CR-170893

TECHNICAL NOTE

Lockheed
Missiles & Space Company, Inc
Huntsville Research & Engineering Center

Contract	NAS8-32982	Date	6 August 1982	Doc.	LMSC-HREC TN D867576

Title RESULTS OF TESTS OF WEATHERED K5NA CLOSEOUT MATERIAL IN THE MSFC HOT GAS FACILITY

BACKGROUND

K5NA is a TPS material used extensively on the Space Shuttle to close out joints, corners, fillets, etc. In some of the areas K5NA is applied over existing cork panels. In the past, the practice has been to mask off the areas to be covered with K5NA before painting the cork. The reason for this is to enable the K5NA to bond directly to the cork rather than to the Hypalon paint. This masking process is very time consuming and costly. It would be very helpful if it could be demonstrated that the K5NA could be applied over the Hypalon.

Another problem with the K5NA is that it is normally painted after it is applied to the vehicle. The question has occurred: could these areas be left unpainted while the SRB is exposed to the weather? That is, does the weathering affect its thermal performance due to absorption of moisture?

A third problem associated with the K5NA application has to do with the use of either water or K5NA solvent for tooling the material into shape. Both have been used at MSFC, but KSC generally uses only solvent.

TEST OBJECTIVES

The objectives of these tests are:

- Determine the effects of using K5NA over painted cork surfaces,
- Determine the effects of weathering on the unpainted K5NA surfaces, and
- Compare the use of water versus solvent for tooling K5NA in place.

SUCCESS CRITERIA

These tests were qualitative in nature. The idea was to compare the post-test panels to see if the K5NA performed reasonably well and did not delaminate from the cork. That is, if the K5NA stayed in place and there were no obvious adverse effects of weathering then the fabrication methods would be declared acceptable.

TEST DESCRIPTION

Figure 1 shows a sketch of a typical panel. It consists of a 1/8" aluminum substrate covered with 5/8 in. P-50 cork coated with Hypalon paint. The basic panel size was 14.125 in. x 27.67 in. The K5NA was troweled in place about half way back on the panel in a lateral "hump," approximately 3/8 in. high and 2 in. wide. The panels were made up with a "side A" and "side B." Each side had a different set of variables, i.e., some were painted, some were unpainted, some were tooled with water, some with solvent, etc. Table 1 shows the configuration of each of the six panels tested with the codes showing how each was fabricated. Each panel was instrumented with eight thermocouples, four under the K5NA and four under the cork as shown in Fig. 1.

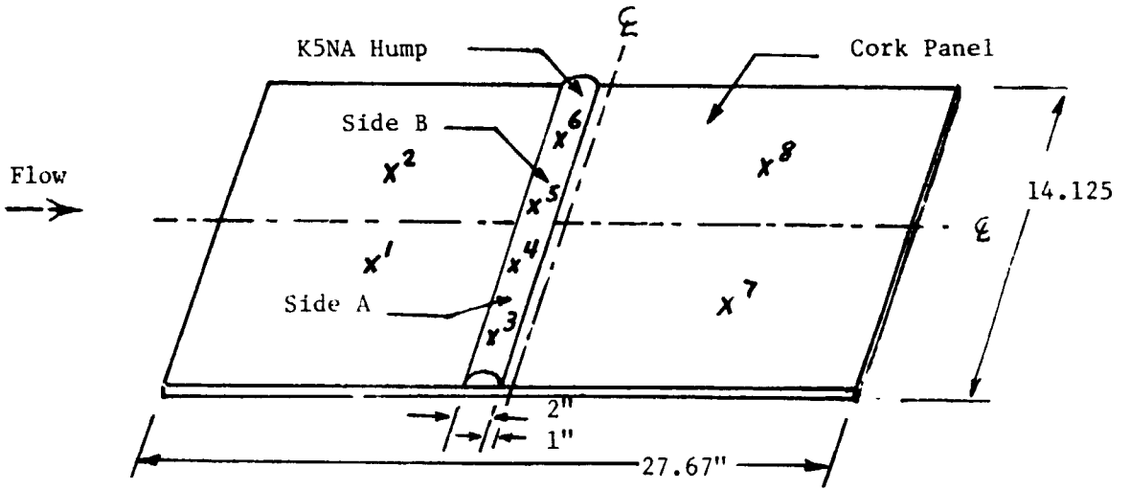

Fig. 1 - Sketch Showing Dimension of Typical Panel
(Not to Scale)

These panels were made up at MSFC and weathered in the natural environment at KSC for approximately four months.

The run time for these tests was based on a required heat load of 1408 Btu/ft^2 determined as follows:

Ascent Aero Heat Load	=	284 Btu/ft^2
Plume Separation Heat Load	=	188 Btu/ft^2
Reentry Heat Load	=	357 Btu/ft^2
Ascent Plume Heat Load	=	500 Btu/ft^2
Total	=	1329 Btu/ft^2

These values are based on Body Point 2106 which is about midway of the aft skirt.

The over-test factor used (per Bob Fisher, EP44) was 1.06, yielding a test heat load required of 1408 Btu/ft^2. Assuming a 27.6 peak heating rate (in position 2 of HFG) yeilded a run time of 51 sec. All panels were tested in position 2 of the HGF at the standard high enthalpy run condition.

Table 1 shows the actual run times for all six tests. Run 1106, Panel WKP-5, was inadvertently run for 60 sec. All others were run for 51 sec as planned. Figures 2 through 13 show pretest and post-test photos of all panels.

TEST RESULTS

Tables 2 through 7 show the pretest, post-test and recession data for all panels. Figure 14 shows the locations at which thickness measurements were made.

Post-test inspection of the panels showed that the K5NA did not delaminate from any of the cork panels, that is the K5NA can be applied over

the painted (Hypalon) cork surface, or to the unpainted cork surface. There were no noticeable differences in the painted and unpainted K5NA surfaces. There were also no noticeable differences with K5NA whether it was tooled with water or solvent.

CONCLUSIONS

As a result of these tests it was concluded that:

- K5NA can be applied over Hypalon surfaces.
- K5NA can be left unpainted.
- K5NA can be tooled with water or solvent.

W. G. Dean, Project Engineer
SRB/TPS Contract

C. D. Andrews, Manager
Systems Engineering Section

Attach: (1) Tables 1 through 7
(2) Figures 1 through 14

Table 1 - PANEL CONFIGURATIONS

Panel No.	Run No.	Run Time (sec)	Fabrication Method* Side	
			A	B
WKP-1	1102	51.05	H-WA-C	NH-WA-C
WKP-2	1103	51.03	H-WA-U	NH-WA-U
WKP-3	1104	51.05	H-SO-U	H-SO-C
WKP-4	1105	51.05	H-WA-C	NH-WA-C
WKP-5	1106	60.04	H-WA-U	NH-WA-U
WKP-6	1107	51.05	H-SA-U	H-SA-C

*Codes:

H = Hypalon
NH = No Hypalon
WA = Water
SO = Solvent
C = Coated
U = Uncoated

Table 2 - RECESSION DATA FOR WKP-1

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (btu/ft2)sec
4	760	630	130	2.54	15.1
5	760	710	50	0.98	13.2
8	750	615	135	2.64	14.4
9	765	755	10	.20	15.6
Avg	759	678	81	1.59	14.6
6	765	595	170	3.33	21.0
7	765	550	215	4.21	21.5
10	765	615	150	2.94	23.0
11	760	530	230	4.51	22.1
Avg	764	573	191	3.75	21.9
16	1185	1060	125	2.45	19.3
17	1180	1025	155	3.04	18.5
Avg	1183	1042	140	2.75	18.9
18	1180	990	190	3.72	17.5
19	1150	980	170	3.33	18.5
Avg	1165	985	180	3.53	18.0

Notes: 1. Serial No. WKP-1
2. Test 1102 - 4/28/82
3. Pos. 2-51.05 sec.

Table 3 - RECESSION DATA FOR WKP-2

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (Btu/ft2)sec
4	750	605	145	2.84	15.1
5	750	665	85	1.67	13.2
8	760	630	130	2.55	14.4
9	760	720	40	0.78	15.6
Avg	755	655	100	1.96	14.6
6	760	595	165	3.23	21.0
7	760	530	230	4.51	21.5
10	765	605	160	3.14	23.0
11	760	490	270	5.29	22.1
Avg	761	555	206	4.04	21.9
16	1140	940	200	3.92	19.3
17	1145	970	175	3.43	18.5
Avg	1143	955	188	3.68	18.9
18	1160	970	190	3.72	17.5
19	1190	1075	115	2.25	18.5
Avg	1175	1023	152	2.97	18.0

Notes:
1. Serial No. WKP-2
2. Test 1103 - 4/28/82
3. Pos. 2-51.03 sec.

Table 4 - RECESSION DATA FOR WKP-3

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (Btu/ft2)sec
4	760	620	140	2.74	15.1
5	760	660	100	1.96	13.2
8	760	600	160	3.14	14.4
9	770	765	5	0.10	15.6
Avg	763	661	102	2.00	14.6
6	755	635	120	2.35	21.0
7	760	600	160	3.13	21.5
10	770	650	120	2.35	23.0
11	760	540	220	4.31	22.1
Avg	761	606	155	3.03	21.9
16	1245	1120	125	2.45	19.3
17	1260	1080	180	3.53	18.5
Avg	1253	1100	153	3.00	18.9
18	1240	1055	185	3.62	17.5
19	1180	1000	180	3.53	18.5
Avg	1210	1028	182	3.57	18.0

Notes: 1. Serial No. WKP-3
2. Test 1104 - 4/28/82
3. Pos. 2-51.03 sec.

Table 5 - RECESSION DATA FOR WKP-4

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (Btu/ft2)sec
4	750	665	85	1.67	15.1
5	755	745	10	0.20	13.2
8	760	630	130	2.55	14.4
9	750	675	75	1.47	15.6
Avg	754	679	75	1.47	14.6
6	755	590	165	3.23	21.0
7	750	540	210	4.11	21.5
10	750	670	80	1.57	23.0
11	770	575	195	3.82	22.1
Avg	756	594	162	3.18	21.9
16	1210	1065	145	2.84	19.3
17	1180	1040	140	2.74	18.5
Avg	1195	1053	142	2.78	18.9
18	1175	1020	155	3.04	17.5
19	1190	1115	75	1.47	18.5
Avg	1183	1068	115	2.26	18.0

Notes: 1. Serial No. WKP-3
2. Test 1105 - 4/28/82
3. Pos. 2-51.05 sec.

Table 6 - RECESSION DATA FOR WKP-5

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (Btu/ft2)sec
4	760	600	160	2.66	15.1
5	760	675	85	1.42	13.2
8	765	620	145	2.42	14.4
9	760	755	5	0.08	15.6
Avg	761	663	99	1.65	14.6
6	760	540	220	3.66	21.0
7	760	520	240	4.00	21.5
10	760	580	180	3.00	23.0
11	770	500	270	4.50	22.1
Avg	763	535	228	3.89	21.9
16	1180	1030	150	2.50	19.3
17	1200	1030	170	2.83	18.5
Avg	1190	1030	160	2.67	18.9
18	1180	1015	165	2.75	17.5
19	1180	980	200	3.33	18.5
Avg	1180	998	182	3.04	18.0

Notes:
1. Serial No. WKP-5
2. Test 1105 - 4/28/82
3. Pos. 2-60.04 sec.

Table 7 - RECESSION DATA FOR WKP-6

Location No.	Pre Test Thick (mil)	Post-Test Thick (mil)	Delta Thick (mil)	Recession Rate (mil/sec)	Heating Rate (Btu/ft2)sec
4	760	695	65	1.27	15.1
5	760	755	5	0.10	13.2
8	750	660	90	1.76	14.4
9	765	765	0	0.00	15.6
Avg	759	719	40	0.78	14.6
6	765	605	161	3.15	21.0
7	765	615	150	2.94	21.5
10	765	620	145	2.84	23.0
11	755	545	210	4.11	22.1
Avg	763	996	167	3.26	21.9
16	1200	1040	160	3.13	19.3
17	1220	1050	170	3.33	18.5
Avg	1210	1045	165	3.23	18.9
18	1200	1020	180	3.53	17.5
19	1215	1120	95	1.86	18.5
Avg	1208	1070	138	2.70	18.0

Notes: 1. Serial No. WKP-6
2. Test 1105 - 4/28/82
3. Pos. 2-51.05 sec.

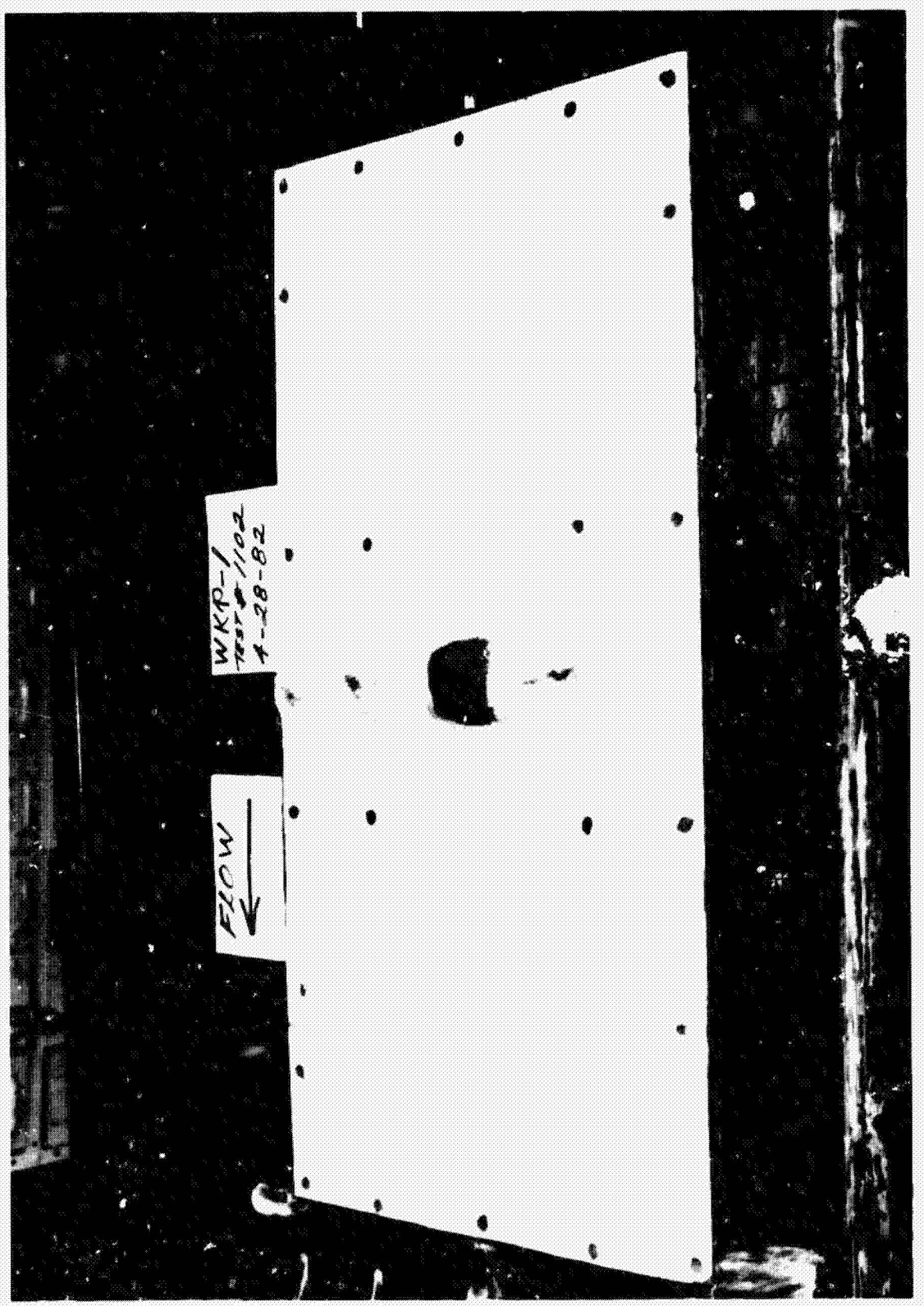

Fig. 2 - Pretest Photo of Panel No. WKP-1

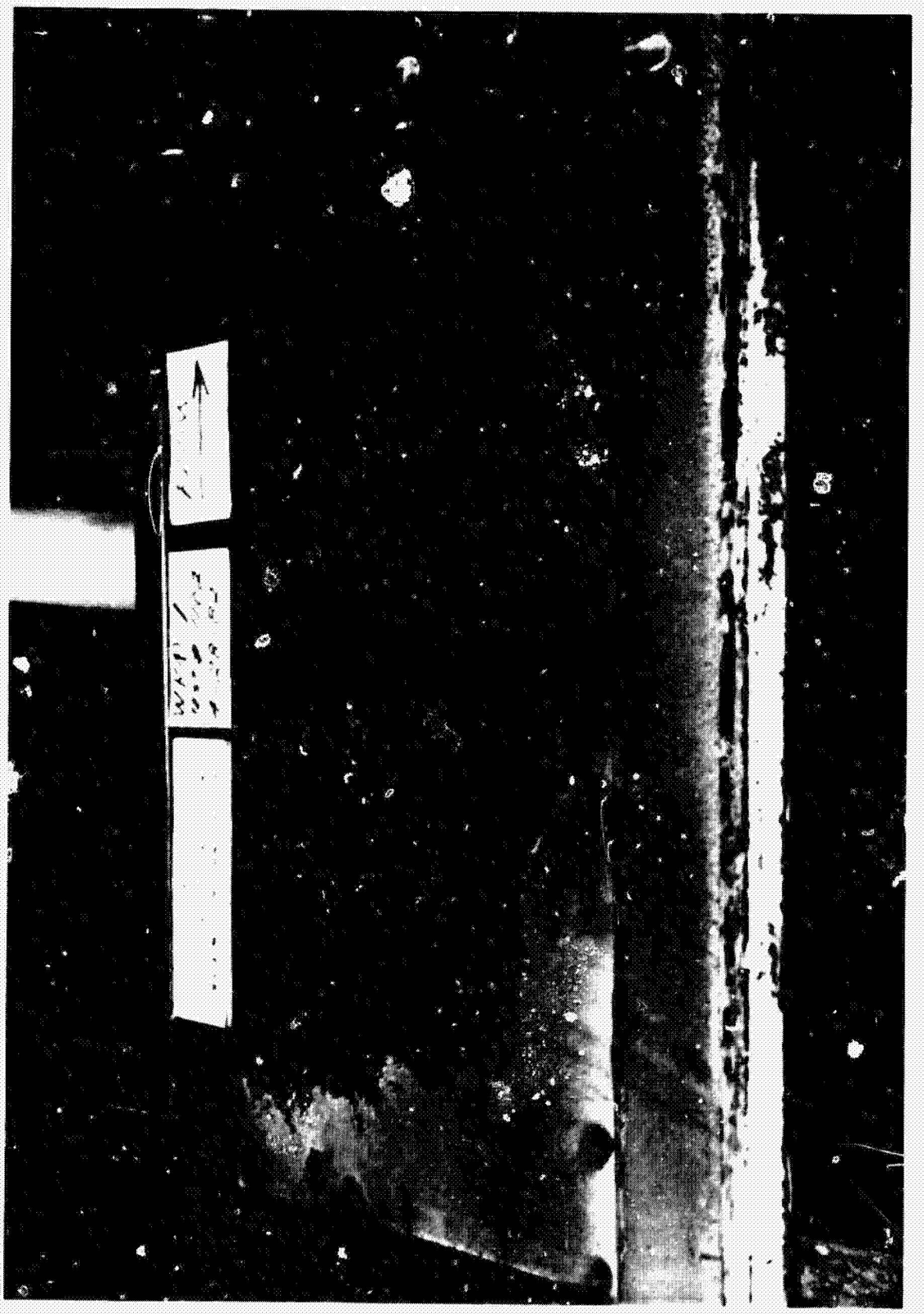

Fig. 3 - Post Test Photo of Panel # WKP-1

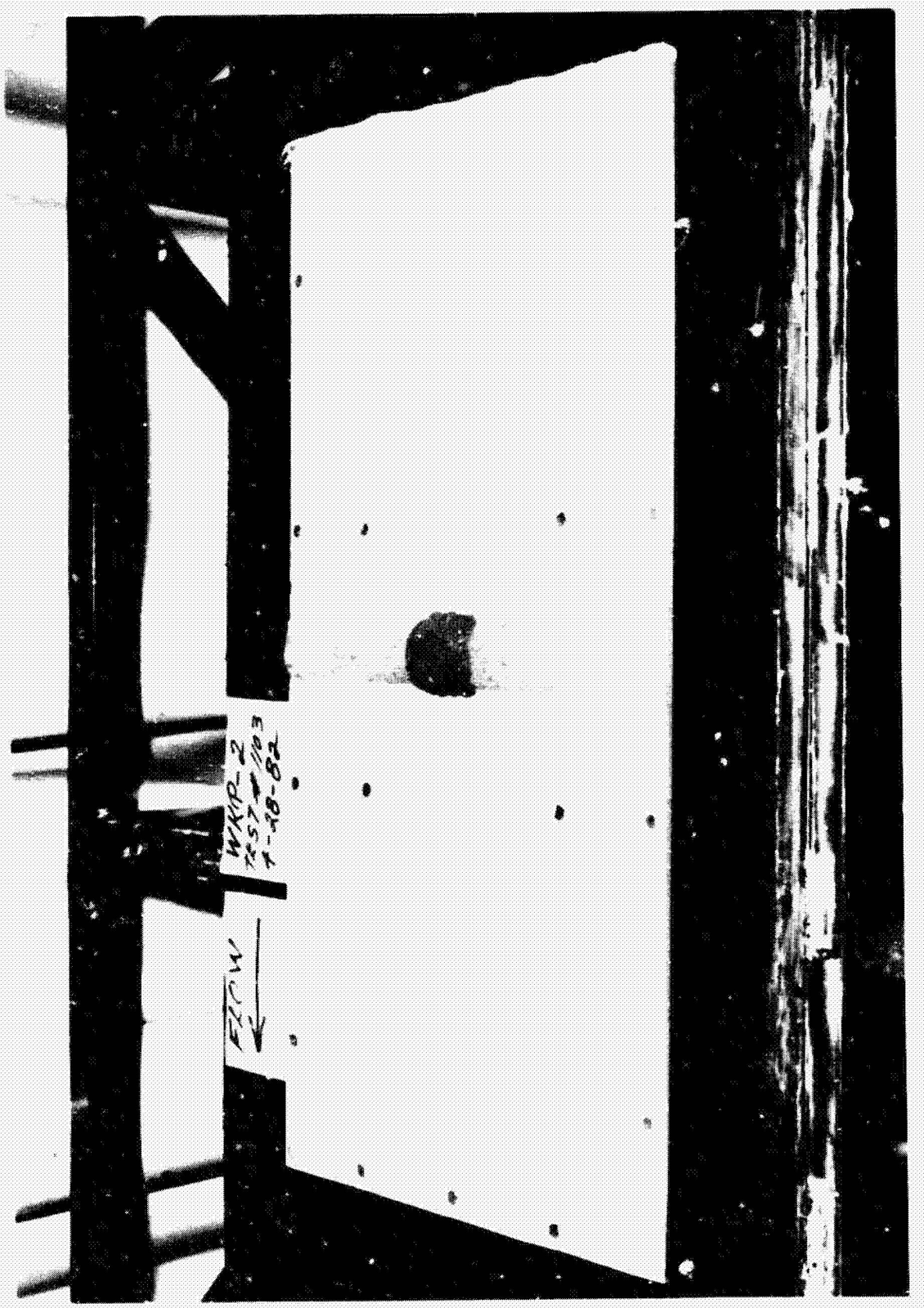

Fig. 4 - Pretest Photo of Panel No. WKP-2

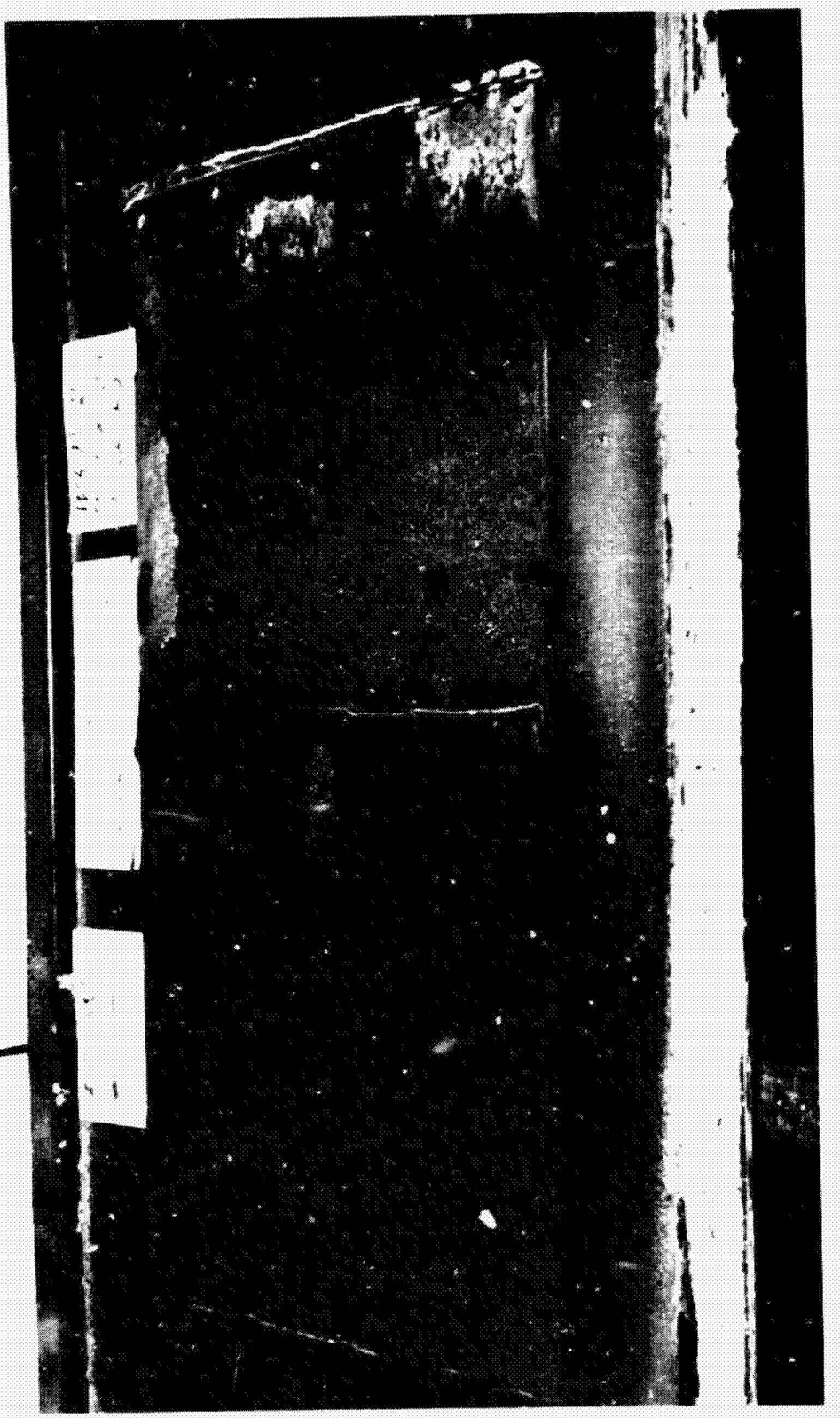

Fig. 5 - Post Test Photo of Panel No. WKP-2

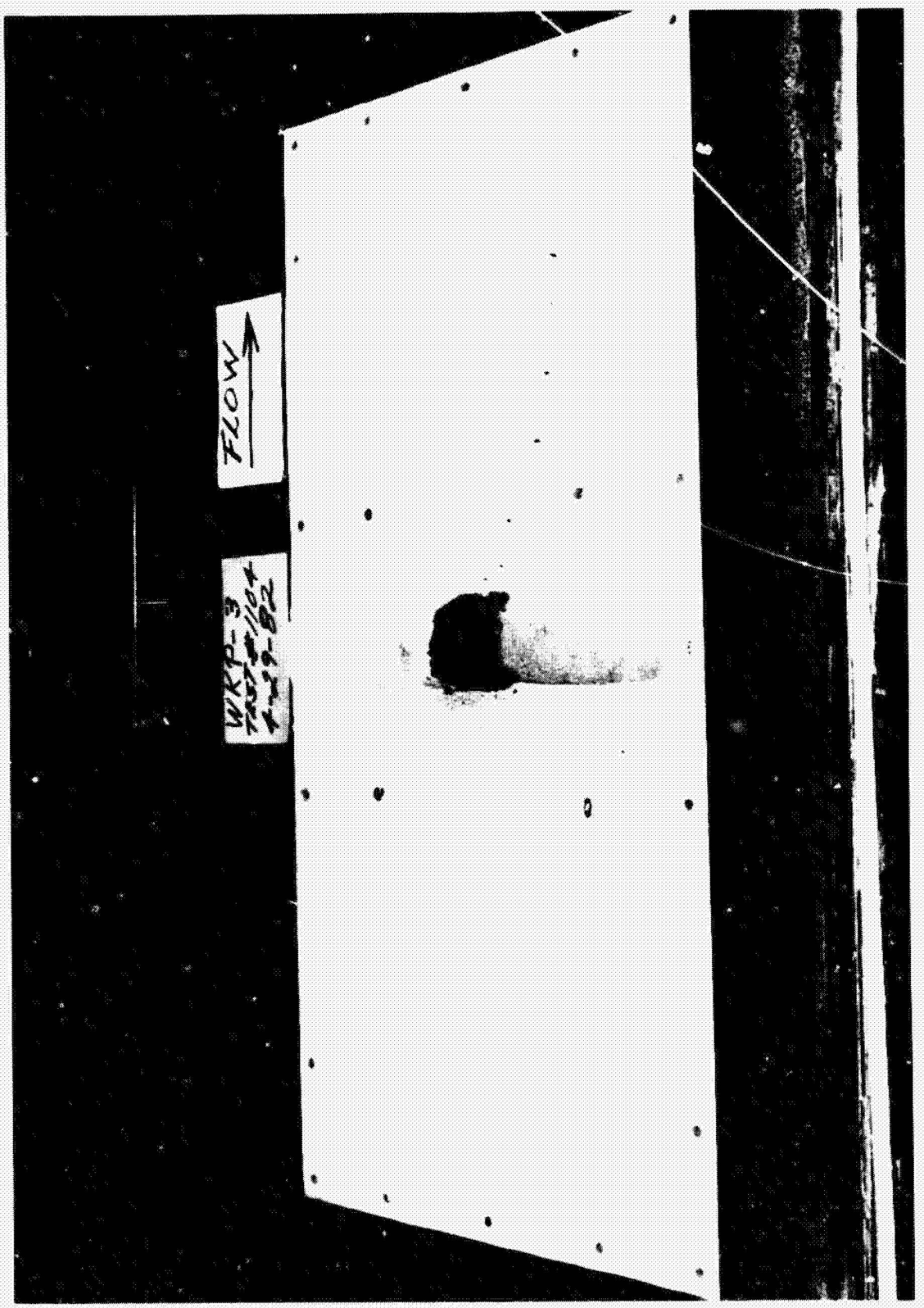

Fig. 6 - Pretest Photo of Panel No. WKP-3

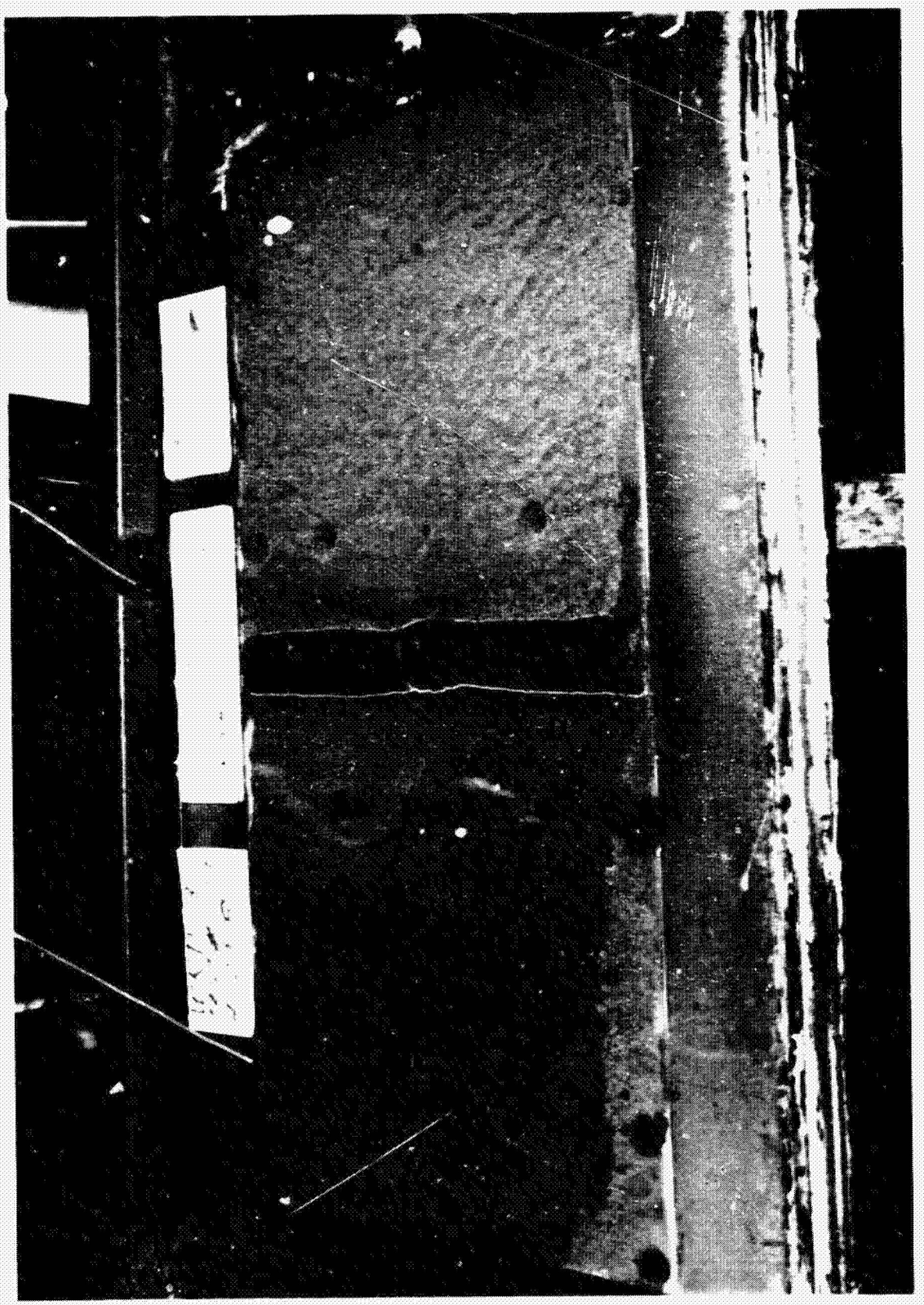

Fig. 7 – Post Test Photo of Panel No. WKP-3

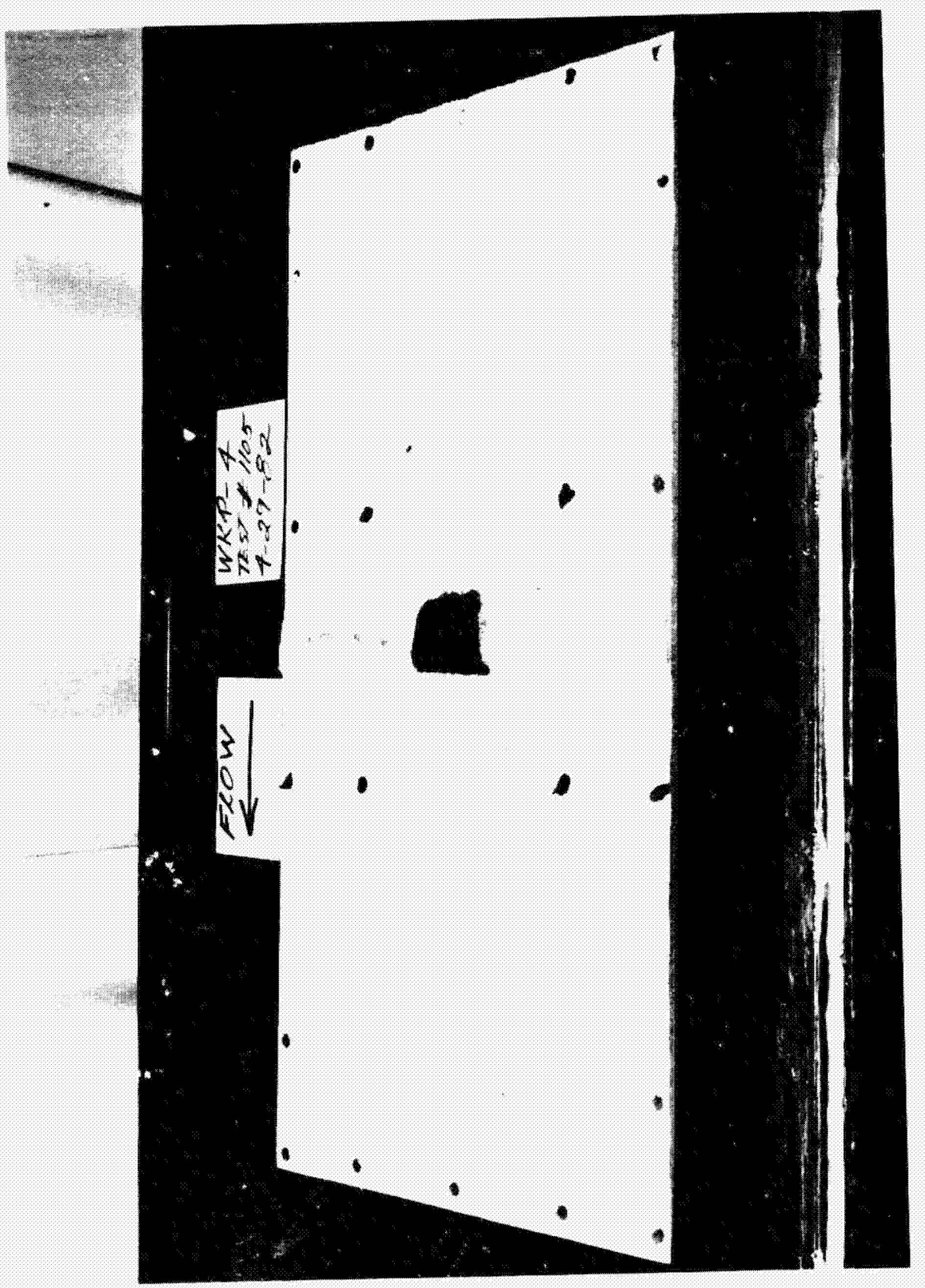

Fig. 8 - Pretest Photo of Panel No. WKP-4

Fig. 9 - Post Test Photo of Panel No. WKP-4

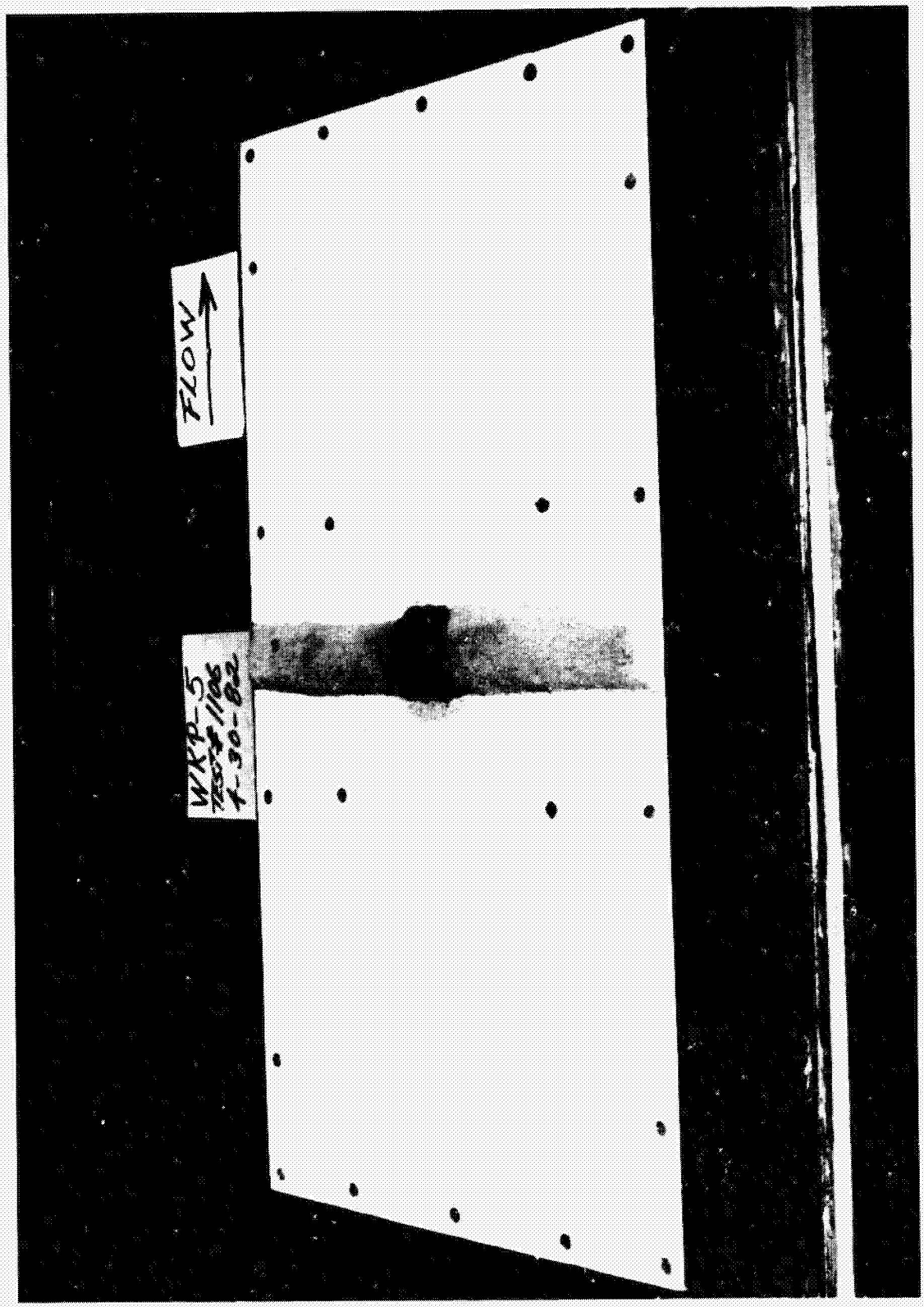

Fig. 10 - Pretest Photo of Panel No. WKP-5

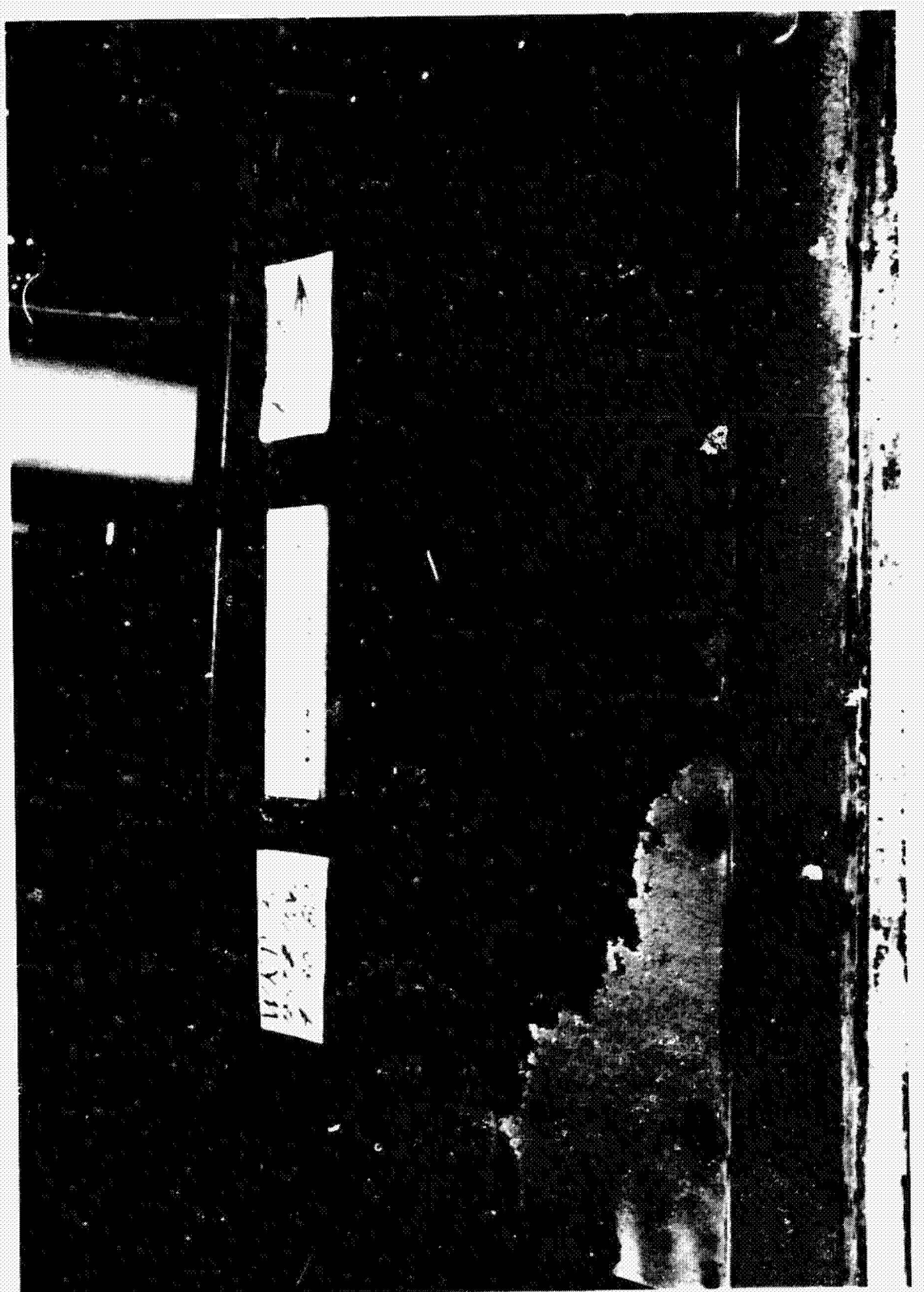

Fig. 11 - Post Test Photo of Panel No. WKP-5

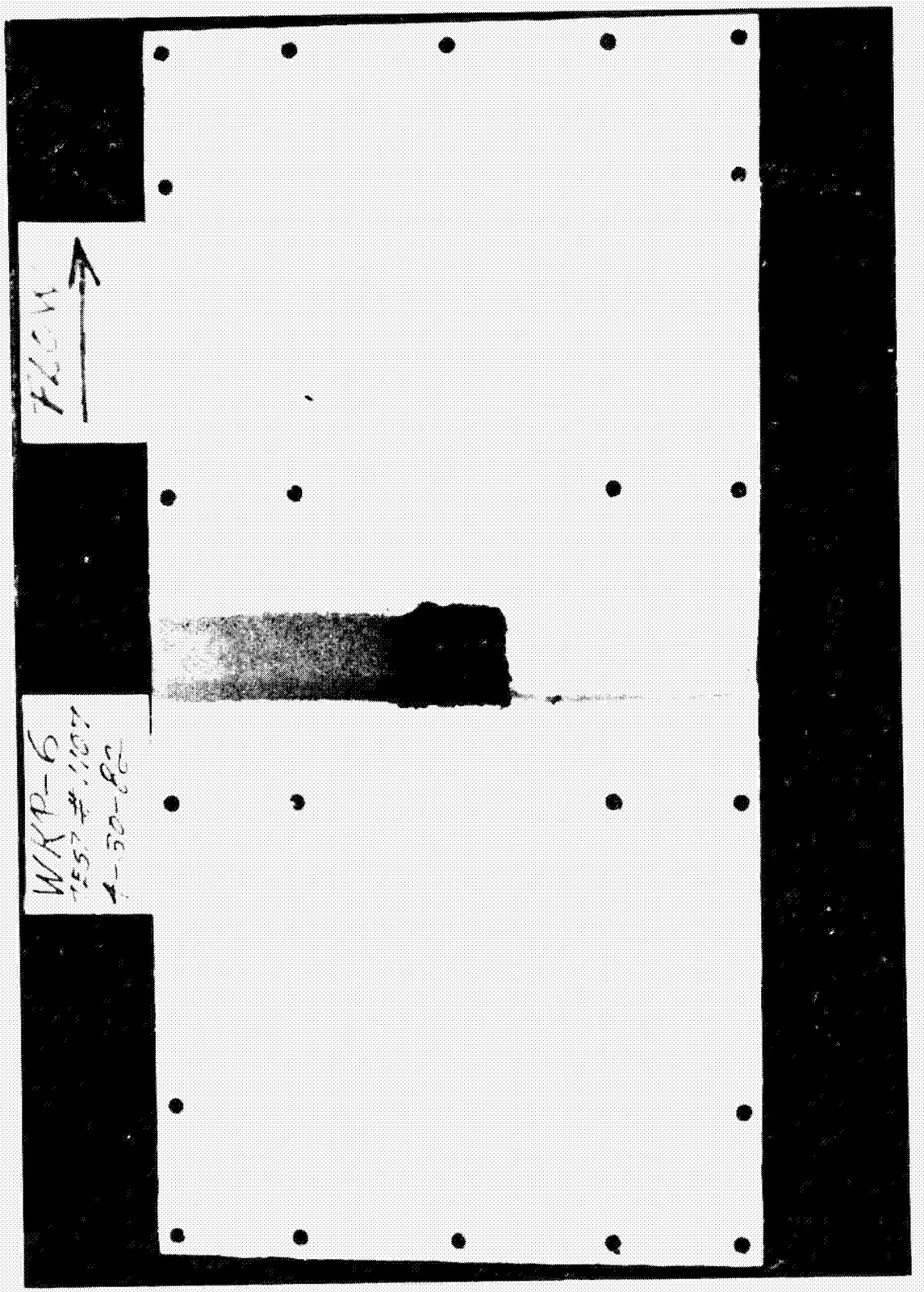

Fig. 12 - Pretest Photo of Panel No. WKP-6

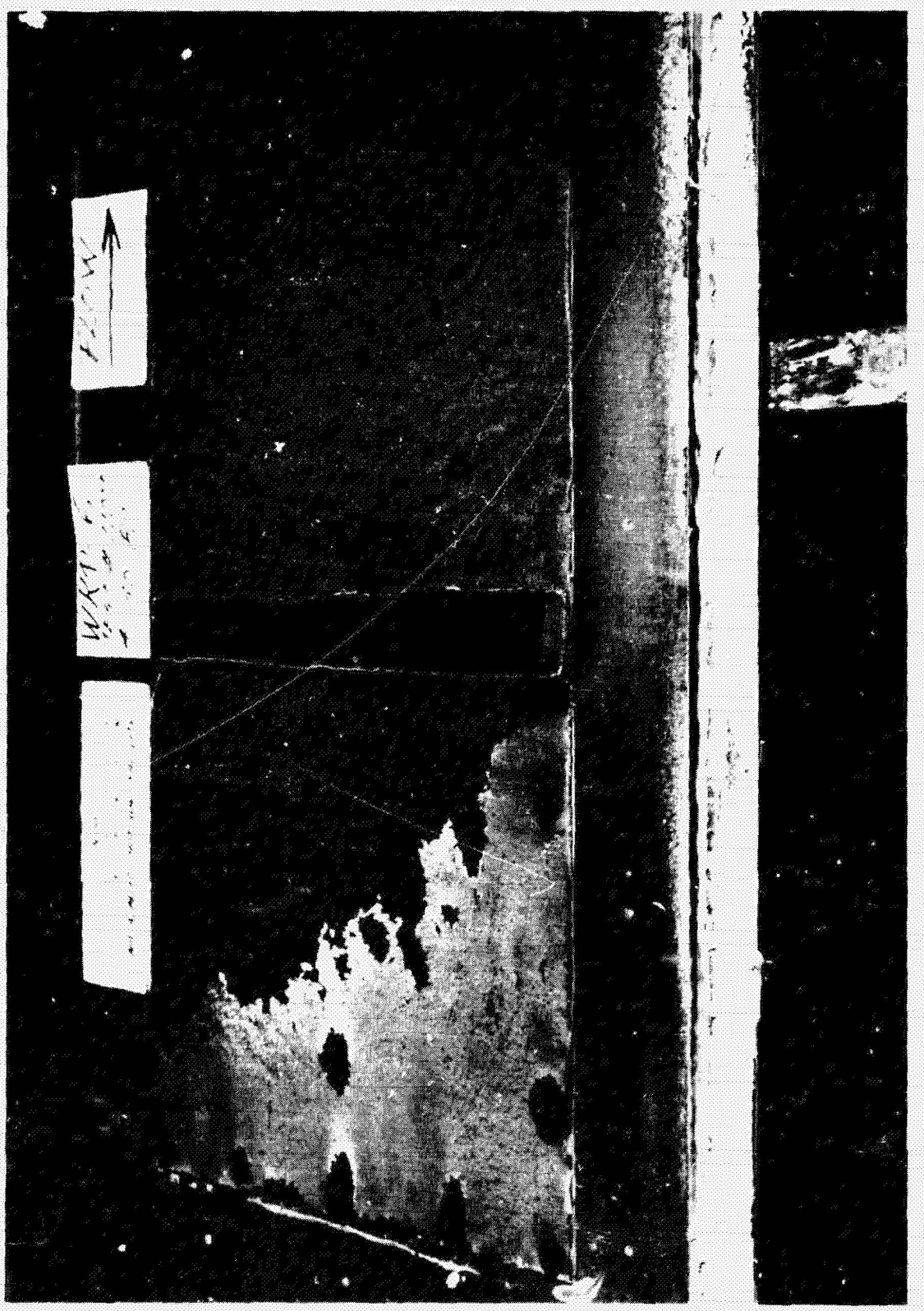

Fig. 13 - Post-Test Photo of Panel No. WKP-6

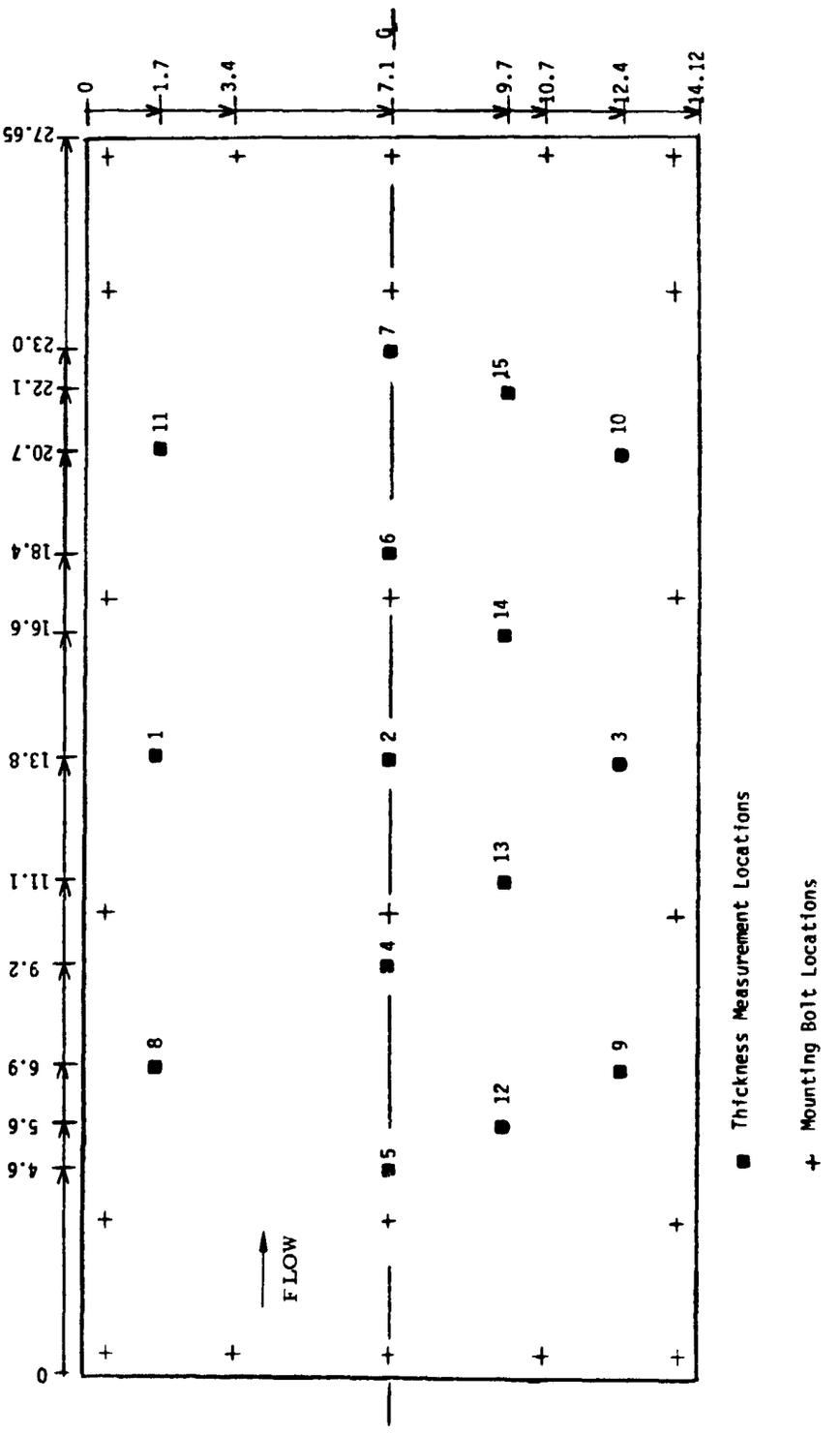

Fig. 14 - Location at Which Thickness Measurements Were Made