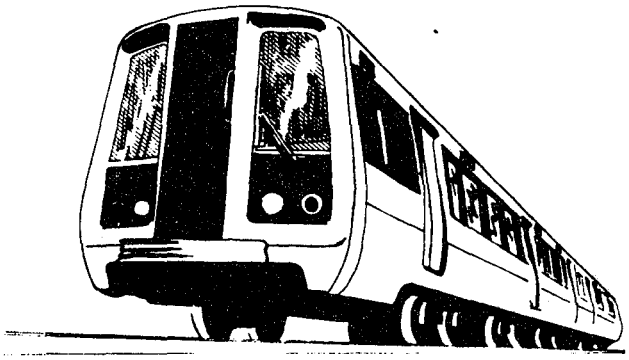
TECHNICAL NOTE

U.S. Department of Transportation
Urban Mass Transportation Administration



TRANSPORTATION TEST CENTER

UMTA/TTC/TN-82/07

March 3, 1982

MARTA "C" CAR: THERMAL CAPACITY TEST

SUMMARY

A Special Engineering Test was conducted on Metropolitan Atlanta Rapid Transit Authority (MARTA) Car 502 to determine the operating temperature at various undercar locations during worst-case simulated revenue service while operating at AW2 weight (100,000 lbs). This simulated revenue service was run for two hours, with no component or system showing an excessive temperature. No deterioration of vehicle performance was noted during the test. The simulated revenue profile, locations of temperature measurements, and the temperatures recorded are tabulated, and trends are shown.

TEST OBJECTIVE

The objective of the test was to determine the stabilized operating temperatures at various under-car locations during a worst-case simulated revenue run.

TEST PROCEDURE

Car Number 502 was instrumented with thermocouples at thirty locations. The vehicle was run for a period of two continuous hours on a simulated revenue route supplied by MARTA (Table 1). At the end of the two hours of simulated revenue service, the vehicle was accelerated to 70 mi/h and full service brakes were applied to a stop. A total of three 70 mi/h runs were made, with a 60-second dwell between runs.

DISCUSSION

The operational profile used for this test was a modification of a similar profile used in testing the "A-B" carset, the principle modification being the use of a fixed 20 second dwell time after stopping at each station in lieu of adjusting the dwell time to accommodate a fixed trip time from station stop to station stop. This alleviates the necessity to alter the dwell times constantly to adjust for the track grades and curves. The profile for the "C" Car test (Table 1) shows the intended time in seconds for each operating condi-

tion. The time to bring the vehicle to a complete stop is dependent upon the maximum speed attained, and as a result no specific time was specified to stop. The test results showed that the average time to run on profile was 5 minutes, 52 seconds. This results in an average braking interval of 30 seconds.

Table 2 is a list of thermocouple locations used for this test. Location zero (0) was the outside ambient temperature. Locations 30 and 31 were for one thermocouple that was recorded at two intervals, the first being peak reading during the brake cycle, and the second being the reading at the instant the vehicle stopped. Selected locations have been plotted in Figures 1 through 10 to show temperature variation trends.

All temperatures were recorded as the vehicle made stop "D" of the profile (the 60-second stop). The profile as shown in Table 1 was repeated 22 times in an elasped time of 2 hours and 9 minutes. The temperatures are shown in Table 3 as runs 1 through 22. At the completion of the 22 runs, the vehicle was accelerated to 70 mi/h and full service dynamic brakes were applied until the vehicle came to a complete stop. This was repeated for a total of three runs, with a 60-second dwell time between each run. The temperatures for these stops are shown as runs 23, 24 and 25 on Table 3.

The temperatures shown as "INIT" (initial) on Table 3 were made immediately prior to the start of the first profile, but after the vehicle had completed one (1) trip around the Transit Track at 30 mi/h.

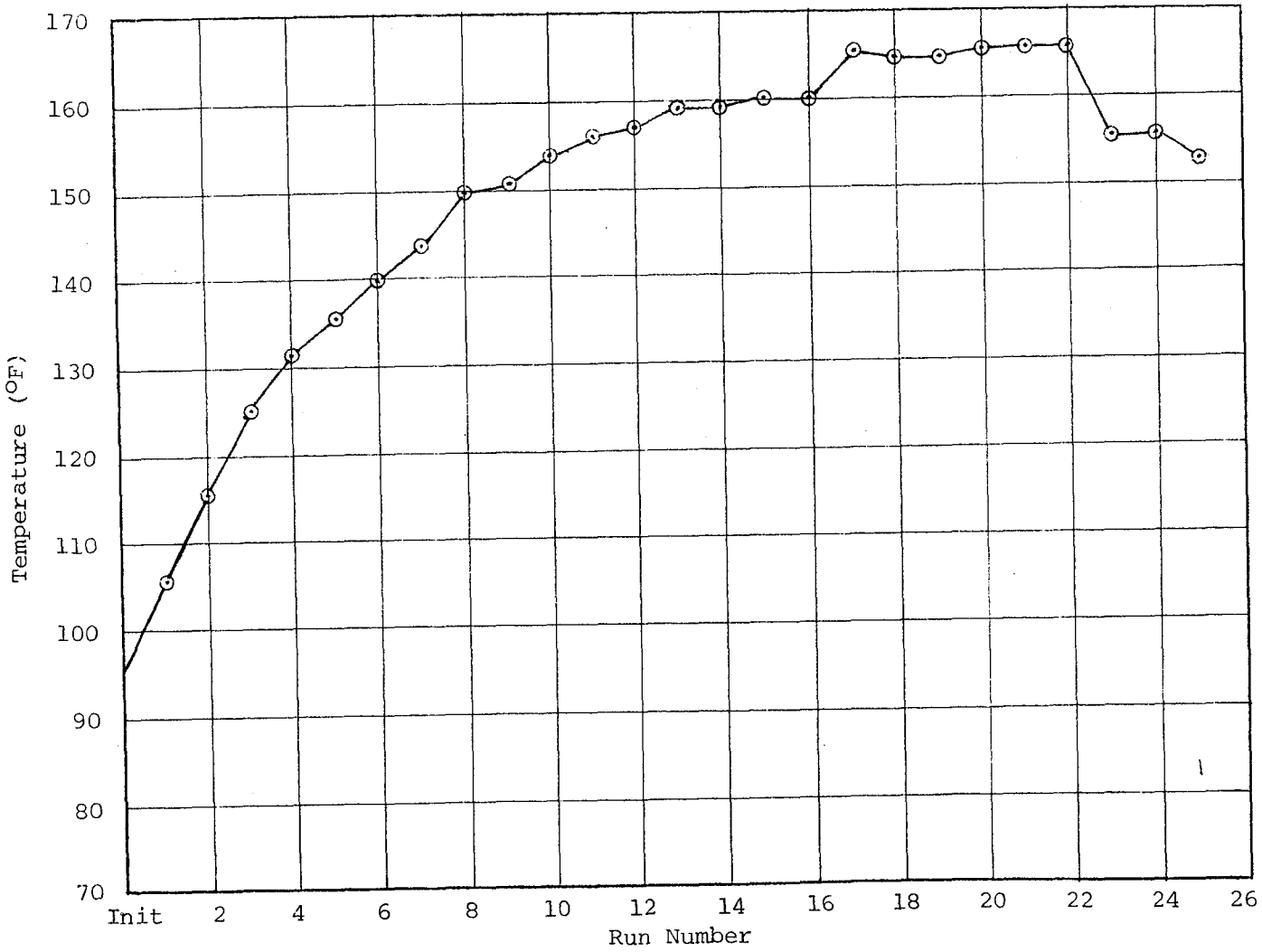


FIGURE 1. TRACTION MOTOR #2 FIELD WINDING, LOCATION 2.

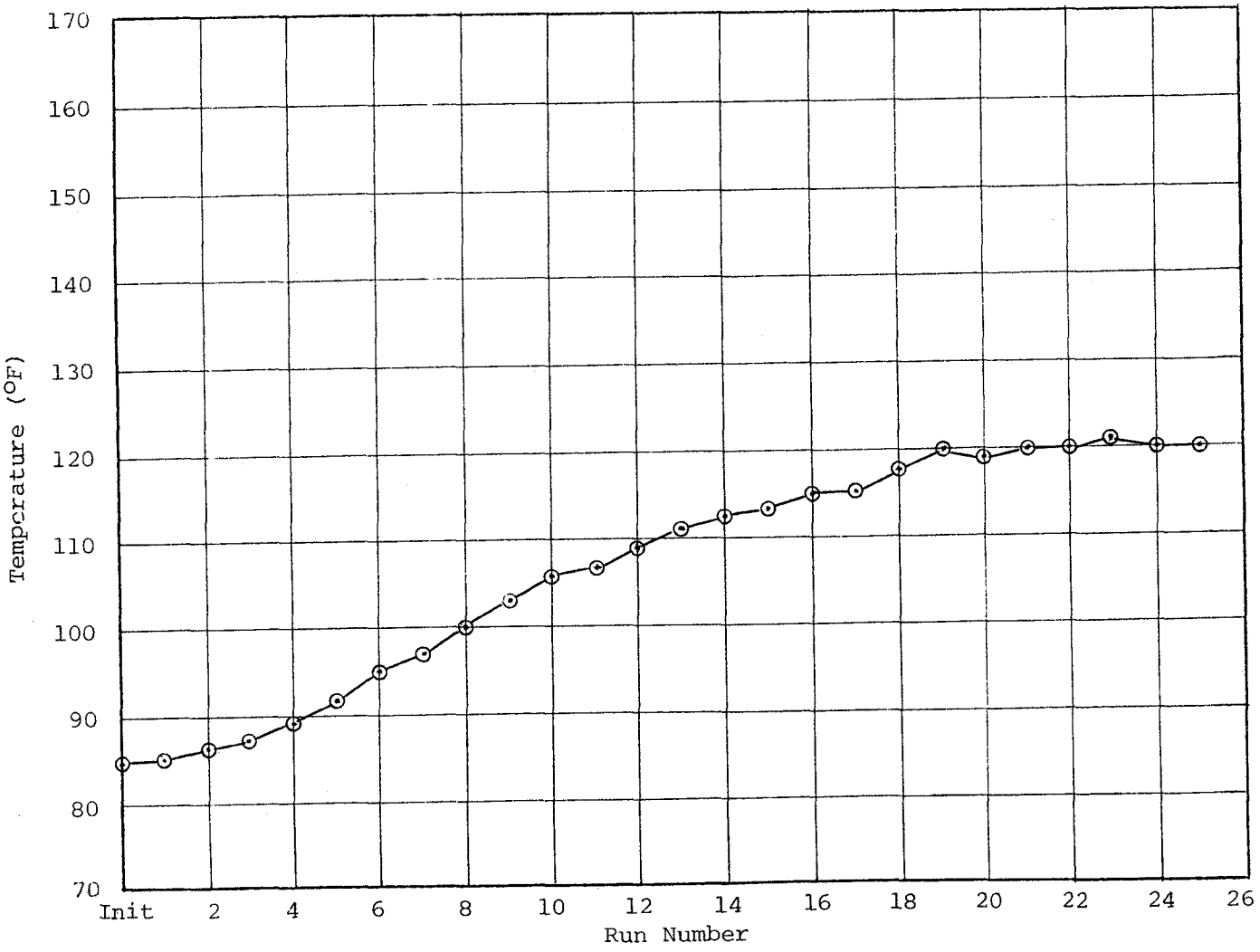


FIGURE 2. TRACTION MOTOR #2 TOP OF CASE, LOCATION 6.

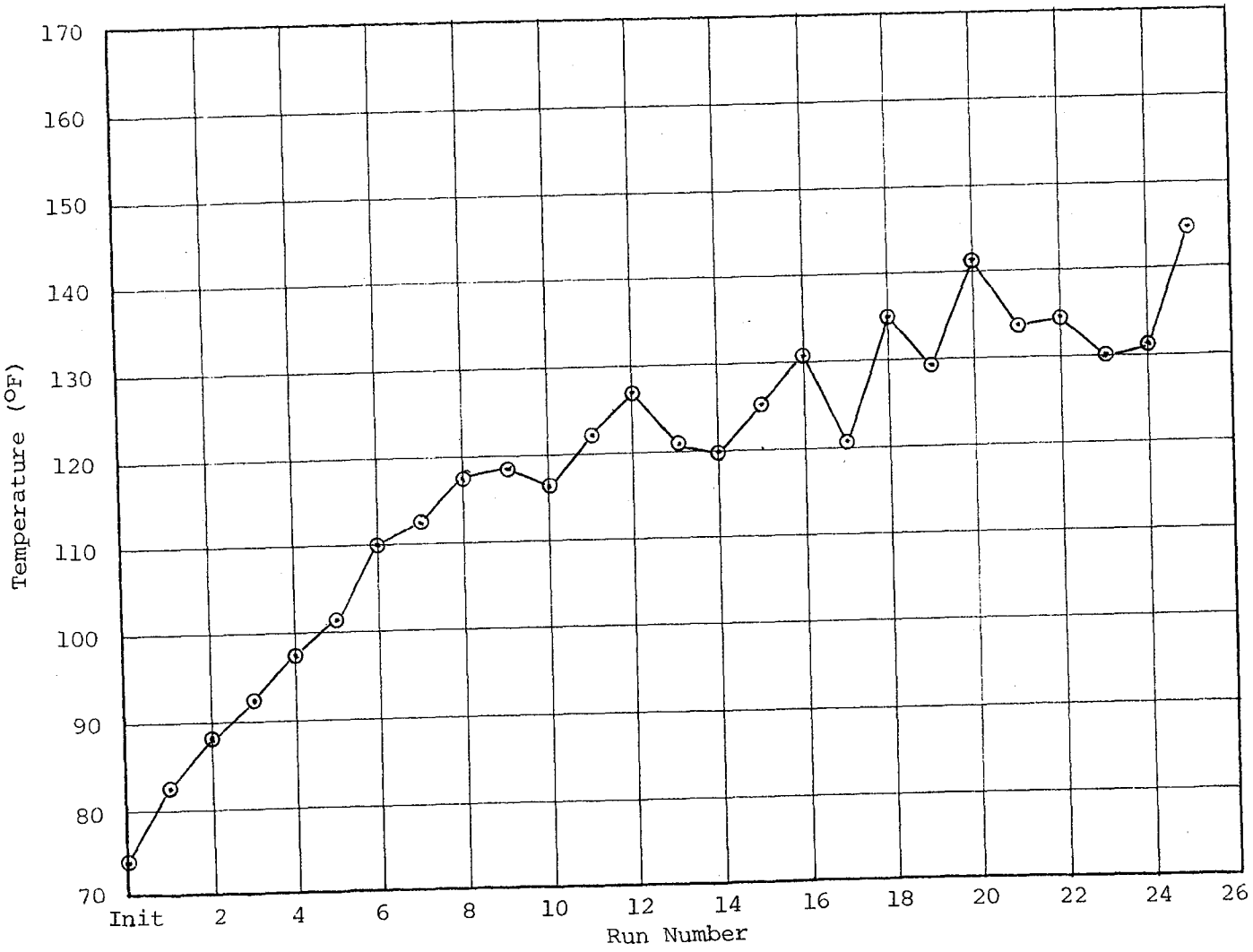


FIGURE 3. SMOOTHING INDUCTOR, LOCATION 9.

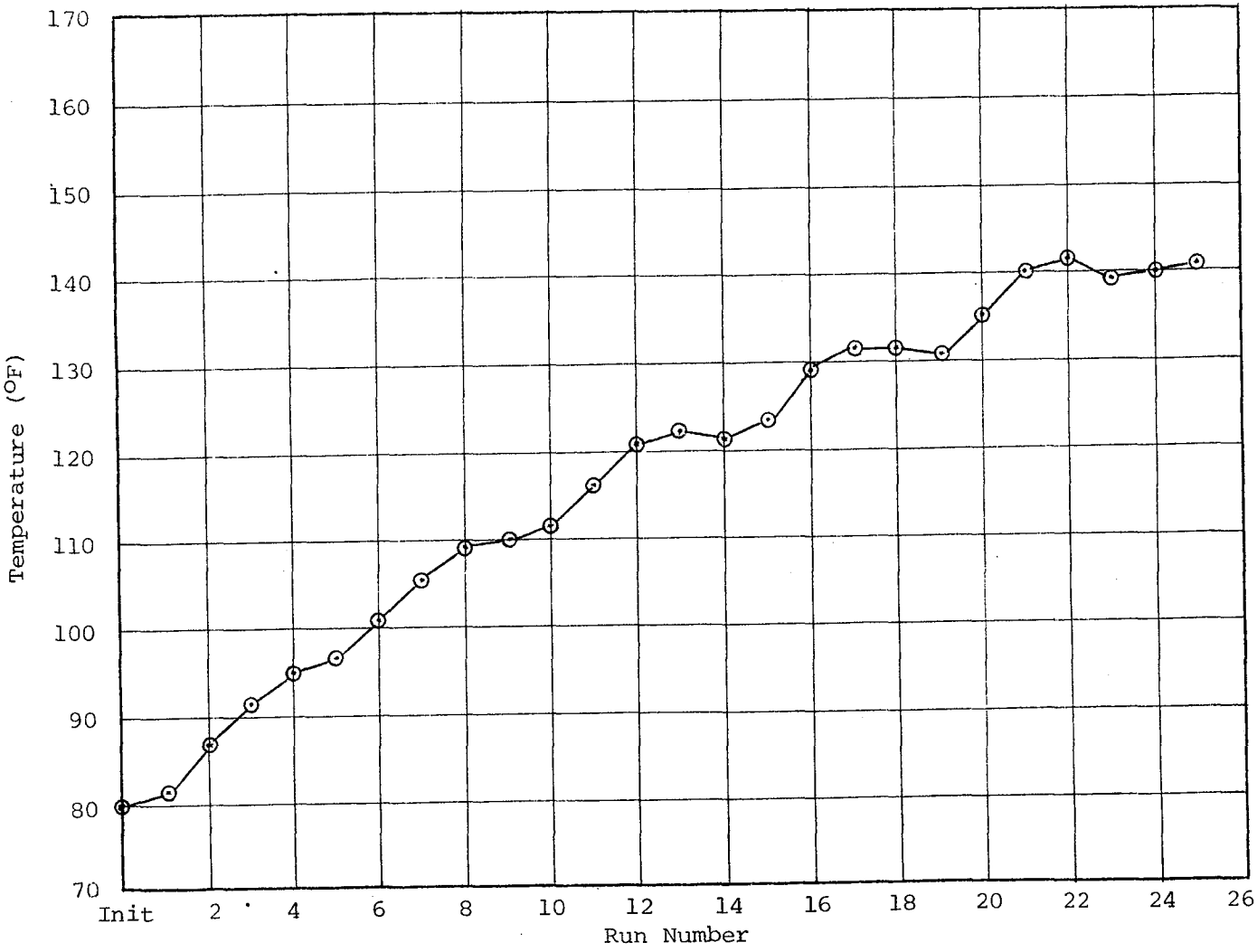


FIGURE 4. INPUT INDUCTOR, LOCATION 10.

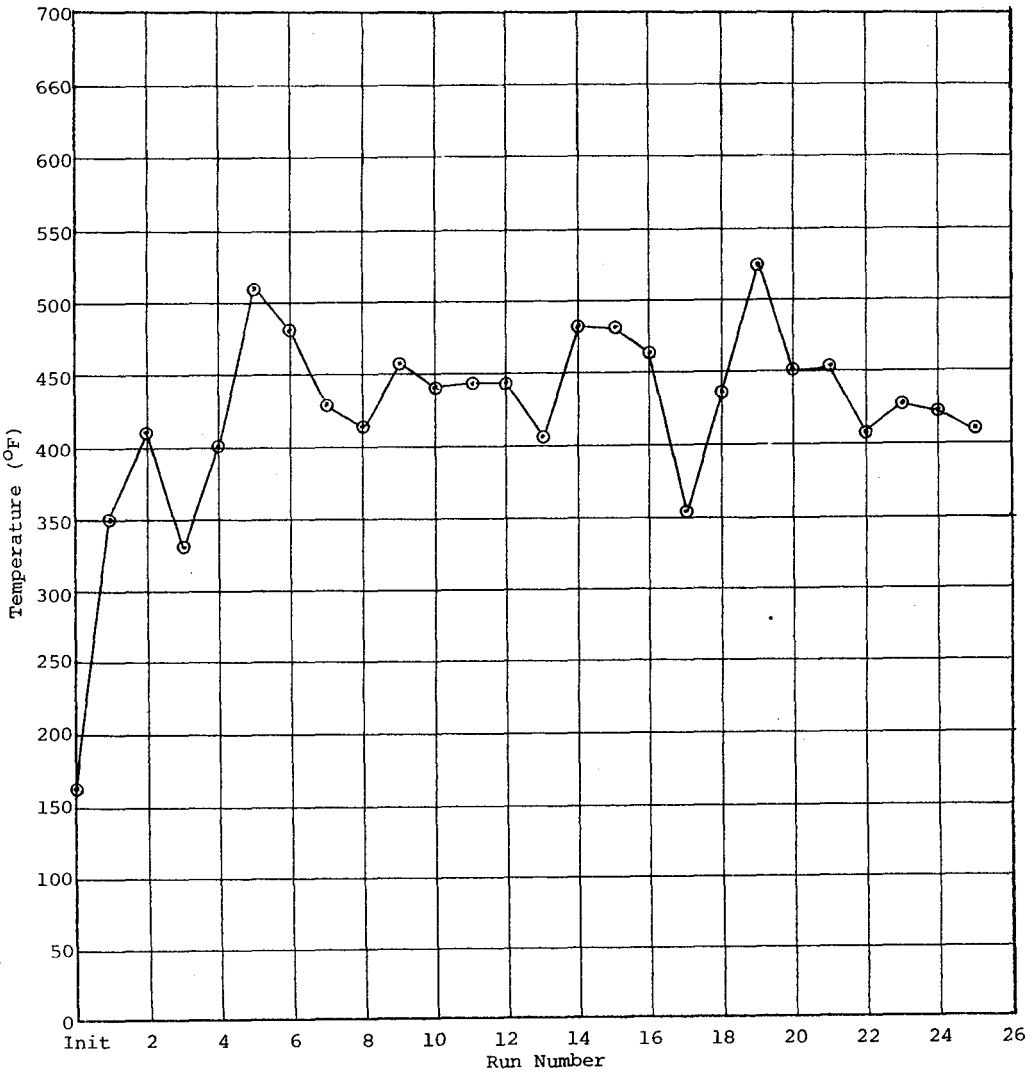


FIGURE 5. BRAKE GRID RESISTOR, OPEN AIR, LOCATION 11.

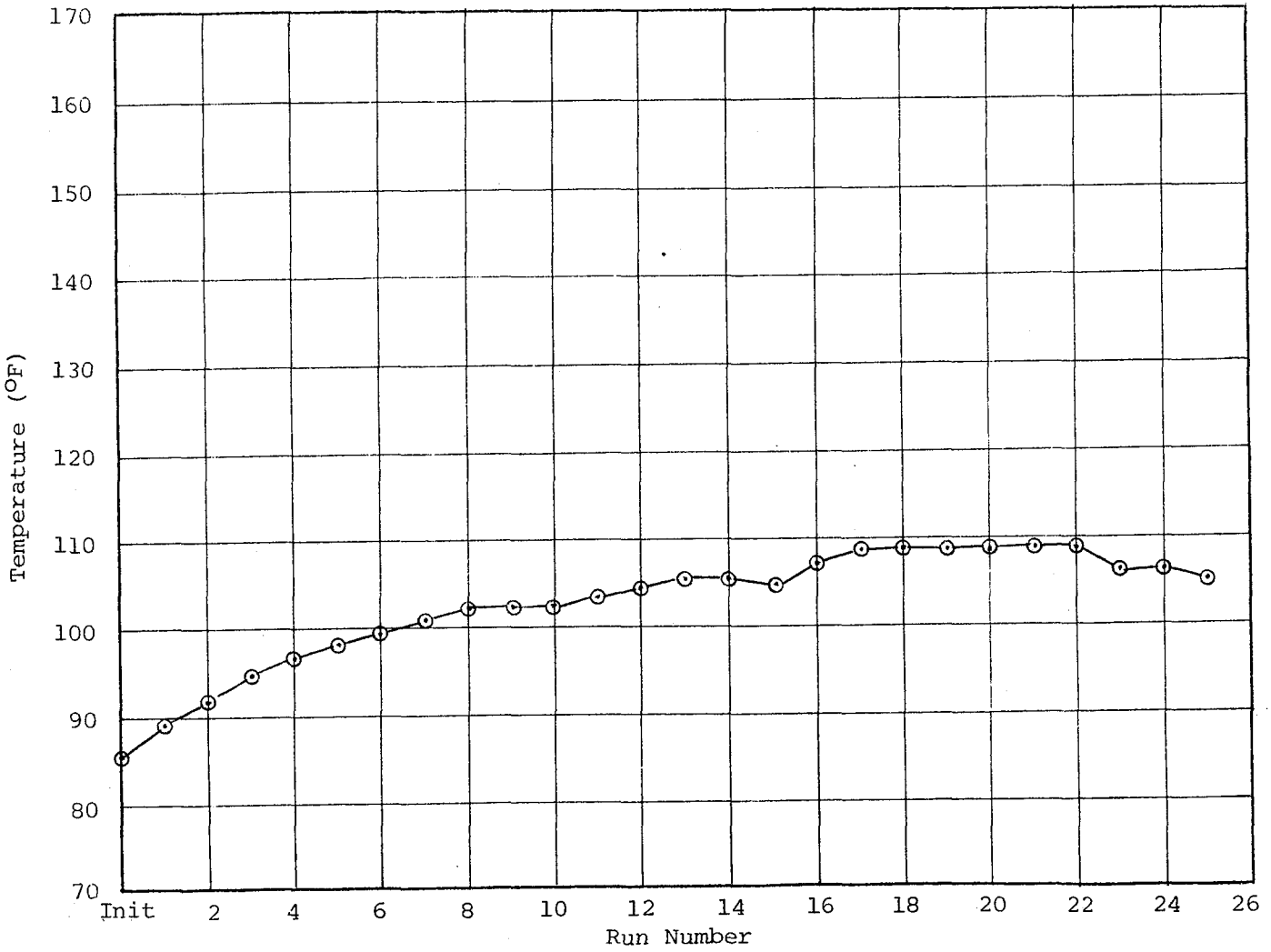


FIGURE 6. VLC COMMUNICATION INDUCTOR, ASPE BAY 4, LOCATION 15.

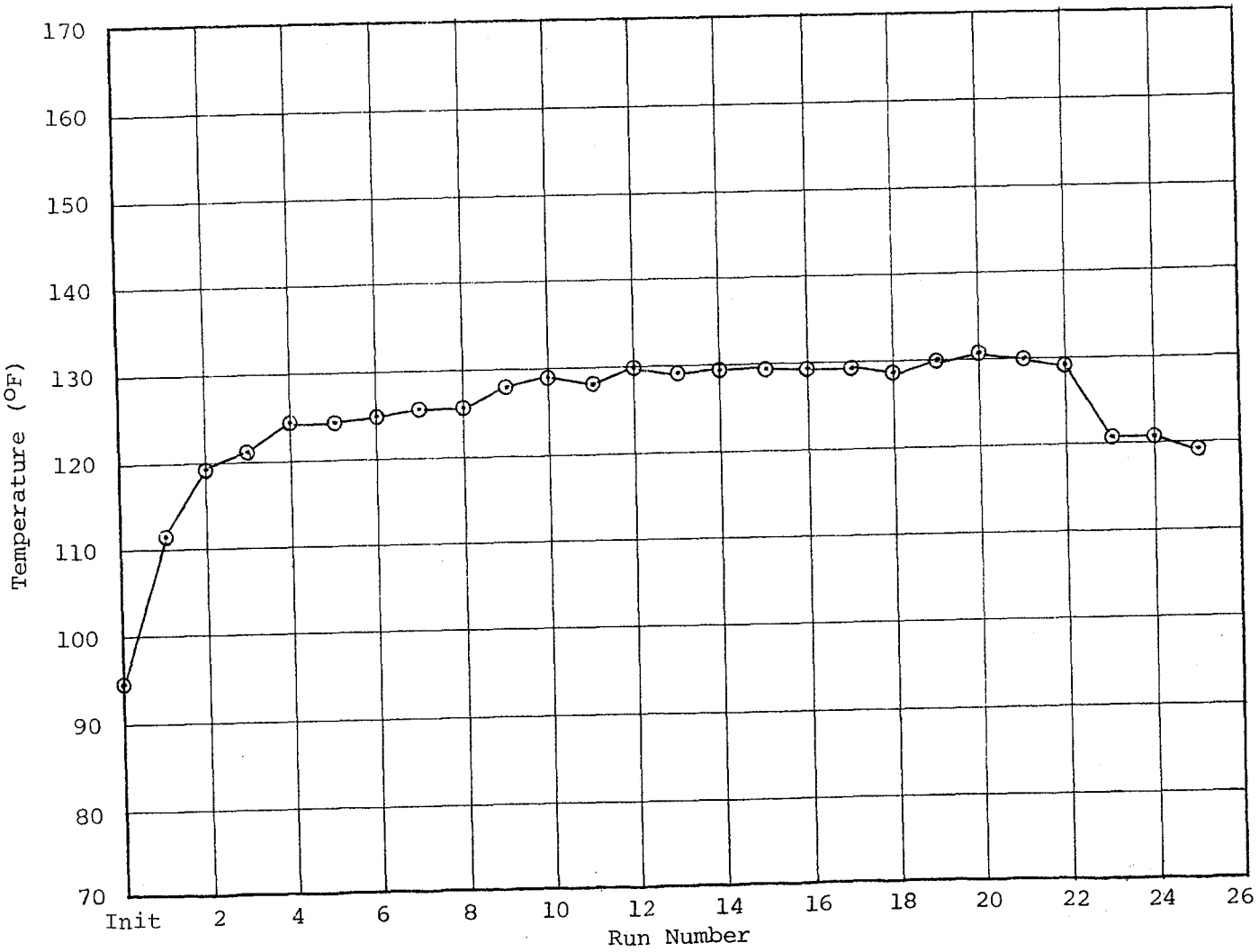


FIGURE 7. MAIN THYRISTOR MOUNTING, PCE BAY 4, LOCATION 18.

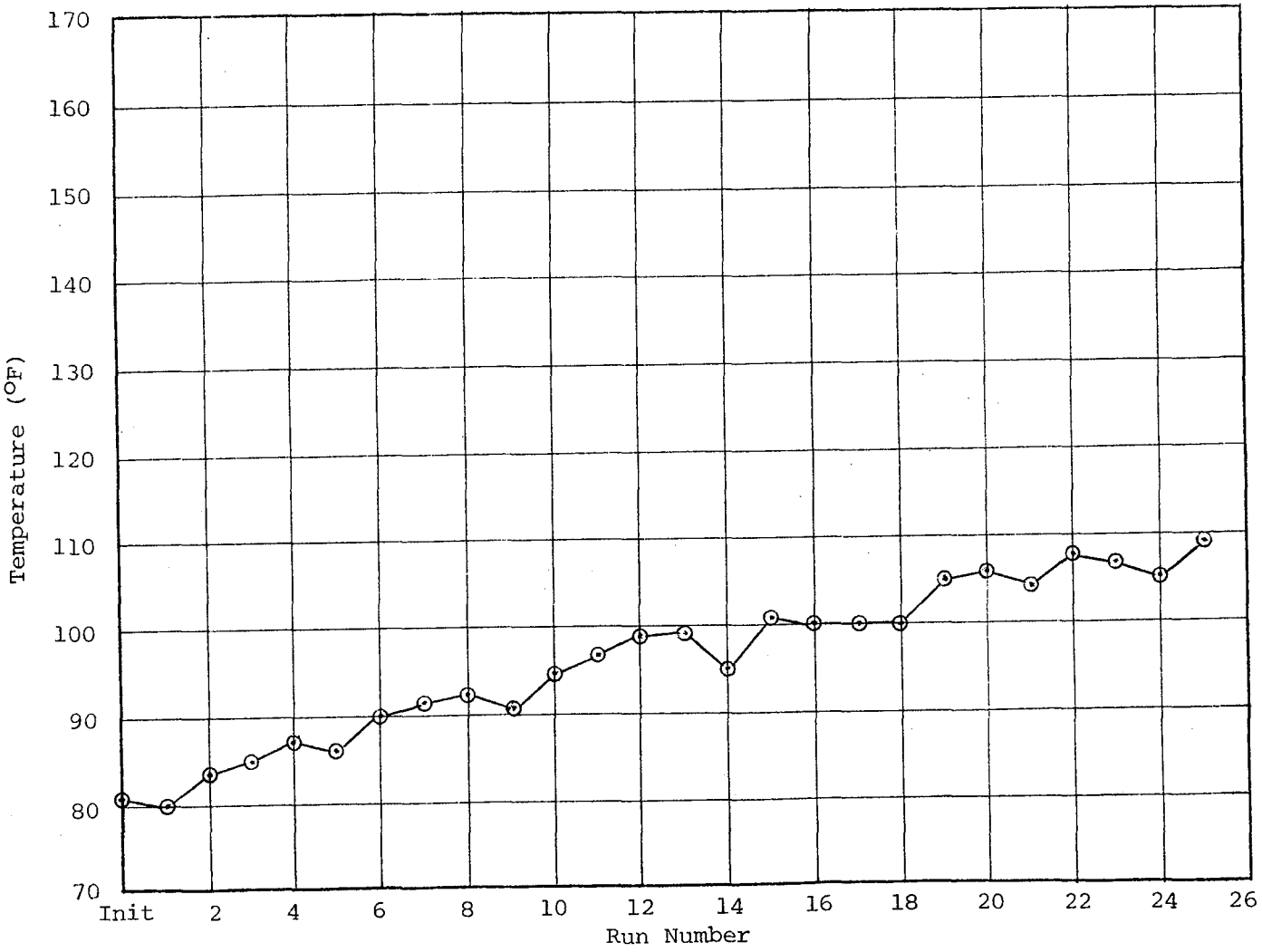


FIGURE 8. AIR COMPRESSOR MOTOR, TOP OF CASE, LOCATION 25.

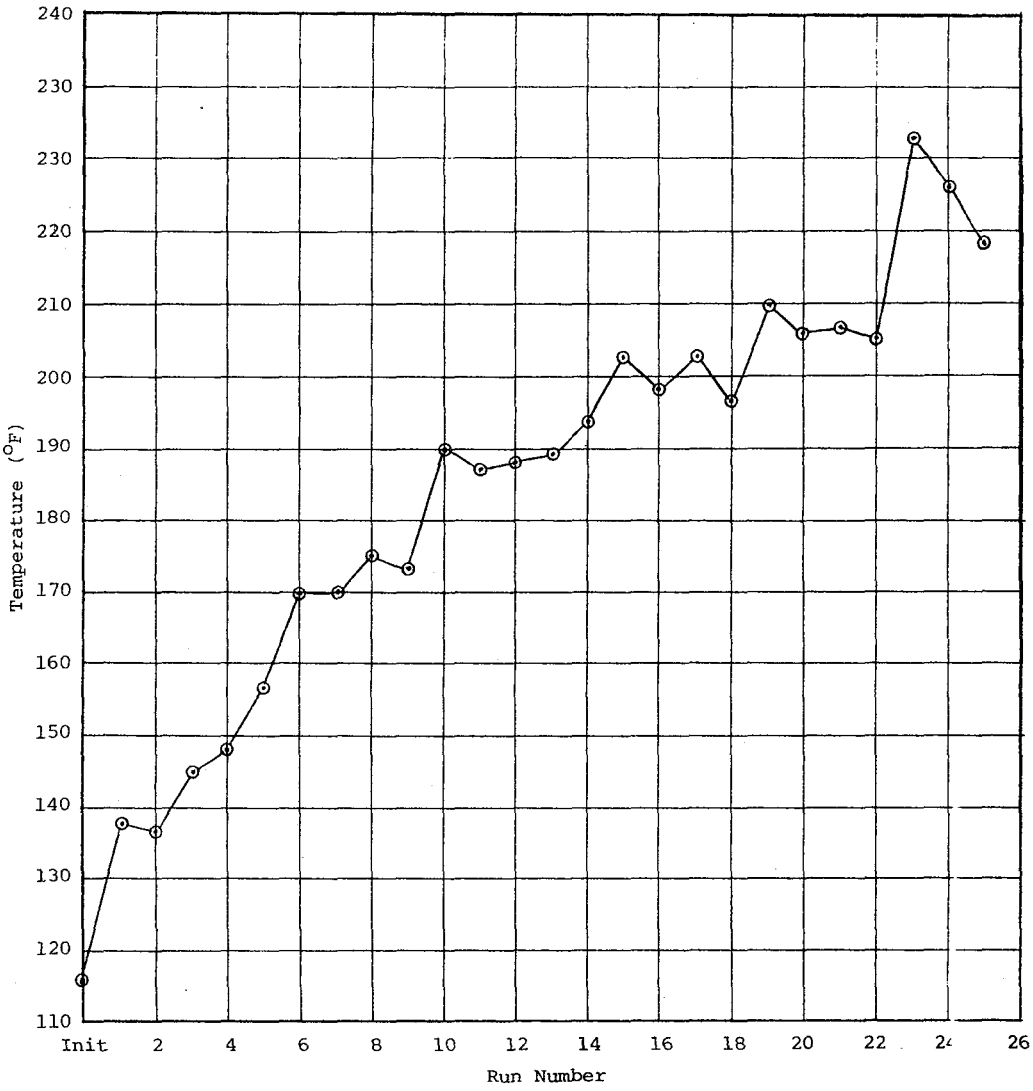


FIGURE 9. BRAKE SHOE, LEFT SIDE AXLE #3, LOCATION 28.

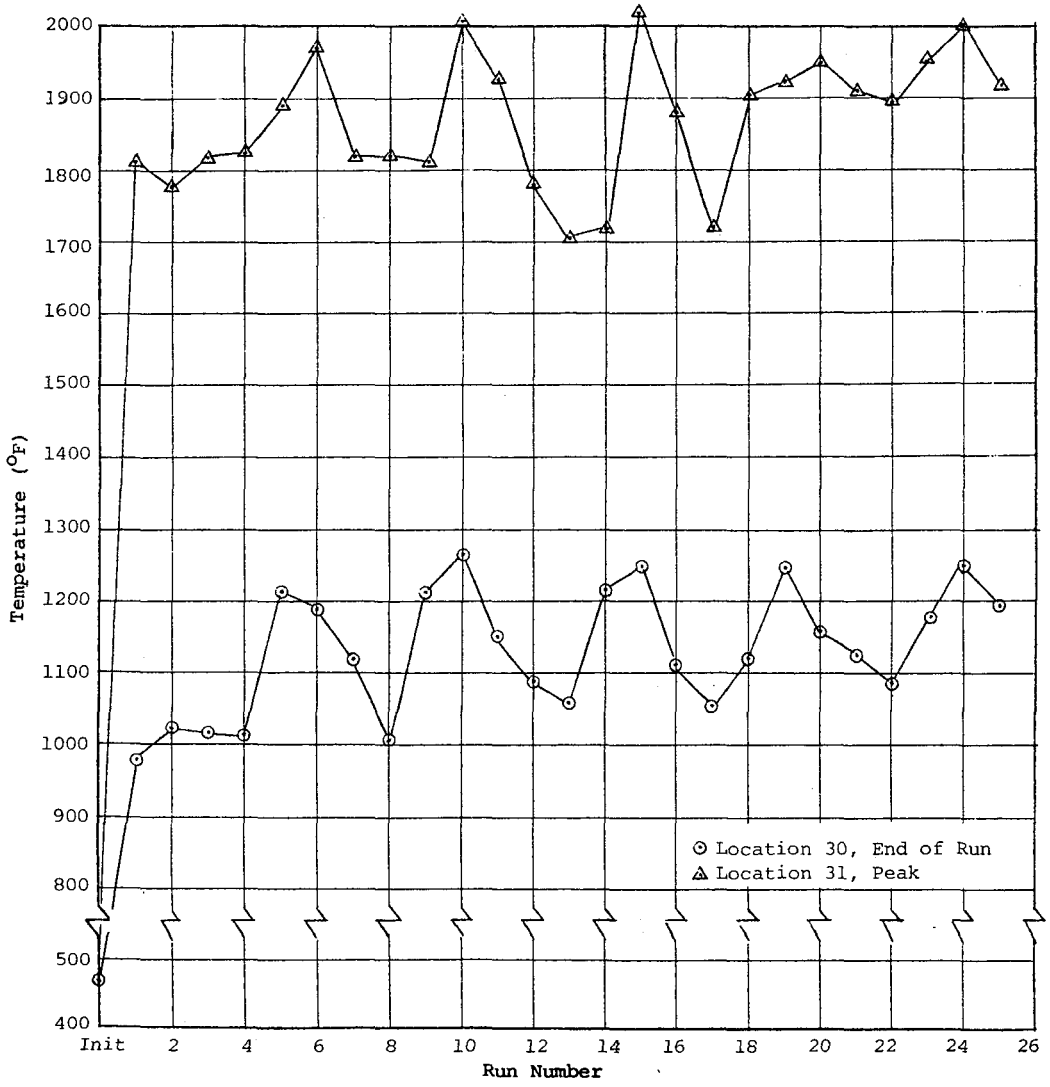


FIGURE 10. BRAKE GRID RESISTOR, LOCATIONS 30 AND 31.

TABLE 1. MARTA "C" CAR THERMAL CAPACITY TEST PROFILE

"P" Signal (Percent)	Condition	Duration (Seconds)
100	Accel	28
70	Accel	4
60	Coast	1
18	Brake	30*
	Dwell	20
100	Accel	28
70	Accel	20
60	Coast	1
18	Brake	30*
	Dwell	20
100	Accel	28
70	Accel	7
60	Coast	1
18	Brake	30*
	Dwell	20
100	Accel	28
70	Accel	3
60	Coast	3
18	Brake	30*
	Dwell	20
		325* TOTAL

NOTES:
*Average determined from test results.
The "P" Signal of 18% was held until the vehicle came to a complete stop. The Dwell Time started at the time the vehicle came to a stop.

TABLE 2. THERMOCOUPLE LOCATION.

CHANNEL	LOCATION
0	Outside Ambient (Open Air)
1	Traction Motor #1 Field Winding (Contact)
2	Traction Motor #2 Field Winding (Contact)
3	Traction Motor #3 Field Winding (Contact)
4	Traction Motor #4 Field Winding (Contact)
5	Traction Motor #1 Case Top (Contact)
6	Traction Motor #2 Case Top (Contact)
7	Traction Motor #3 Case Top (Contact)
8	Traction Motor #4 Case Top (Contact)
9	Smoothing Inductor Surface Adjacent to Input Inductor (Contact)
10	Input Inductor Surface Adjacent to Smoothing Inductor (Contact)
11	Brake Resistor Grid FWD End FWD Unit (Open Air)
12	Brake Resistor Grid Rear End FWD Unit (Open Air)
13	Brake Resistor Grid Middle Rear Unit (Open Air)
14	ASPE Bay #2 Internal (Open Air Between Capacitors)
15	ASPE Bay #4 Internal (Open Air VLC Communication Inductor)
16	ASPE Bay #6 Internal (Open Air VLC Smoothing Inductor)
17	PCE Bay #2 Internal (Open Air Between Capacitor Bank & Inductor)
18	PCE Bay #4 Internal (Open Air Main Thyristor)
19	PCE Bay #5 Internal (Open Air Near Blend Thyristor)
20	PCE Bay #6 Internal (Open Air Between A22 & A21)
21	PCE Cooling Duct Intake Approx. 3 Inches In (Open Air)
22	Undercar Midway ASPE Bay #5 & Resistor Grid (Open Air)
23	Undercar Midway PCE Bay #5 & Reservoir (Open Air)
24	Battery Box Internal (Open Air)
25	Air Compressor Motor Case Top (Contact)
26	Brake Shoe L1 Internal (Contact)
27	Brake Shoe R2 Internal (Contact)
28	Brake Shoe L3 Internal (Contact)
29	Brake Shoe L4 Internal (Contact)
30	Brake Resistor Grid Rear End FWD Unit (Contact) End of Run
31	Brake Resistor Grid Rear End FWD Unit (Contact) Peak

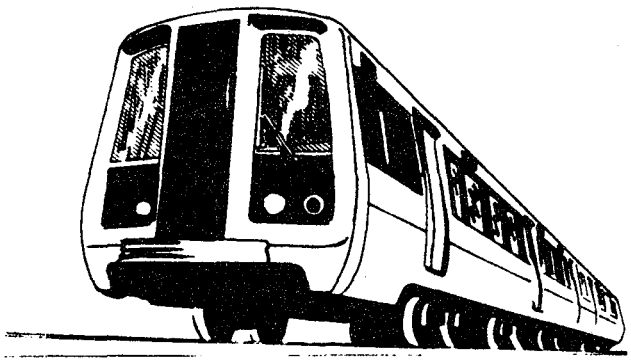
TABLE 3. MARTA "C" CAR THERMAL CAPACITY TEST.

		Run Numbers																	All Temperatures - Degrees Fahrenheit								
LOC	INIT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	LOC
0	68	73	69	71	67	70	76	69	71	71	72	71	70	70	68	78	78	85	72	72	72	72	72	72	72	73	0
1	89	97	107	113	120	122	127	128	132	135	136	139	138	141	141	142	143	143	145	143	146	143	145	140	140	137	1
*2	95	106	117	126	132	137	140	144	149	151	153	156	157	159	159	160	160	166	165	165	166	166	166	156	156	153	2
3	90	101	112	118	125	129	133	137	140	140	142	150	147	148	147	148	151	151	152	150	151	153	154	144	143	140	3
4	90	96	105	113	117	120	124	128	131	131	134	136	138	138	137	139	141	141	143	142	150	144	143	141	141	141	4
5	78	78	78	80	79	81	84	85	86	87	88	91	91	91	92	93	94	96	95	95	96	96	96	95	95	96	5
*6	85	85	86	87	89	92	95	97	100	103	196	107	109	111	113	114	115	115	118	120	119	120	120	121	120	120	6
7	83	83	85	87	89	90	93	96	99	100	101	104	107	108	107	108	111	113	113	113	113	115	115	115	114	115	7
8	82	82	83	85	87	88	91	93	95	97	99	101	102	104	104	105	106	108	109	109	109	110	111	111	111	112	8
*9	74	83	88	93	96	102	110	113	117	118	116	123	127	121	120	126	131	121	135	129	142	134	135	130	132	145	9
*10	80	82	87	92	95	97	101	106	109	110	112	117	121	123	122	124	129	132	132	131	136	140	142	139	140	141	10
*11	166	350	410	333	401	509	480	436	417	457	542	445	446	408	480	479	463	355	438	525	451	454	409	428	424	411	11
12	126	191	188	188	196	266	240	230	221	227	253	252	246	233	235	289	190	165	230	275	302	248	251	261	243	217	12
13	128	223	202	196	212	285	274	245	210	279	348	258	254	223	293	277	221	196	245	312	261	271	228	257	257	237	13
14	90	93	94	96	98	99	100	101	103	104	105	105	106	108	108	109	111	111	112	112	113	113	113	113	113	113	14
*15	86	89	92	95	97	98	99	101	103	103	103	104	105	106	106	105	107	108	108	108	108	108	108	106	106	105	15
16	87	89	91	94	95	96	98	99	101	101	102	103	104	105	105	105	107	108	108	108	109	109	109	109	108	108	16
17	85	93	97	99	103	104	105	105	106	108	108	107	108	109	109	109	109	109	110	110	110	109	109	106	106	104	17
*18	94	112	119	121	124	124	125	126	126	128	129	128	130	129	129	129	129	129	128	130	131	130	129	121	121	119	18
19	76	75	76	77	79	78	79	79	81	82	82	82	83	82	82	82	82	83	85	84	84	83	83	84	84	83	19
20	79	80	81	82	84	84	84	85	86	87	88	87	88	87	88	88	88	88	89	90	89	88	88	89	89	89	20
21	75	74	75	76	78	77	77	79	80	80	80	80	81	81	81	80	80	81	83	83	81	82	81	82	82	81	21
22	74	84	121	136	90	93	137	106	112	96	199	148	140	99	97	133	124	134	112	104	150	116	135	105	120	129	22
23	71	74	70	81	81	78	74	86	79	84	82	85	79	89	86	82	72	71	91	86	82	102	100	86	90	77	23
24	71	72	73	74	73	73	74	75	76	75	75	77	78	78	75	76	79	81	79	78	78	79	79	78	78	73	24
*25	81	80	84	85	87	86	90	92	93	91	95	97	99	99	95	101	100	100	100	105	106	104	108	107	105	109	25
26	106	115	120	131	132	137	147	145	150	146	156	157	159	158	159	166	162	166	161	171	170	170	169	185	185	177	26
27	99	104	111	117	119	123	129	134	136	139	142	145	149	150	151	152	155	156	157	158	161	163	163	165	167	167	27
*28	116	138	136	145	148	157	170	170	175	173	190	187	188	189	194	203	198	203	197	210	206	207	205	233	226	218	28
29	105	116	126	132	134	140	148	153	156	158	162	168	171	172	174	175	179	180	178	181	186	188	188	192	194	193	29
*30	466	981	1024	1018	1015	1213	1188	1119	1005	1215	1270	1150	1094	1062	1202	1251	1114	1058	1121	1249	1162	1123	1087	1180	1251	1195	30
*31	466	1816	1785	1821	1825	1893	1976	1818	1819	1809	2005	1931	1778	1703	1721	2010	1884	1724	1904	1928	1951	1908	1794	1954	2001	1931	31

*Trends are plotted in Figures 1 through 10.
LOC = Location, see Table 2.
INIT = Initial Value.

UMTA/TTC/TN-82/07-15

TECHNICAL NOTE



TRANSPORTATION TEST CENTER

U.S. Department of Transportation
Urban Mass Transportation Administration

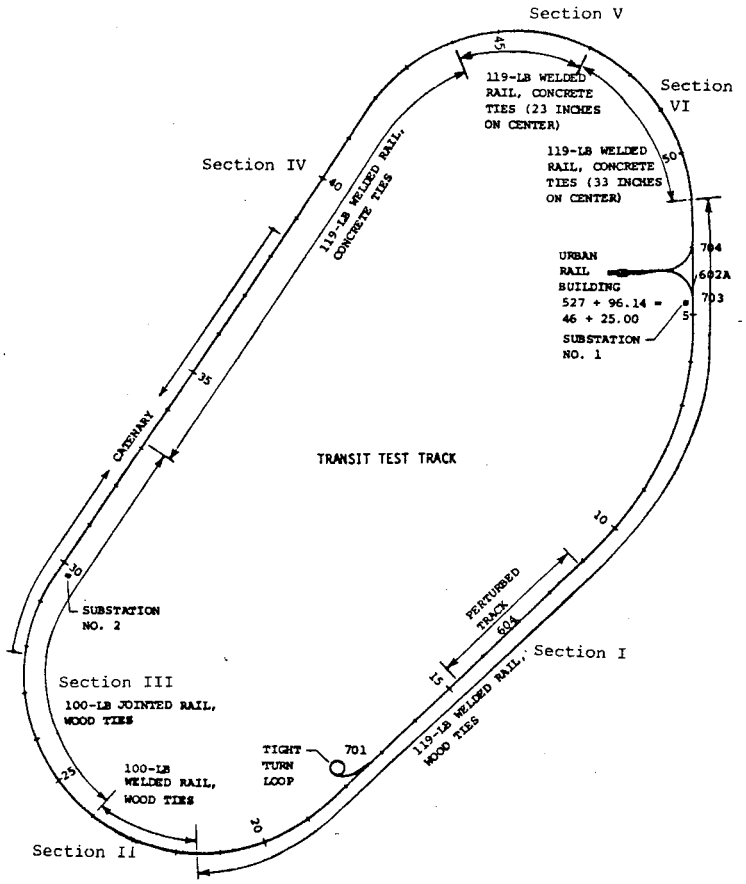
Test and evaluation activities of the Urban Mass Transportation Administration (UMTA) are coordinated through The Office of Technical Assistance in Washington, D.C., and are conducted by The UMTA Program Office at the Transportation Test Center (TTC) in Pueblo, Colorado.

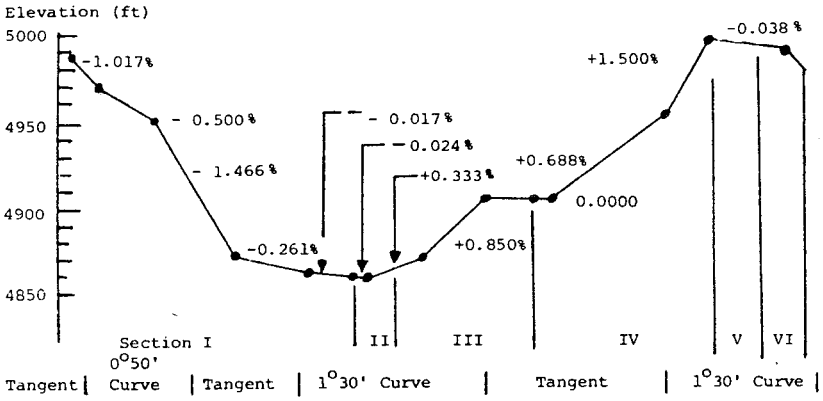
The urban rail transit test facilities at the TTC provide for test and evaluation of urban rail vehicles, subsystems, track, and structural components in an environment that is both safe and free from the scheduling constraints imposed by revenue service operations.

The Transit Test Track (TTT) is a 9.1 mile oval (see next page) designated for sustained 80 mi/h vehicle operation with the exception of the perturbed track section, which is subject to a speed limit based on ride quality test requirements and safety considerations. Power is provided either by a conventional third rail or a section of overhead catenary cable; the third rail was constructed to New York City Transit Authority specifications.

The rectifier station voltage can be varied infinitely from 400 to 1,200 V.d.c. with a current limit of 11,000 A. The stations each feed from one bus to all of the TTT and are designed to operate in several alternate modes, including computer control. Voltage can be controlled at a constant level at the substation, or at the position of the vehicle and held within the above constraints to a constant value at the vehicle regardless of demand or voltage drop through the rails. In alternate modes of operation the test vehicle can be subjected to a voltage profile or a voltage step such as might occur in revenue service at the transition between one substation and another.

The Test Center's technical support capabilities include test management, engineering instrumentation, calibration and electronic repair, photo-optical instrumentation, and data processing. In addition, TTC has the capability to assist users in developing test plans and requirements, and preparing reports.





NOTES:

Track Curvature:

Sta. to Sta.		Degree of Curve
55.3	10.3	0° 50"
18.9	29.4	1° 30"
41.8	50.8	1° 30"

Elevation:

Minimum - 4863 ft at Station 22.0.
Maximum - 5003 ft at Station 46.0.

Curve Superelevation:

1° 30' curves are superelevated a maximum of 4.5". The maximum superelevation on the 0° 50' curve is 2".

Tight Turn Loop

150 ft radius.
119 lb AREA Head Hardened running rail.
85 lb ASCE restraining rail installed as per Massachusetts Bay Transit Authority specifications.