80 1.5

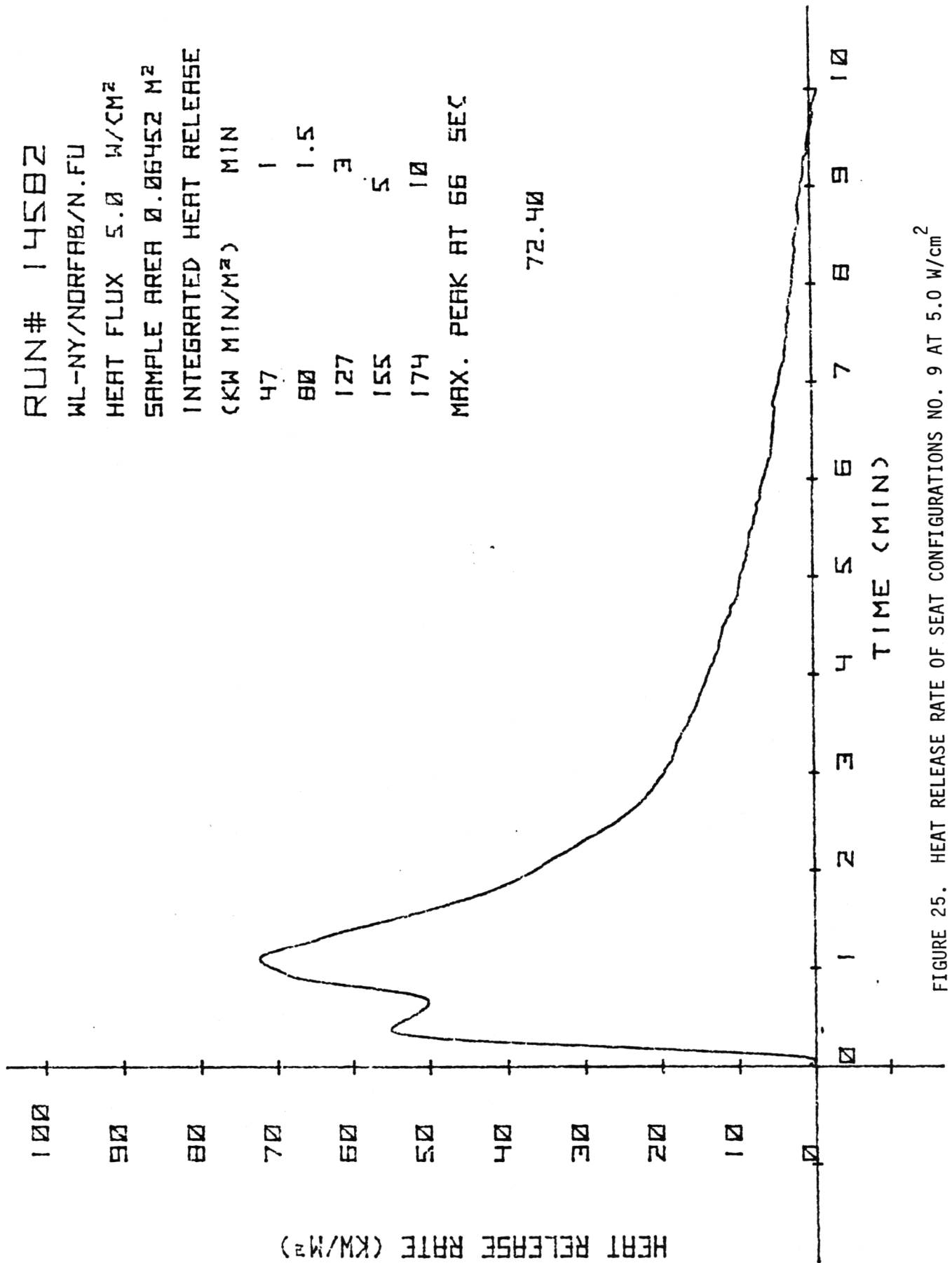
127 3

155 5

174 10

MAX. PEAK AT 66 SEC

72.40

FIGURE 25. HEAT RELEASE RATE OF SEAT CONFIGURATIONS NO. 9 AT 5.0 W/CM²

RUN # 12602

WL-NY/F.R.U

HEAT FLUX 2.5 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

10.20

13.59

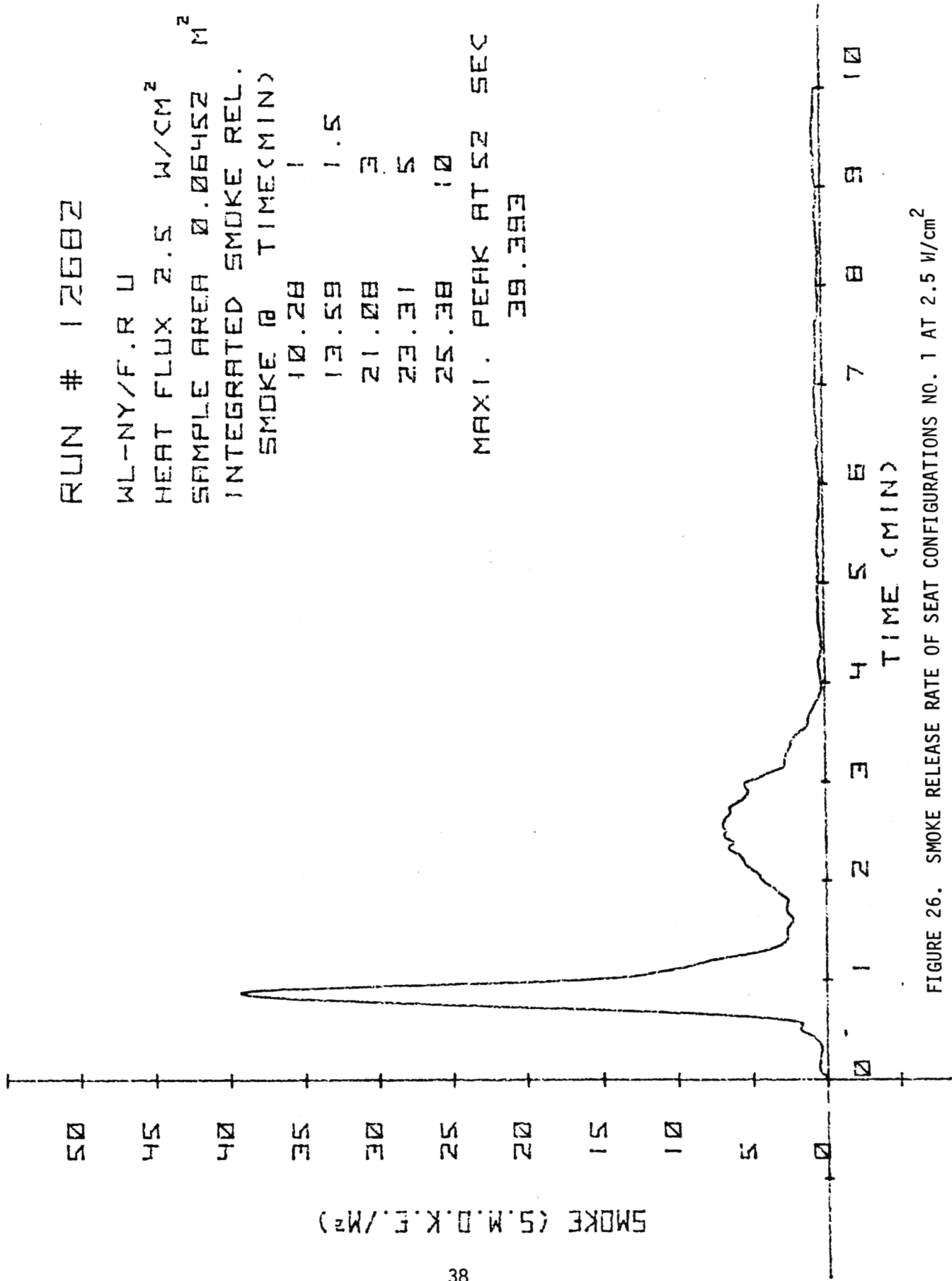
21.00

23.31

25.30

MAXI. PEAK AT 52 SEC

39.393

FIGURE 26. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 1 AT 2.5 W/cm²

RUN # 10982

WL-NY/V3/F.R.U

HEAT FLUX 2.5 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

1.44

2.12

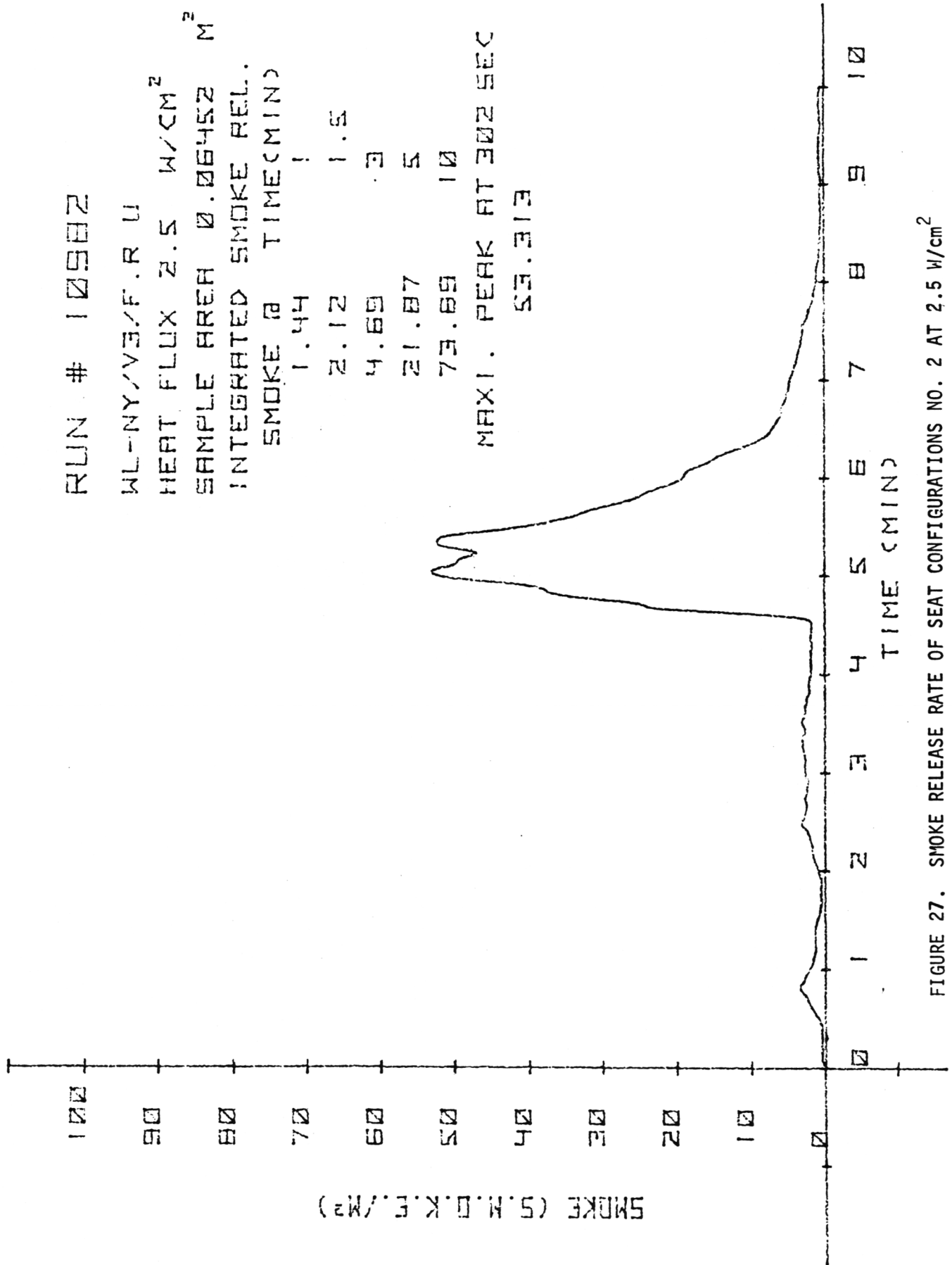
4.69

21.87

73.89

MAXI. PEAK AT 302 SEC

53.313

FIGURE 27. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 2 AT 2.5 W/cm²

RUN # 11282

WL-NY/3/BLS/F.RU

HEAT FLUX 2.5 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

1.49

1

1.70

1.5

2.65

3

56.71

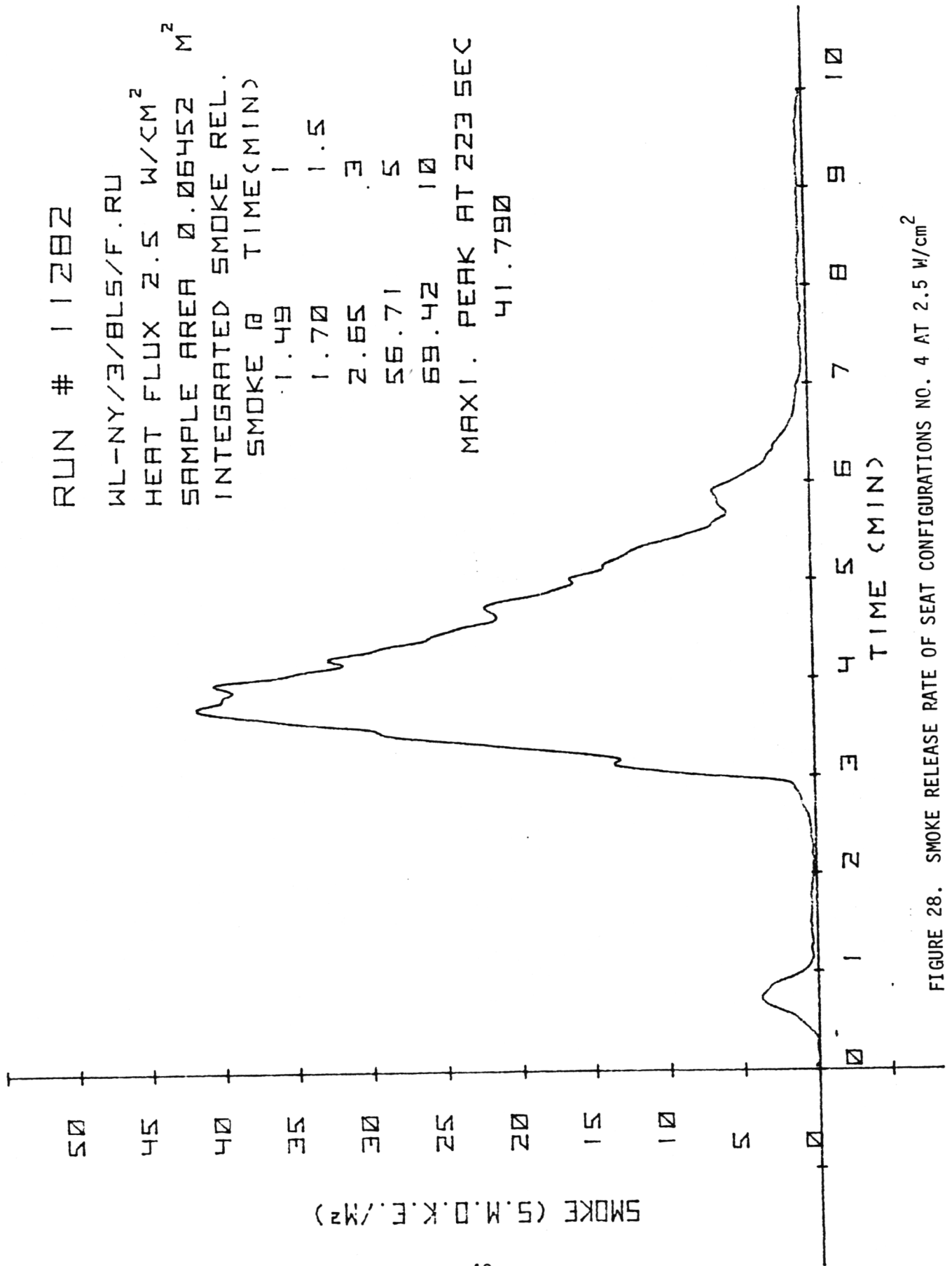
5

69.42

10

MAXI. PEAK AT 223 SEC

41.790

FIGURE 28. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 4 AT 2.5 W/CM²

RUN # 11382

WL-NY/CEL10X/F.RU

HEAT FLUX 2.5 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE R TIME(MIN)

2.73

1

10.89

1.5

23.14

3

27.48

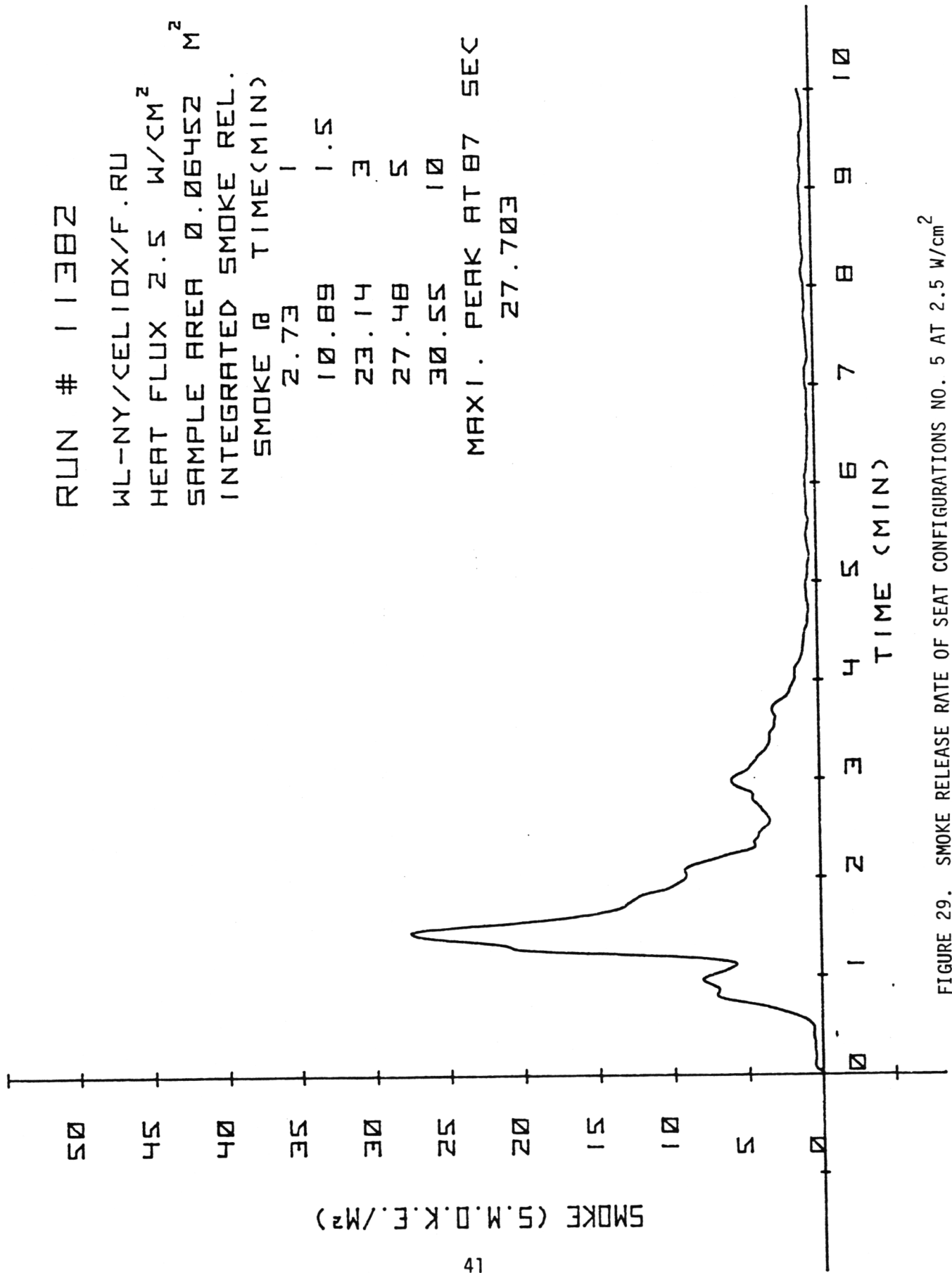
5

30.55

10

MAXI. PEAK AT 87 SEC

27.703

FIGURE 29. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 5 AT 2.5 W/cm²

RUN # 11682

WL-NY/NORFAB/F.RU

HEAT FLUX 2.5 W/CM²

SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

6.60	1
16.65	1.5
39.80	3
41.32	5
42.81	10

MAXI. PEAK AT 81 SEC

31.441

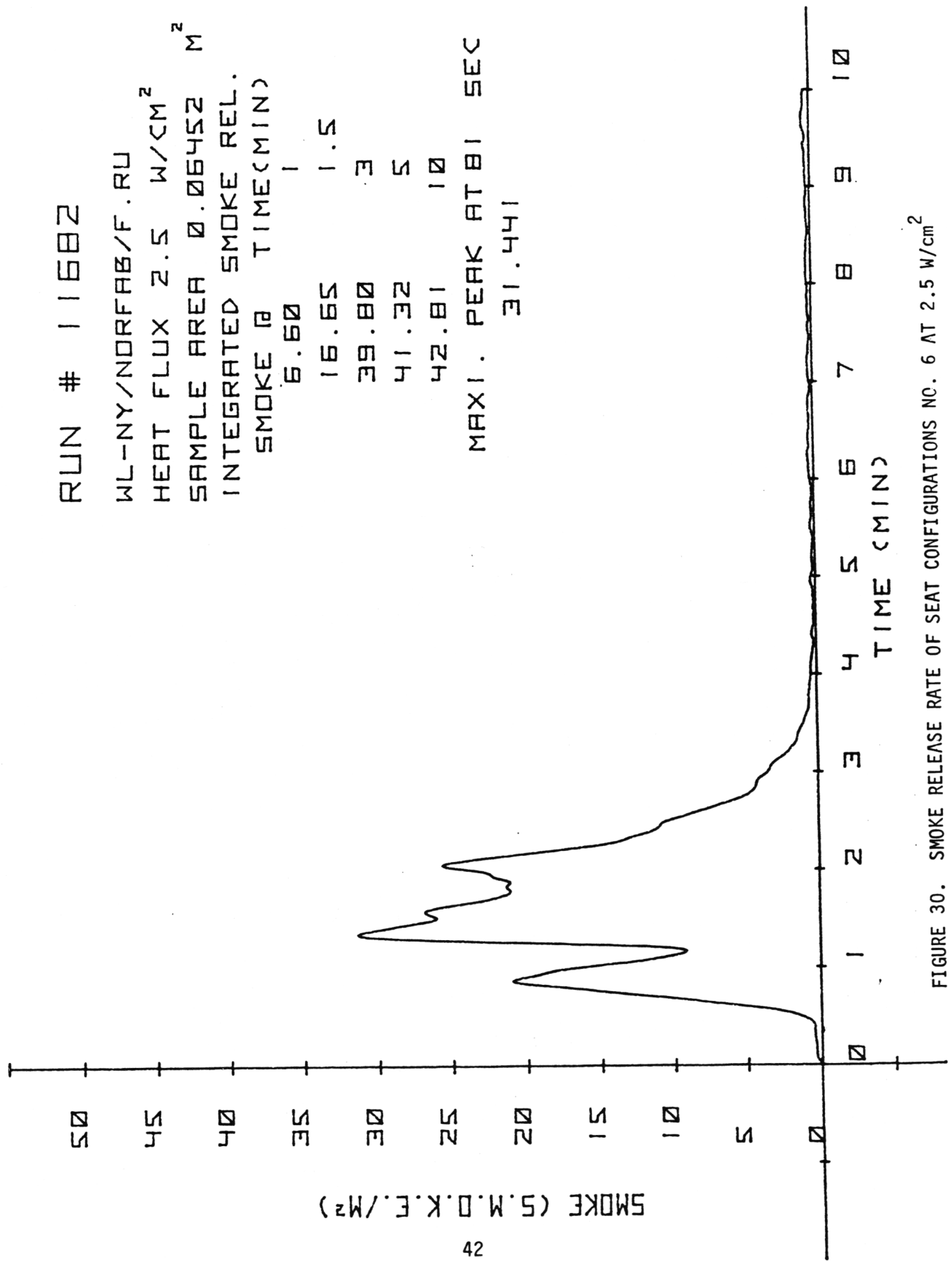


FIGURE 30. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 6 AT 2.5 W/cm²

RUN # 12080

WL-NY/V3/N.F.U

HEAT FLUX 2.5 W/cm²SAMPLE AREA 0.06452 m²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

5.71

1

9.15

1.5

19.54

3

40.84

5

96.09

10

MAXI. PEAK AT 302 SEC

47.237

SMOKE (S.M.D.K.F./M²)

TIME (MIN)

FIGURE 31. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 8 AT 2.5 W/cm²

RUN # 12382

WL-NY/NORFAB/N.F.U

HEAT FLUX 2.5 W/CM²

SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

5.23	1
16.03	1.5
35.44	3
36.54	5
38.06	10

MAXI. PEAK AT 85 SEC

28.899

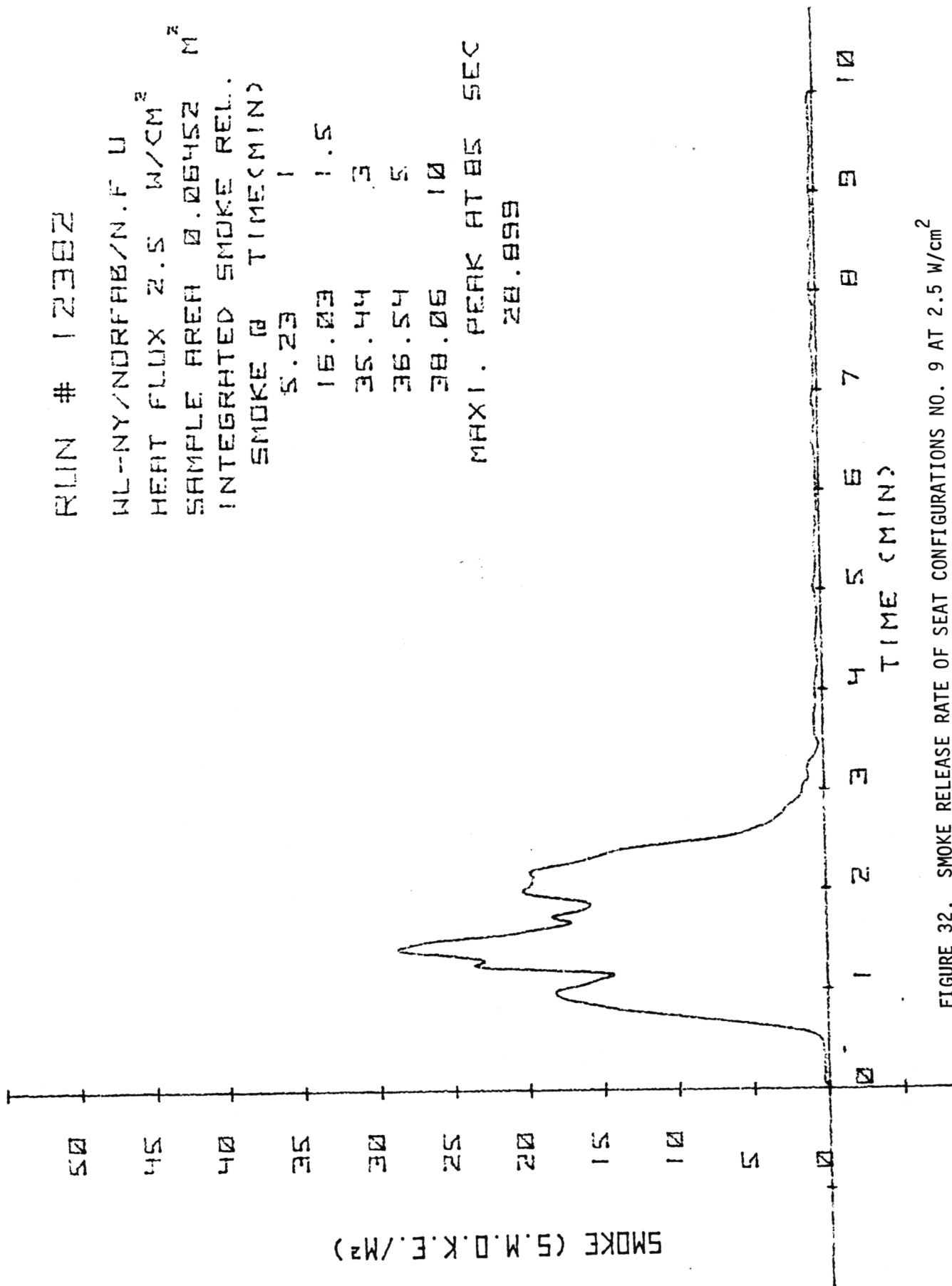


FIGURE 32. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 9 AT 2.5 W/cm²

RUN # 13182

WL-NY/F.R U

HEAT FLUX 5.0 W/CM²SAMPLE AREA 0.06452 M²

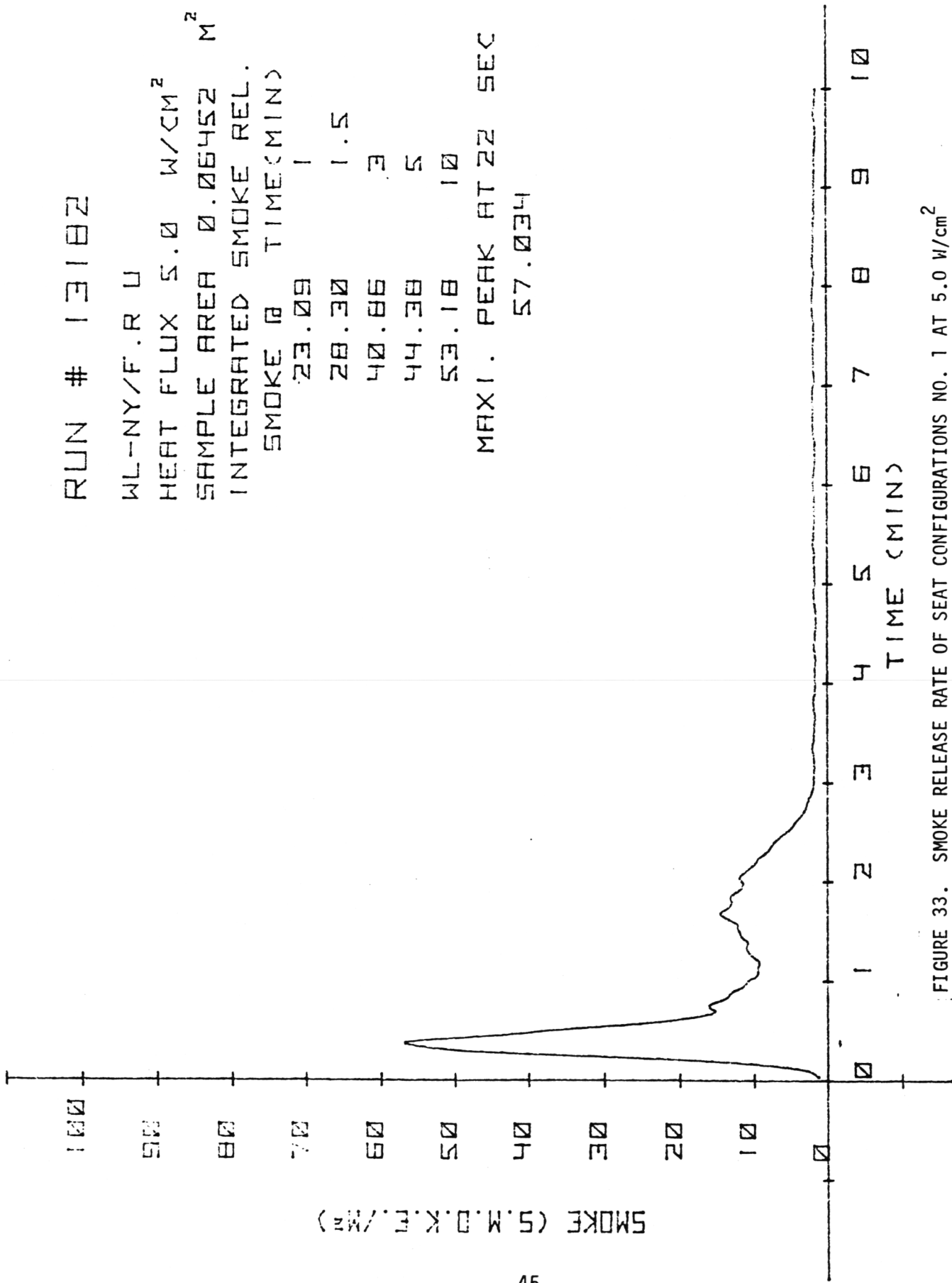
INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

23.09	1
28.30	1.5
40.86	3
44.38	5
53.18	10

MAXI. PEAK AT 22 SEC

57.034

FIGURE 33. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 1 AT 5.0 W/CM²

RUN # 13282

WL-NY/V3/F.RU

HEAT FLUX 5.0 W/CM²
 SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE @ TIME(MIN)

19.80	1
22.32	1.5
83.91	3
97.21	5
99.71	10

MAXI. PEAK AT 121 SEC

84.423

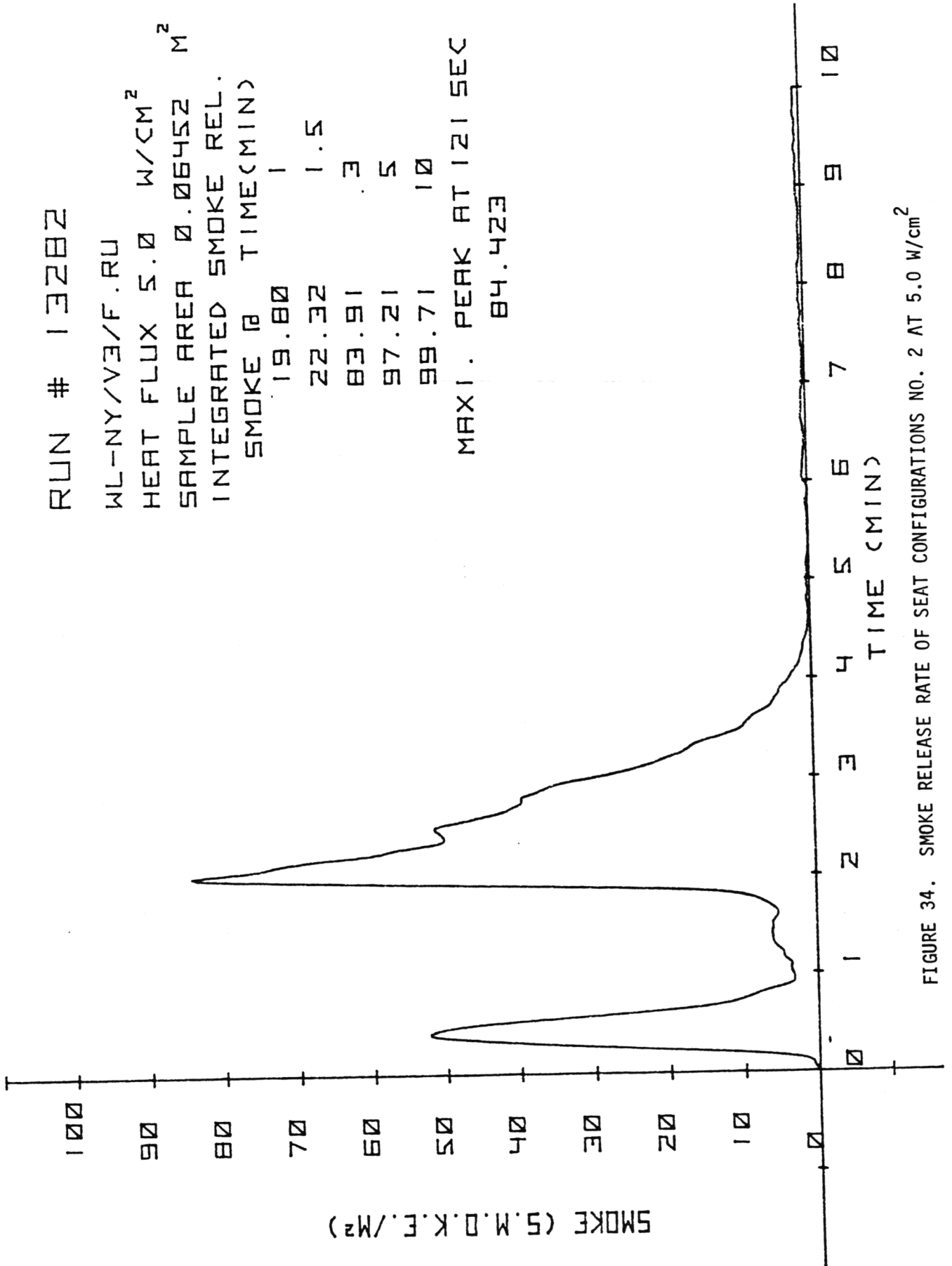
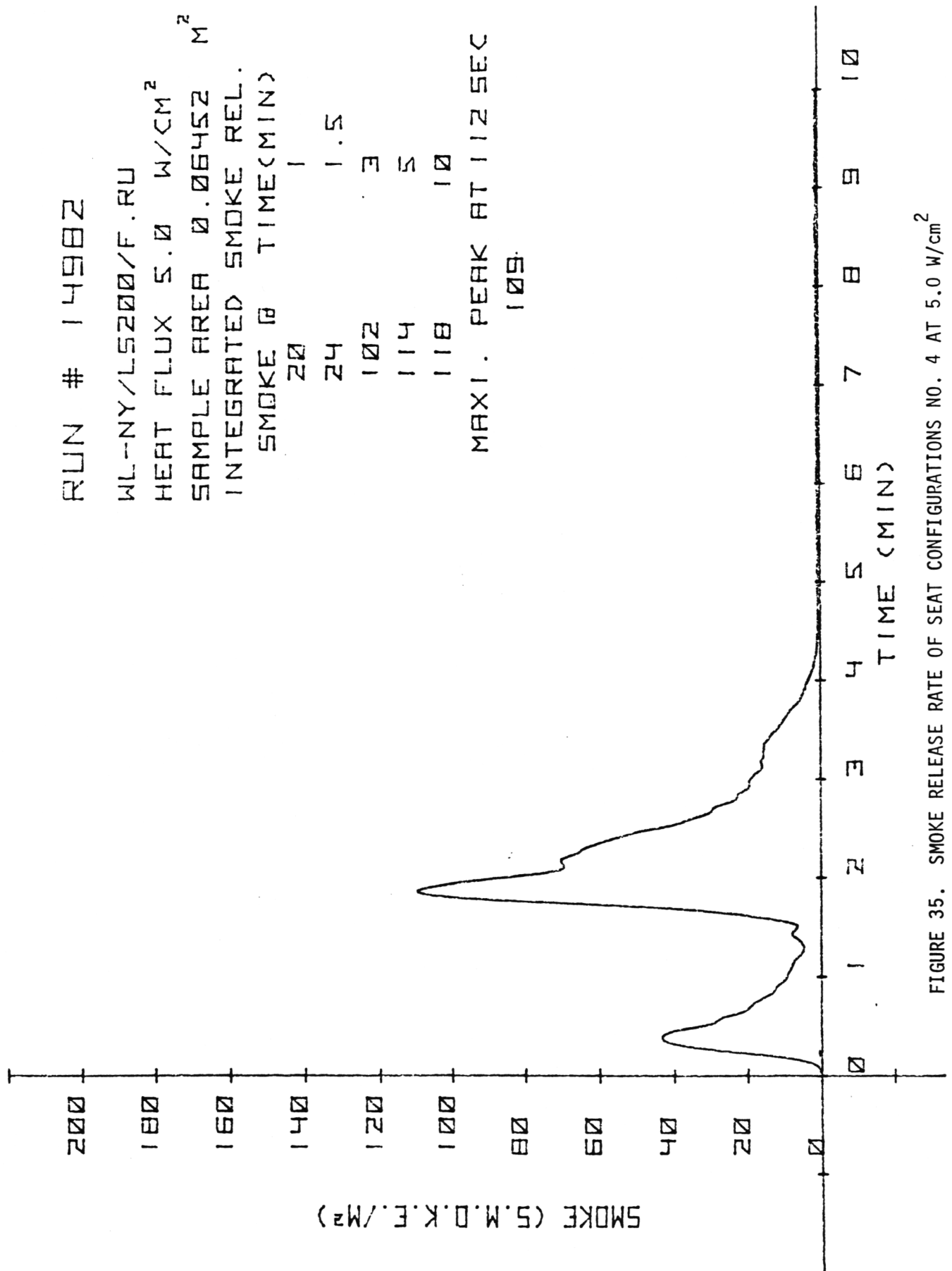


FIGURE 34. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 2 AT 5.0 W/cm²

FIGURE 35. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 4 AT 5.0 W/cm²

RUN # 13782

WL-NY/CEL10X/F.RU

HEAT FLUX 5.0 W/CM²SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE R TIME(MIN)

29.29

37.12

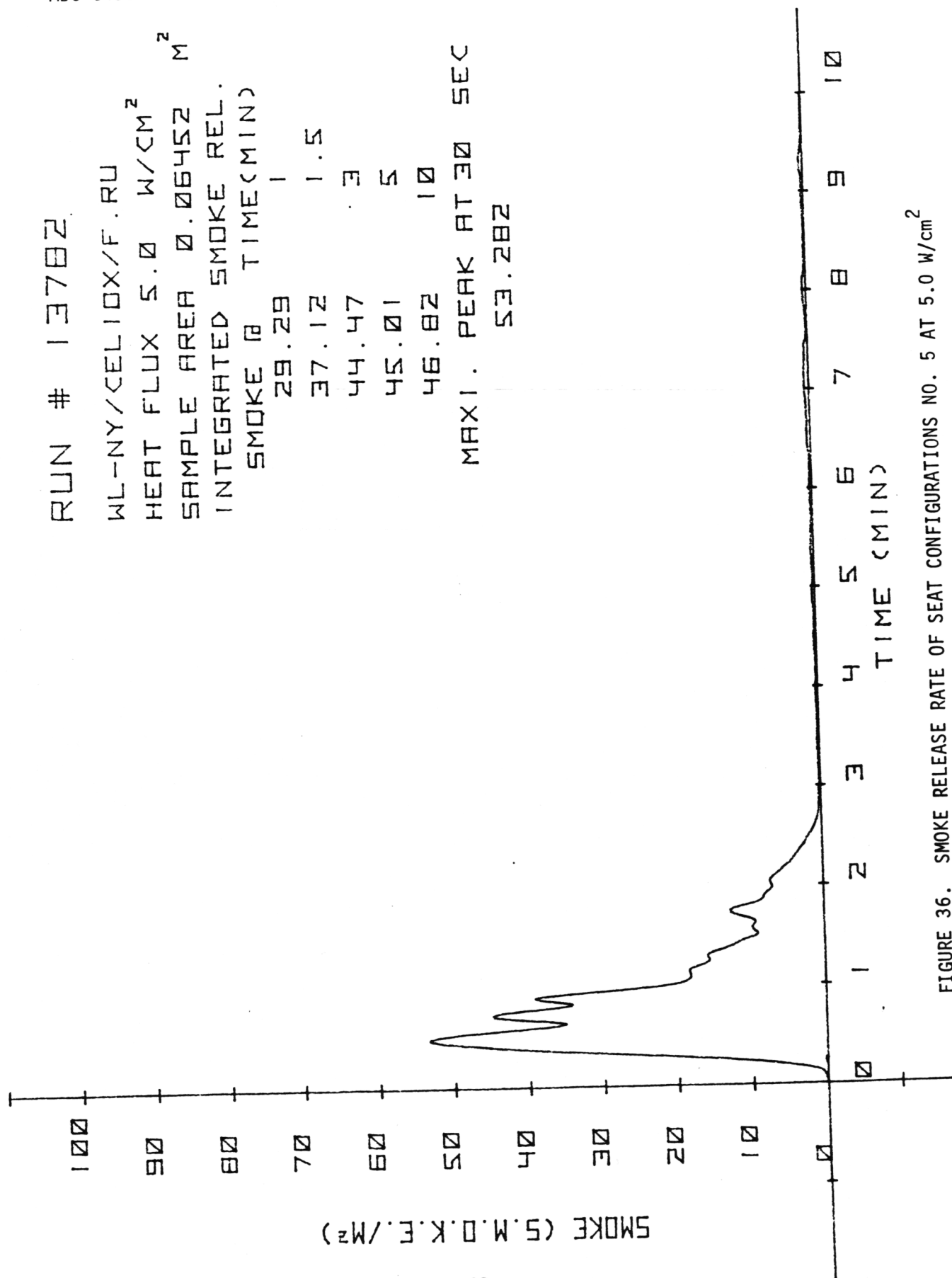
44.47

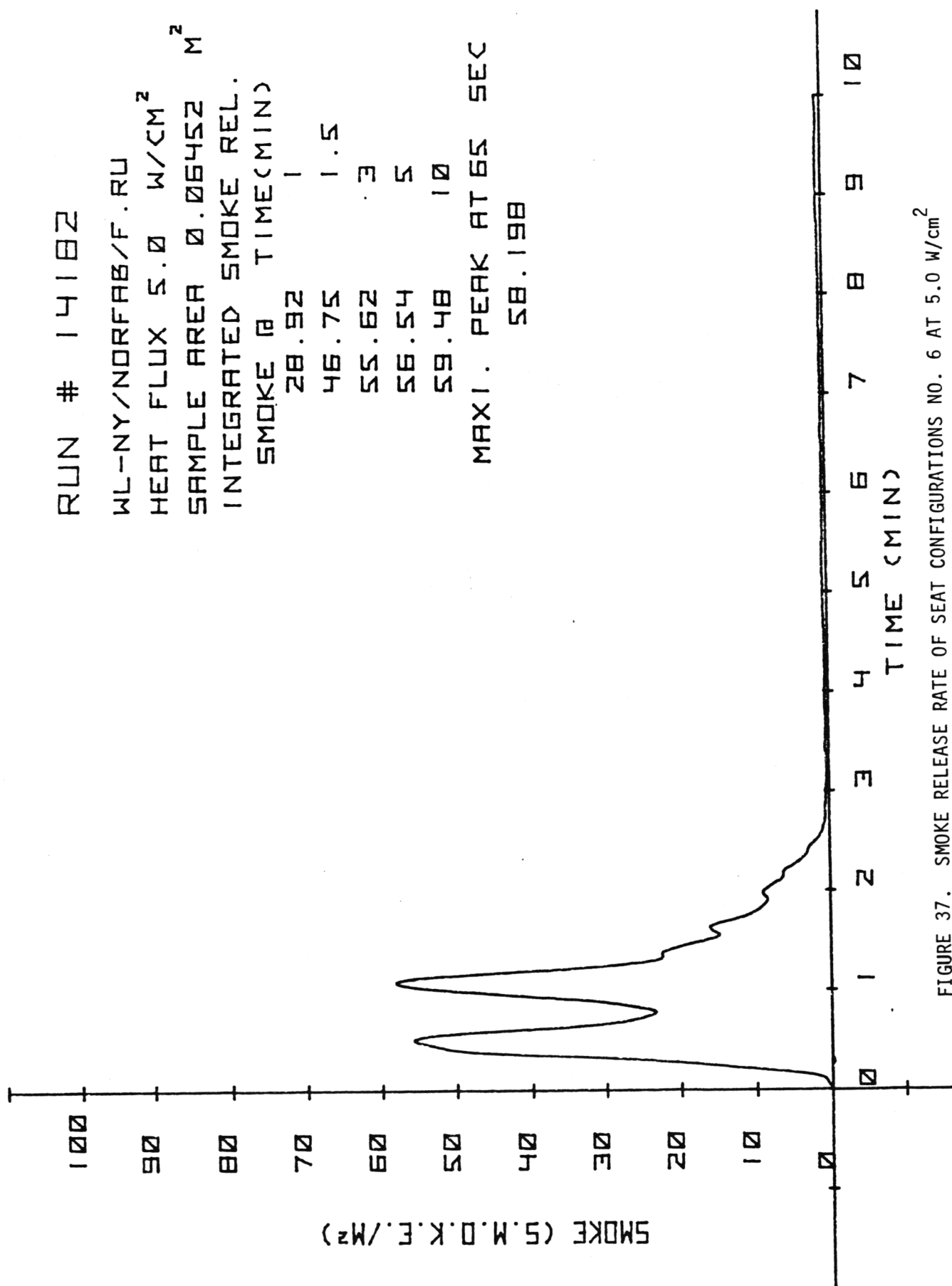
45.01

46.82

MAXI. PEAK AT 30 SEC

53.282

FIGURE 36. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 5 AT 5.0 W/cm²

FIGURE 37. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 6 AT 5.0 W/cm²

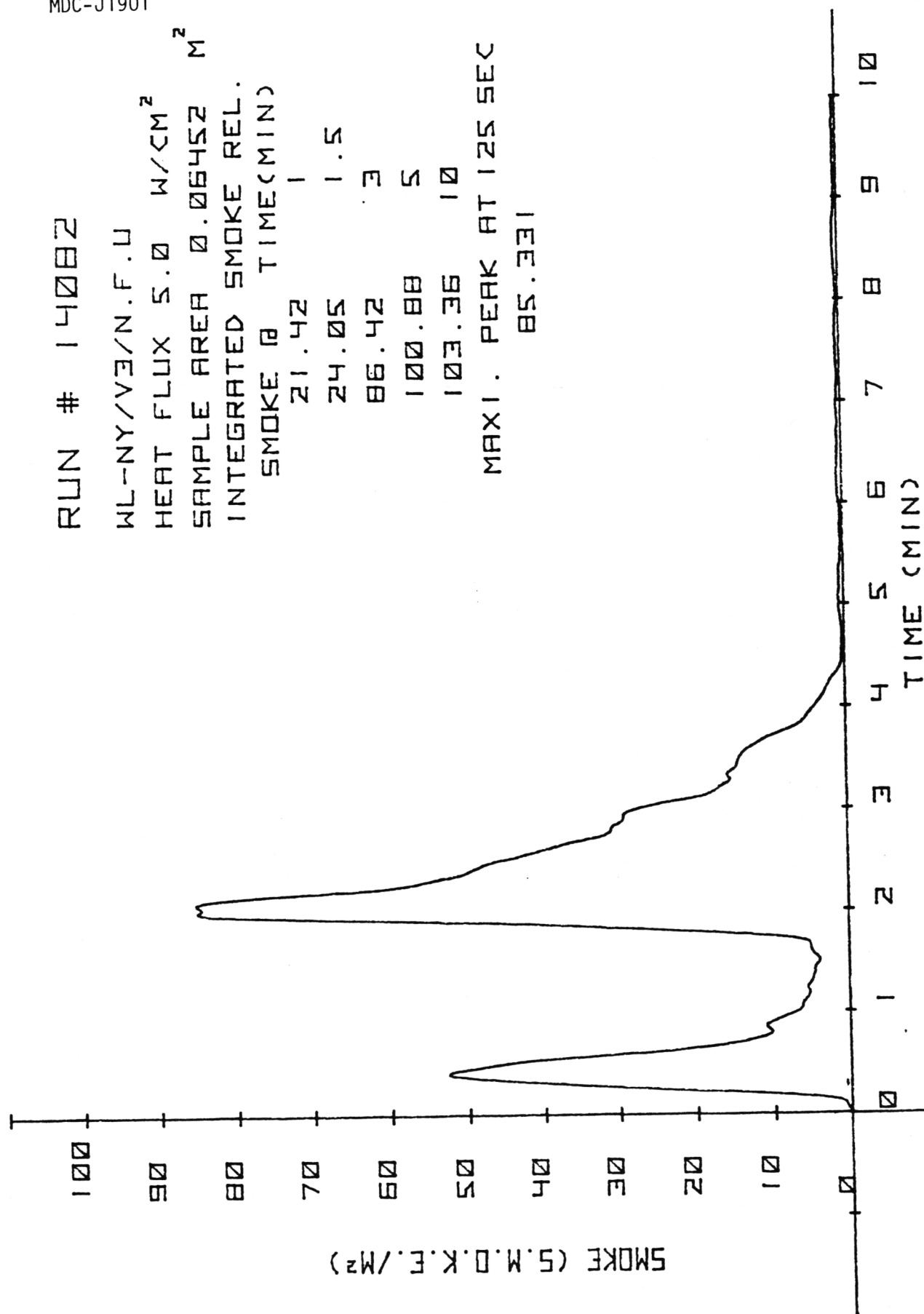


FIGURE 38. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 8 AT 5.0 W/cm²

RUN # 14582

WL-NY/NORFAB/N.FU

HEAT FLUX 5.0 W/CM²

SAMPLE AREA 0.06452 M²

INTEGRATED SMOKE REL.

SMOKE R TIME(MIN)

34	1
48	1.5
54	3
54	5
55	10

MAXI. PEAK AT 24 SEC
65

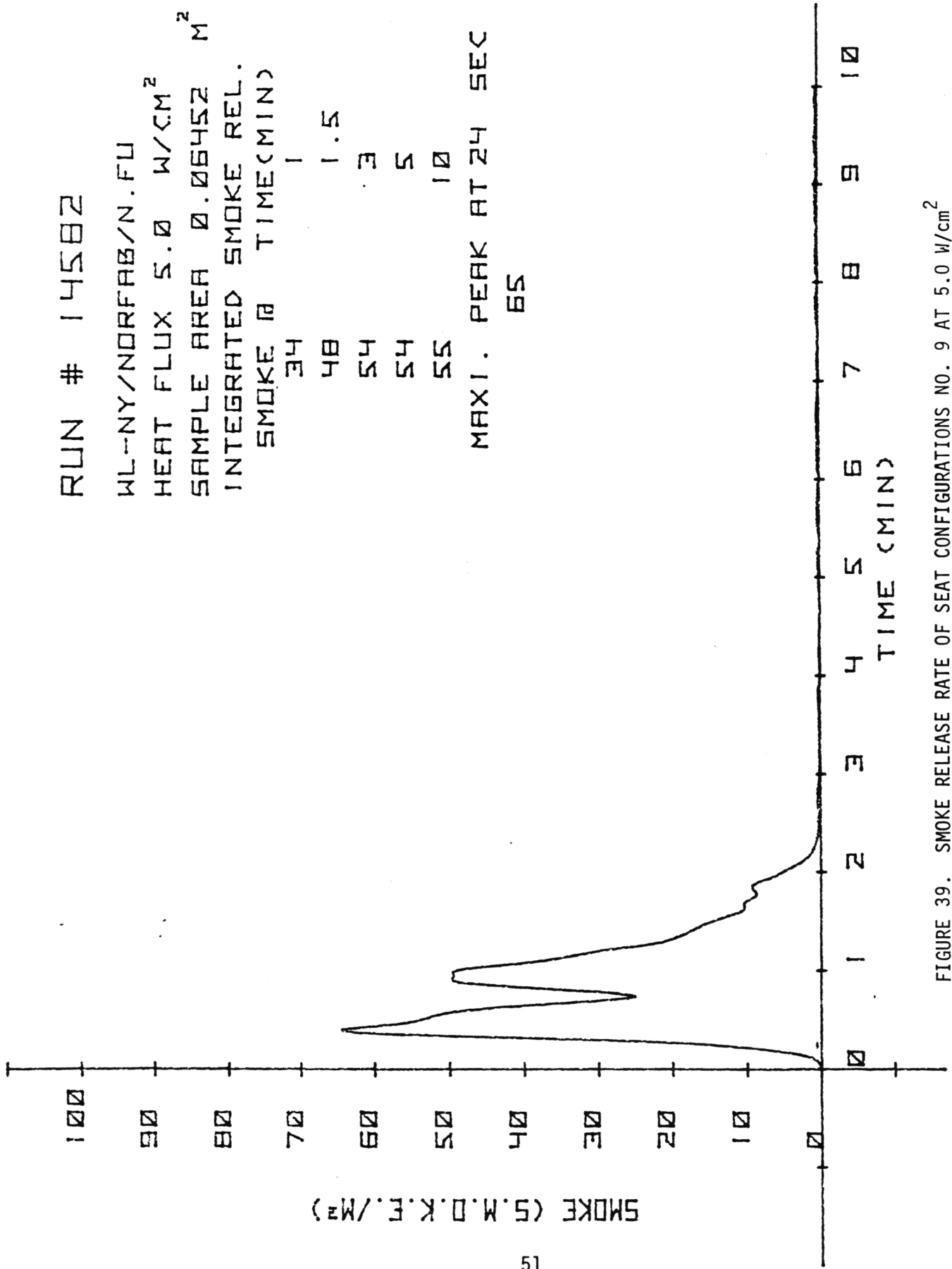


FIGURE 39. SMOKE RELEASE RATE OF SEAT CONFIGURATIONS NO. 9 AT 5.0 W/CM²