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92-2150

SUBJECT: SPRAYABLE SILICONE ABLATIVE COATING, GE PRODUCT CODE CPC-1050, POST LAUNCH EVALUATION ON LAUNCH COMPLEX 40, CAPE CANAVERAL AIR FORCE STATION

RELATED DOCUMENTATION: MTB-921-89

1.0 SUMMARY

An inspection was performed on 30 September and 01 October 1992, to assess the condition of Launch Complex 40 Umbilical Tower ablative coating after a launch of a Titan 34D missile. Photographic documentation of the post-launch condition was also gathered. Overall performance of CPC-1050 Silicone Ablative has been evaluated as excellent.

2.0 FOREWORD

2.1 Based on favorable results documented in MTB 921-89, the prime contractor for LC-40 Facilities Modification (Bechtel Job No. 20964, Contract No. KQO-804691) elected to topcoat the inorganic zinc primer on the Umbilical Tower (UT) with the subject silicone ablative coating. Specification T-002, GENERAL PAINTING, called for the following topcoat schedule:

Area of UT	Dry Film Thickness
Pipe Support Structure	125 MILS
Exposed Steel below El. 134'4" (Level 2)	125 MILS
Exposed Steel between El. 134'4" (Level 2) and El. 146'4" (Level 3)	80 MILS

2.2 As will become apparent in the results section, actual dry film thickness (DFT) readings of the coating varied considerably from those specified, both above and below. Whether these variations were due to locally generated changes not documented, or to other factors, could not be ascertained prior to the completion of this report. No adverse impact on the structural steel was identified as a result of this variation in ablative coating thickness.

3.0 MATERIALS AND EQUIPMENT

3.1 The materials and equipment used for the application of the silicone ablative have been described in detail in MTB 921-89, paragraph 2.0.

3.2 DFT readings were obtained with a Microtest IV SM-3 gage (for coatings less than or equal to 100 MILS) or a Microtest IV SM-10 gage (for coatings greater than 100 MILS). DFT gages were field calibrated using manufacturer's supplied instructions.

4.0 TEST PROCEDURES

4.1 Test measurement points were identified on LC-40 UT and deluge piping support structures so that surfaces exposed to varying blast effects could be monitored. These areas were:

1. South Face Level 4
2. North Face Level 4
3. East Face Level 4
4. South Face Level 3
5. North Face Level 3
6. East Face Level 3
7. South Face Level 2
8. North Face Level 2
9. East Face Level 2
10. South Face Level 1
11. East Face Level 1
12. East Face Ground Level
13. Deluge Pipe Supports

4.2 Film thickness readings were taken prior to and after the launch. The entire UT and launcher systems were inspected for damage, including areas not coated with the silicone ablative.

5.0 RESULTS

5.1 The following Table contains the results of the DFT readings, including a visual evaluation of the ablative coating surface after launch.

TABLE 1

1. South face level 4 (measurement from deck level and 6 from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	21 MILS	21 MILS	NO VISIBLE
B. 3'UP	20 MILS	20 MILS	DAMAGE ON
C. 6'UP	21 MILS	21 MILS	SURFACE.

2. North face level 4 (measurement from deck level and 6' from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	76 MILS	75 MILS	NO VISIBLE
B. 3'UP	34 MILS	34 MILS	DAMAGE ON
C. 6'UP	25 MILS	25 MILS	SURFACE.

3. East face level 4 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	33 MILS	32 MILS	LIGHT SOOTY
B. 3'UP	28 MILS	27 MILS	DEPOSIT.
C. 6'UP	20 MILS	20 MILS	MINOR NICKS
D. 1'UP	40 MILS	40 MILS	AND SCRATCHES
E. 3'UP	29 MILS	29 MILS	<1% OF SURFACE.
F. 6'UP	20 MILS	19 MILS	
G. 1'UP	25 MILS	24 MILS	
H. 3'UP	30 MILS	30 MILS	
I. 6'UP	25 MILS	25 MILS	
J. 1'UP	30 MILS	30 MILS	
K 3'UP	18 MILS	17 MILS	
L. 6'UP	20 MILS	20 MILS	

4. South face level 3 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	80 MILS	79 MILS	LIGHT SOOTY
B. 3'UP	80 MILS	80 MILS	DEPOSIT.
C. 6'UP	75 MILS	75 MILS	

TABLE 1 (cont.)

5. North face level 4 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	93 MILS	92 MILS	NO VISIBLE
B. 3'UP	81 MILS	81 MILS	DAMAGE ON
C. 6'UP	150 MILS	148 MILS	SURFACE.

6. East face level 3 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	153 MILS	151 MILS	LIGHT SOOTY
B. 3'UP	180 MILS	180 MILS	DEPOSIT.
C. 6'UP	170 MILS	168 MILS	MINOR NICKS
D. 1'UP	269 MILS	268 MILS	AND SCRATCHES
E. 3'UP	273 MILS	271 MILS	<1% OF SURFACE.
F. 6'UP	175 MILS	173 MILS	
G. 1'UP	262 MILS	262 MILS	
H. 3'UP	225 MILS	225 MILS	
I. 6'UP	224 MILS	221 MILS	
J. 1'UP	273 MILS	269 MILS	
K 3'UP	264 MILS	261 MILS	
L. 6'UP	236 MILS	236 MILS	

7. South face level 2 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	129 MILS	129 MILS	NO VISIBLE
B. 3'UP	168 MILS	168 MILS	DAMAGE ON
C. 6'UP	112 MILS	112 MILS	SURFACE.

8. North face level 2 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	73 MILS	72 MILS	NO VISIBLE
B. 3'UP	77 MILS	76 MILS	DAMAGE ON
C. 6'UP	77 MILS	77 MILS	SURFACE.

TABLE 1 (cont.)

9. East face level 2 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	107 MILS	105 MILS	LIGHT SOOTY
B. 3'UP	183 MILS	180 MILS	DEPOSIT.
C. 6'UP	210 MILS	207 MILS	MINOR NICKS
D. 1'UP	164 MILS	164 MILS	AND SCRATCHES
E. 3'UP	198 MILS	196 MILS	<2% OF SURFACE.
F. 6'UP	201 MILS	201 MILS	
G. 1'UP	188 MILS	188 MILS	
H. 3'UP	175 MILS	175 MILS	
I. 6'UP	218 MILS	216 MILS	
J. 1'UP	196 MILS	190 MILS	
K 3'UP	185 MILS	181 MILS	
L. 6'UP	228 MILS	222 MILS	

10. South face level 1 (measurement from deck level and 6" from edge of ablative coating coverage).

	BEFORE	AFTER	REMARKS
A. 1'UP	60 MILS	60 MILS	NO VISIBLE
B. 3'UP	88 MILS	88 MILS	DAMAGE ON
C. 6'UP	67 MILS	67 MILS	SURFACE.

11. East face level 1 (measurement from deck level and 1' from edge).

	BEFORE	AFTER	REMARKS
A. 1'UP	40 MILS	40 MILS	LIGHT SOOTY
B. 3'UP	75 MILS	72 MILS	DEPOSIT.
C. 6'UP	60 MILS.	59 MILS	

12. East face ground level (measured 7' above ground level at the indicated distance from south end).

	BEFORE	AFTER	REMARKS
A. 1'	85 MILS	82 MILS	NICKS AND
B. 2'	235 MILS	232 MILS	GOUGES OVER
C. 3'	284 MILS	281 MILS	<5% OF SURFACE.
D. 4'	268 MILS	262 MILS	
E. 5'	231 MILS	230 MILS	
F. 6'	259 MILS	255 MILS	
G. 7'	301 MILS	291 MILS	
H. 8'	346 MILS	345 MILS	

TABLE 1 (cont.)

I. 9'	381 MILS	375 MILS
J. 10'	370 MILS	364 MILS
K 15'	241 MILS	232 MILS
L. 20'	246 MILS	235 MILS
M. 25'	315 MILS	315 MILS
N. 30'	370 MILS	370 MILS
O. 31'	352 MILS	335 MILS
P. 32'	359 MILS	345 MILS
Q. 33'	301 MILS	288 MILS
R. 34'	262 MILS	251 MILS
S. 35'	220 MILS	220 MILS
T. 36'	258 MILS	245 MILS
U. 37'	213 MILS	210 MILS
V. 38'	175 MILS	172 MILS
W. 39'	120 MILS	111 MILS
X. 40'	93 MILS	71 MILS

13. Deluge pipe supports (edge facing launcher).

	BEFORE	AFTER	REMARKS
A. Support 1			
1. 3'UP	31 MILS	17 MILS	NICKS, GOUGES, AND EXPOSURE OF BARE METAL ON <5% OF SURFACE. MODERATE SOOT ON DELUGE PIPING.
2. 6'UP	58 MILS	52 MILS	
B. Support 2			
1. 5'UP	23 MILS	15 MILS	
2. 7'UP	62 MILS	53 MILS	
C. Support 3			
1. 5'UP	21 MILS	10 MILS	
2. 7'UP	66 MILS	47 MILS	
D. Support 4			
1. 5'UP	26 MILS	8 MILS	
2. 7'UP	71 MILS	34 MILS	

5.2 The ablative material applied to the structural steel on the CX-40 UT withstood the thermal and pressure shock loadings associated with the launch, exhibiting little or no loss of thickness due to ablation. Figure 1 shows an overall view of the UT. The arrow indicates the transition from the silicone ablative coating and the steel coated with 4-6 mils of inorganic zinc only. Approximately 30% of the surface of the silicone ablative on the east

face was covered with a black, sooty material easily removed with finger pressure. The sooty material is probably the combustion product from organic material used in the launch pad area. Low pressure water washing can be used to remove this material.

5.3 The ablative material film thickness, as measured, was not in accordance with the specification. Although no damage to the structural steel resulted in this case, proper application of the required thickness is important to control costs of installation and repair. Areas receiving substantially less material than specified can be expected to require a maintenance topcoat prior to the majority of the UT.

5.4 The application of the MARTYTE™ over the ablative shown in Figure 2 was not required. MARTYTE™ is a ceramic filled, amine-cured epoxy compound developed by Martin Marietta. Figure 3 details the interface of MARTYTE™ and the silicone ablative. While the silicone ablative remained virtually unaffected, the MARTYTE™ suffered spalling and delamination. The spalled MARTYTE™, impacting against the silicone ablative, is believed responsible for some of the gouging seen in Figure 4.

5.5 Isolated areas near the northeast and southeast corners, where film thicknesses were well below specified, experienced ablation to bare metal. These areas might also have been abraded during the insertion of the mobile launch structure. Although the total area of this type damage was minor, an increase in specified film thickness is indicated. Figure 5 shows a typical example of this type of damage.

5.6 Isolated areas, between ground level and five feet above ground level, experienced total loss of ablative material and inorganic zinc primer. Figure 6 shows the west side of the deluge piping; Figure 7 shows the west side of the deluge piping support; and Figure 8 shows the deluge piping on the east side of the UT.

5.7 Portions of the deluge water nozzles penetrating the UT walls were protected with MARTYTE™ (See Figure 9). This time consuming process can be eliminated with the development of small unit repair kits, discussed further in paragraph 7.0.

6.0 CONCLUSIONS

6.1 Based on the findings of this inspection, the silicone ablative material applied to CX-40 UT showed little or no loss of thickness due to ablation.

6.2 Due to the lack of damage to the silicone ablative, the application of MARTYTE™ over the ablative was not required. The practice of protecting the deluge water nozzle penetrations with MARTYTE™ is not required.

6.3 Instances of ablation to bare metal were due to either insufficient application thickness or mechanical damage during installation of the mobile launcher.

6.4 The black sooty residue found after the launch was easily removed and not associated with the ablation process.

6.5 Despite the extreme heat conditions of the launch, the silicone ablative material retained its original color, protected the underlying steel, and remained virtually unaffected. The excellent performance characteristics significantly reduced the effort involved with the normal post-launch pad refurbishment.

7.0 RECOMMENDATIONS

7.1 In future applications, apply silicone ablative at 200 mils from ground level to Level 2 and 150 mils from Level 2 to the end of coverage on the east face of UT. Increase coverage around corners to 300 mils/200 mils, respectively. Silicone ablative should be applied in a minimum of two colored coats, the first coat 60-75% of the total thickness. This will allow maintenance personnel easy evaluation for the need to topcoat.

7.2 Develop a repair kit capable of patching small nicks and gouges. Dual hypodermic type kits, similar to commercial glues is one possible approach. Such a repair kit could also be used to apply silicone ablative in areas such as the deluge nozzles seen in Figure 9. Alternately or in parallel, efforts to increase the toughness through reformulating should be investigated.

7.3 Future applicators should be trained to achieve a more uniform film thickness. Wide variation in applied thicknesses in the present case was probably caused by the lack of familiarity with the coating and the plural component spray rig required for application. Lack of control of film thickness will affect the materials cost, as well as jeopardize the underlying steel structure.

7.4 Several areas, not coated with silicone ablative, should be coated in the future. Items include: Electrical panel blast shields (Figure 10); EAGE building doors (Figure 11); Piping supports of the south end of UT (Figure 12); Ladder at the southeast corner of UT (Figure 13); Launcher supports (figure 14); Deflector supports (Figure 15); and miscellaneous ground hardware (Figures 16 and 17).

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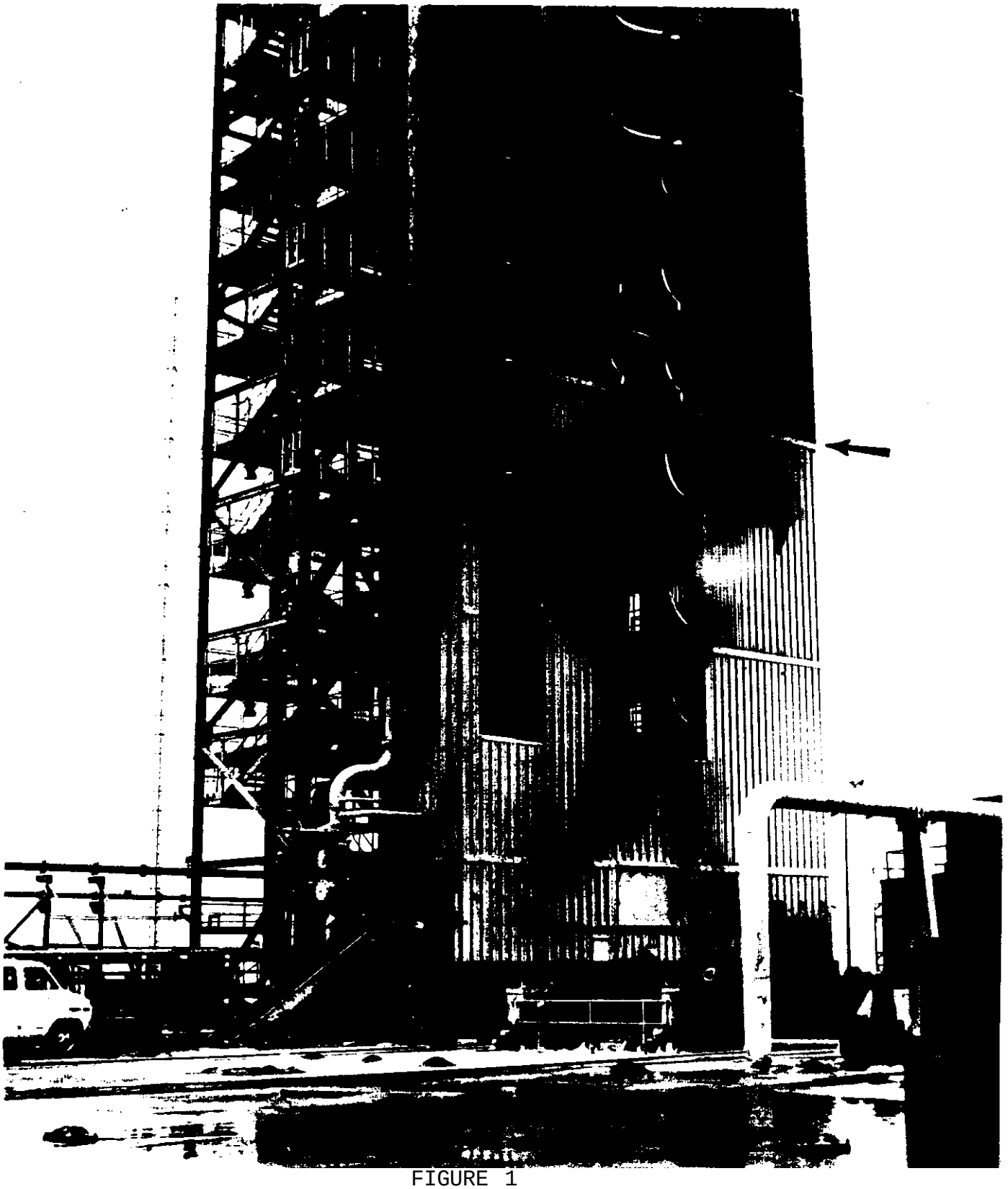

FIGURE 1

OVERALL VIEW OF LAUNCH COMPLEX 40 UMEILICAL TOWER. THE ARROW INDICATES THE TRANSITION FROM THE SILICONE ABLATIVE COATING (GRAY) TO INORGANTC ZINC PRIMER (GREENISH-GRAY).

FIGURE 2

OVERALL VIEW OF MARTYTE™ APPLICATION OVER ABLATIVE MATERIAL

FIGURE 3

CLOSE UP VIEW OF SPALLING AND DELAMINATION OF MARTYTE™. THE SILICONE ABLATIVE MATERIAL IS VIRTUALLY UNAFFECTED. THE ARROW INDICATES AREA OF SPALLED MARTYTE™.

FIGURE 4

POSSIBLE MARTYTE™ IMPACT AREAS ON SILICONE ABLATIVE. ARROWS INDICATE GOUGES CAUSED BY FLYING DEBRIS.

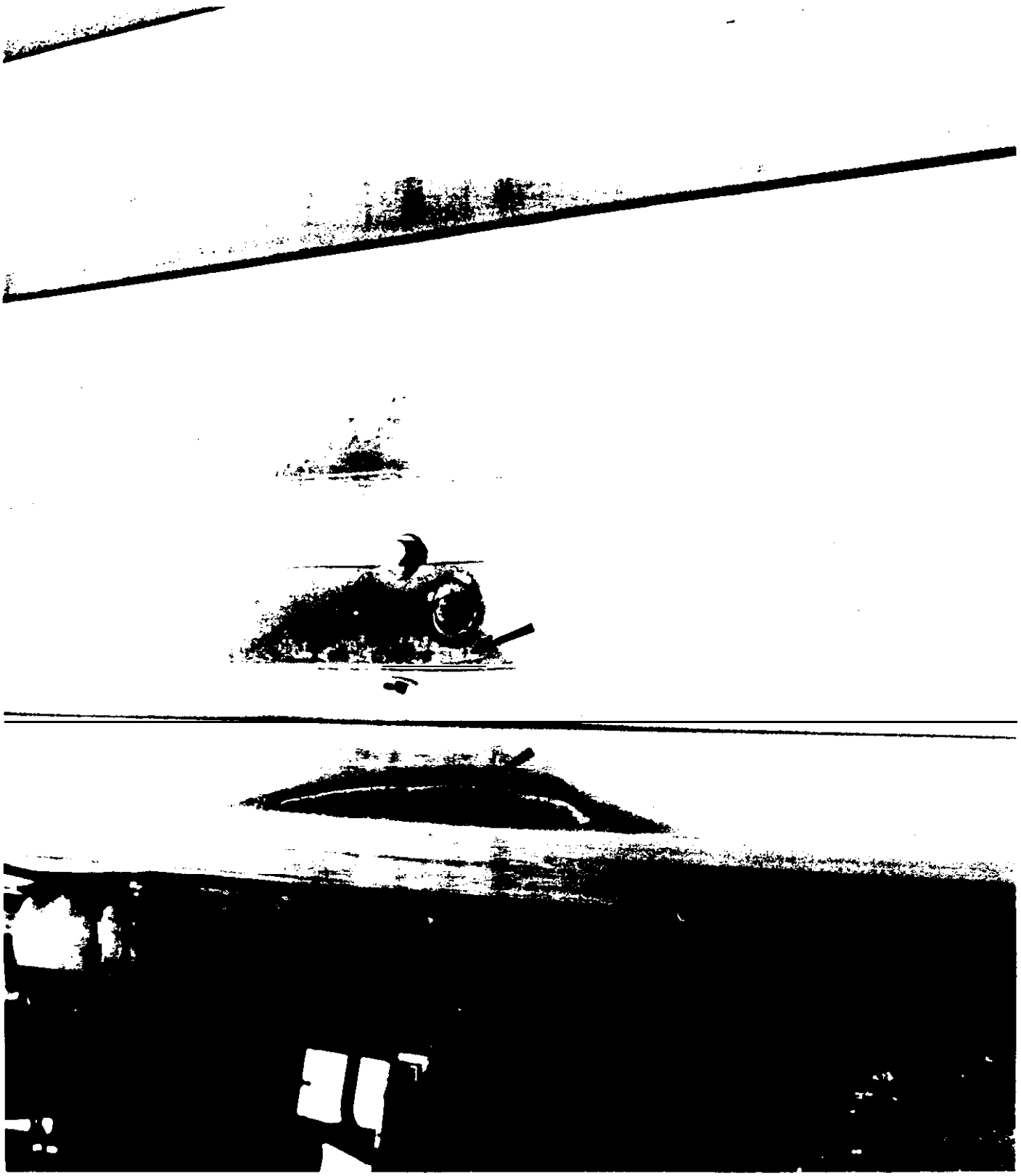

FIGURE 5

DAMAGED AREA OF SILICONE ABLATIVE. APPLICATION THICKNESS OF MATERIAL WAS BELOW THAT SPECIFIED. AREAS MARKED BY ARROWS MAY HAVE BEEN ABRADED BY THE MOBILE LAUNCHER PLATFORM.

FIGURE 6

LAUNCH DAMAGE OF SILICONE ABLATIVE ON DELUGE PIPING. BOTH ABLATIVE AND ZINC PRIMER WERE TOTALLY REMOVED DURING LAUNCH.

FIGURE 7

LAUNCH DAMAGE TO DELUGE PIPING SUPPORT. TOTAL REMOVAL OF ABLATIVE SYSTEM WAS VERY MINOR.

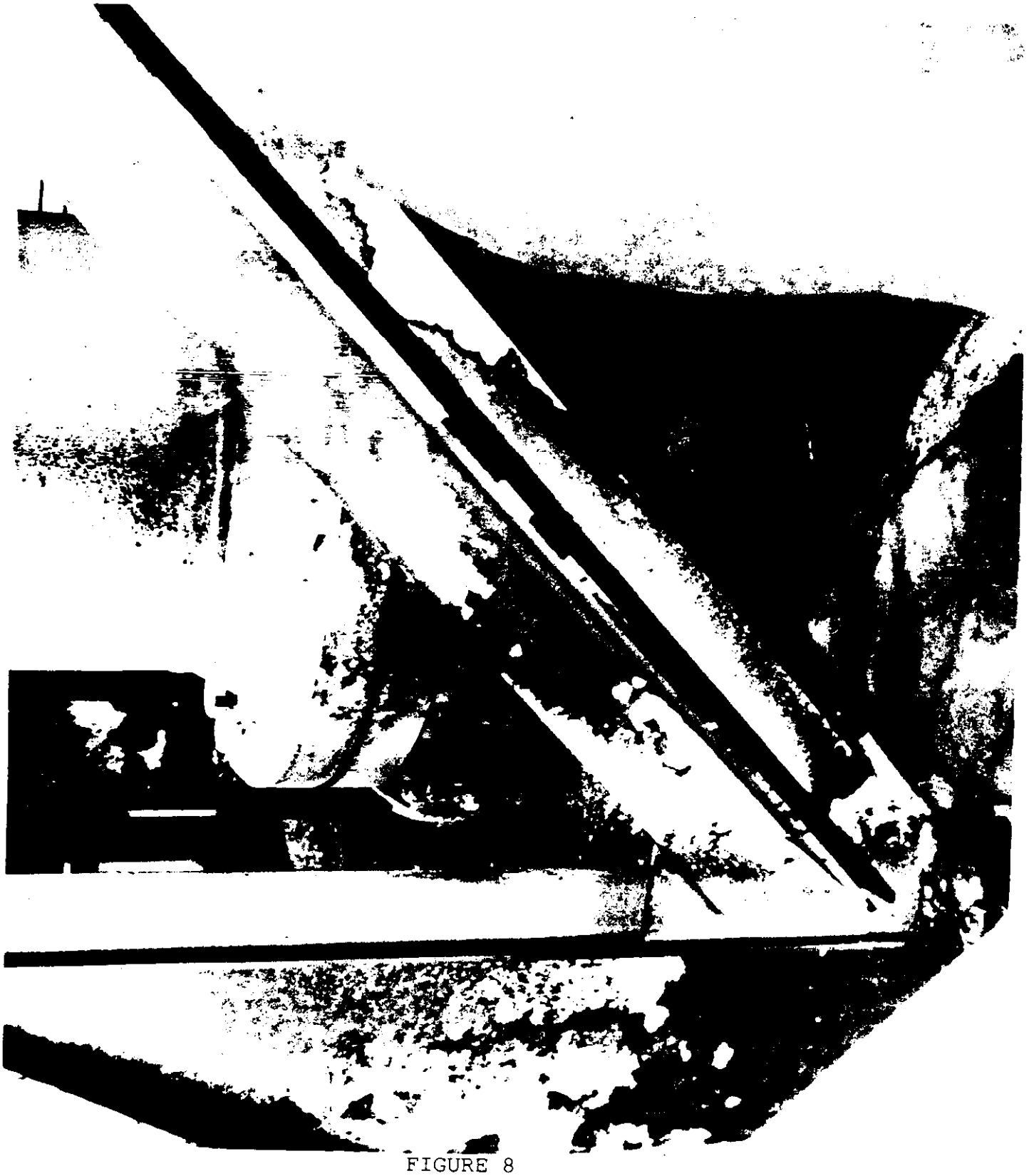

FIGURE 8

LAUNCH DAMAGE TO DELUGE PIPING ON EAST SIDE OF UT.
STRUCTURAL MEMBERS WERE NOT PROTECTED BY ABLATIVE.

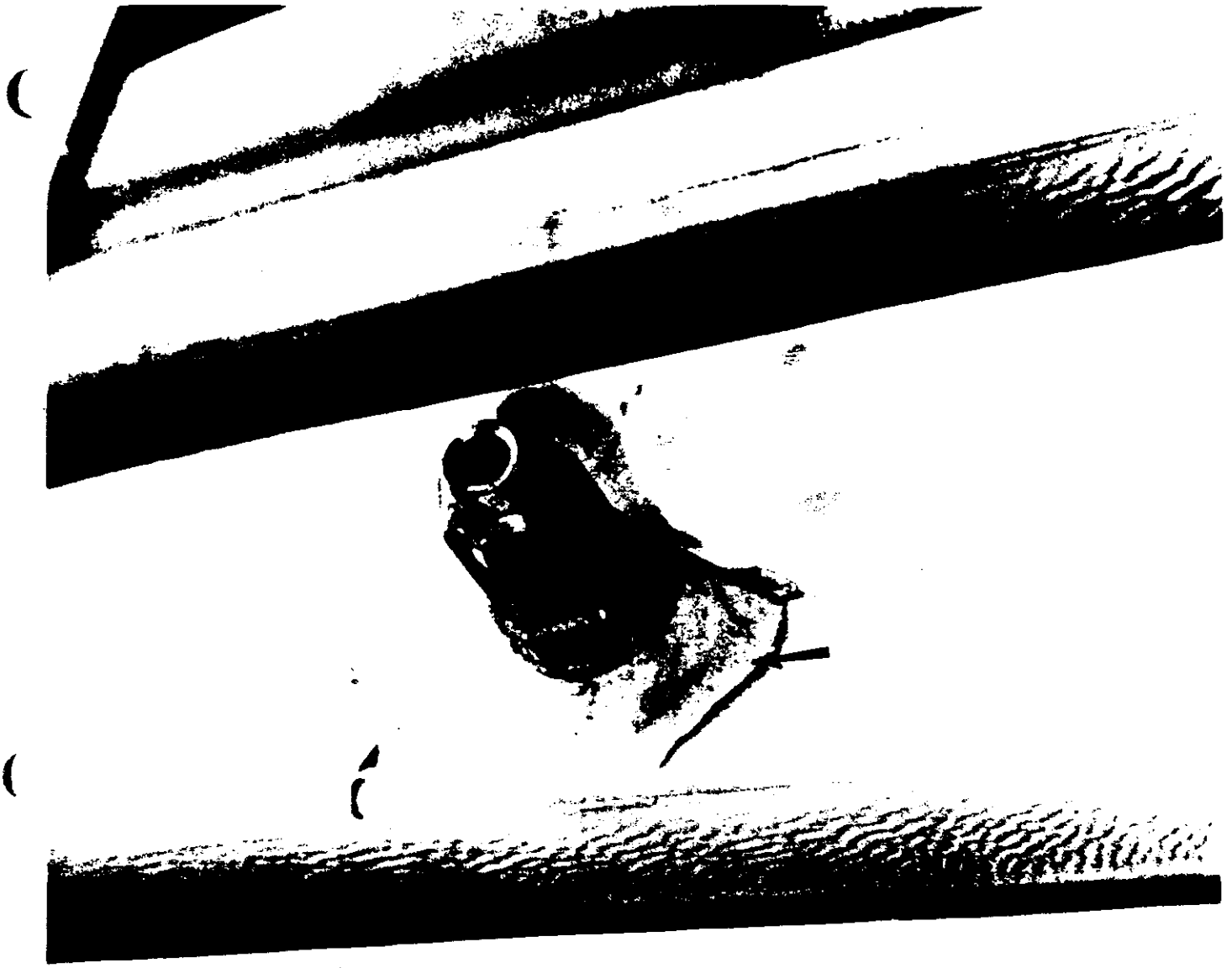

FIGURE 9

VIEW OF MARTYTE™ APPLICATIONS (INDICATED BY ARROW) TO DELUGE NOZZLE PENETRATION ON UMBILICAL TOWER SIDING. THIS PROCESS SHOULD BE ELIMINATED.

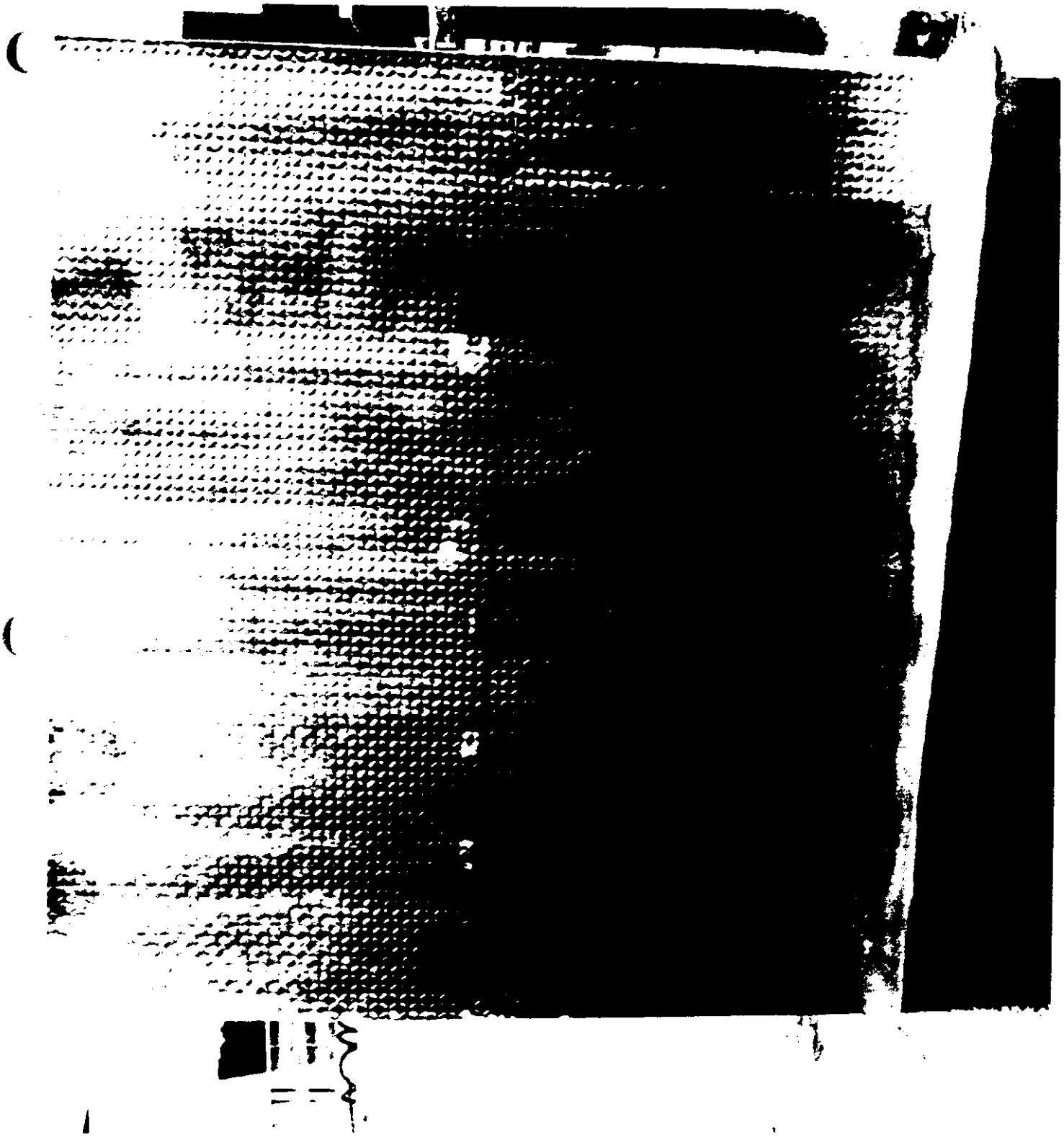

FIGURE 10

LAUNCH DAMAGE TO UNPROTECTED ELECTRICAL PANEL BLAST SHIELDS. THIS AREA SHOULD BE COATED WITH ABLATIVE.

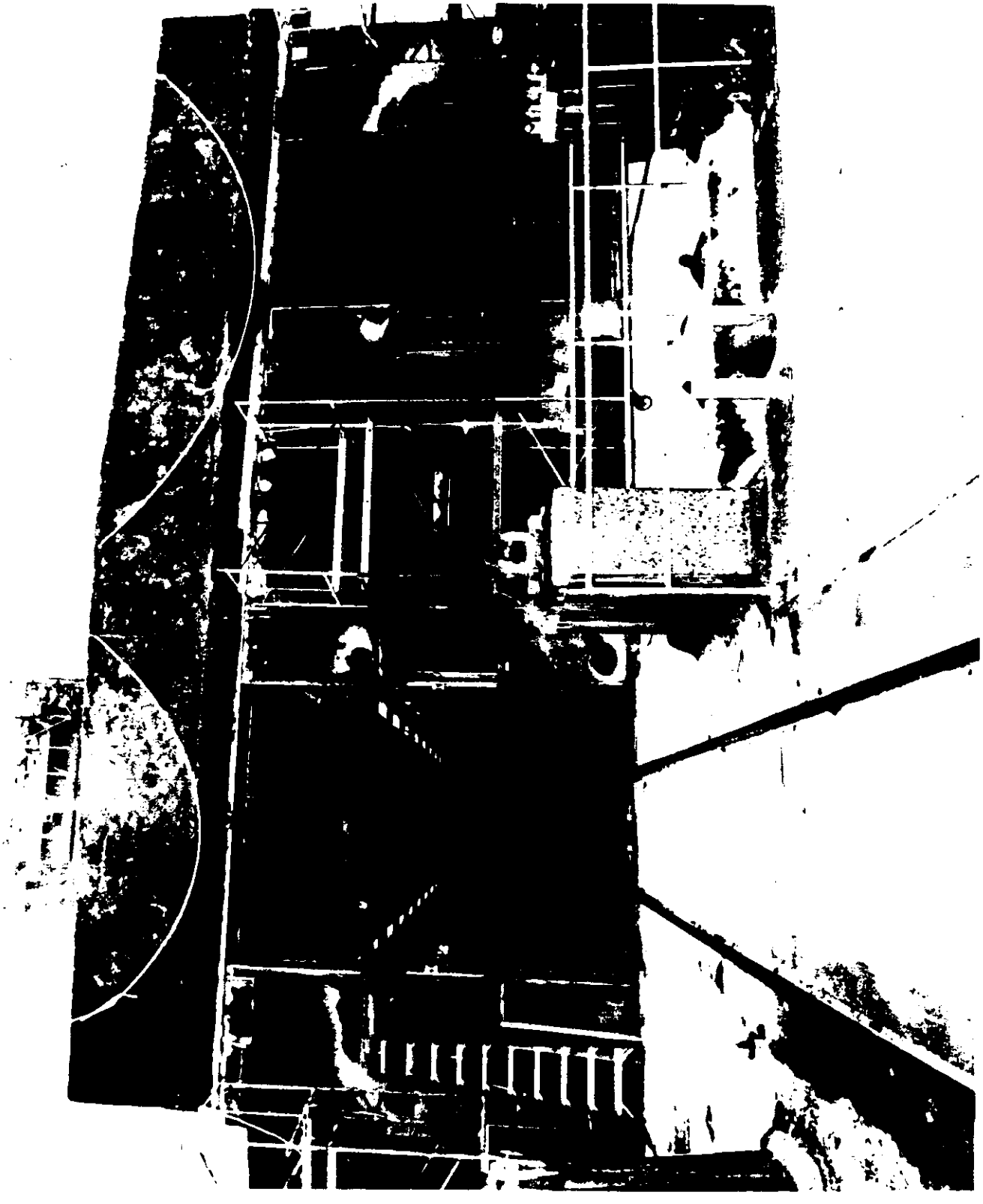

FIGURE 11

LAUNCH DAMAGE TO UNPROTECTED EAGE BUILDING DOORS. THIS AREA SHOULD BE COATED WITH ABLATIVE.

FIGURE 12

LAUNCH DAMAGE TO UNPROTECTED PIPING SUPPORTS ON SOUTH END OF UMBILICAL TOWER. THIS AREA SHOULD BE COATED WITH ABLATIVE.

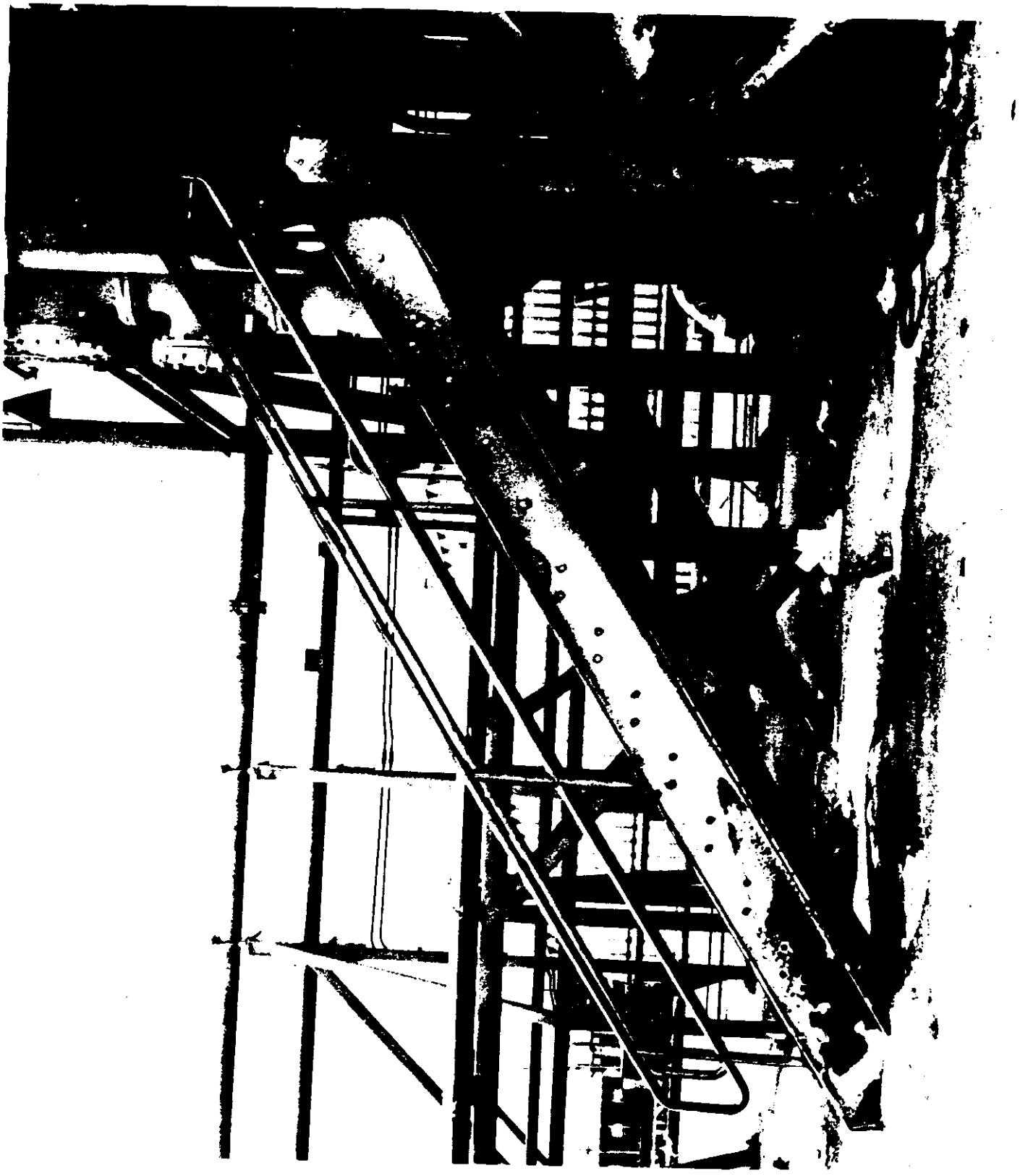

FIGURE 13

LAUNCH DAMAGE TO UNPROTECTED STAIRWAY ON SOUTHEAST CORNER OF UMBILICAL TOWER. THIS AREA SHOULD BE COATED WITH ABLATIVE.

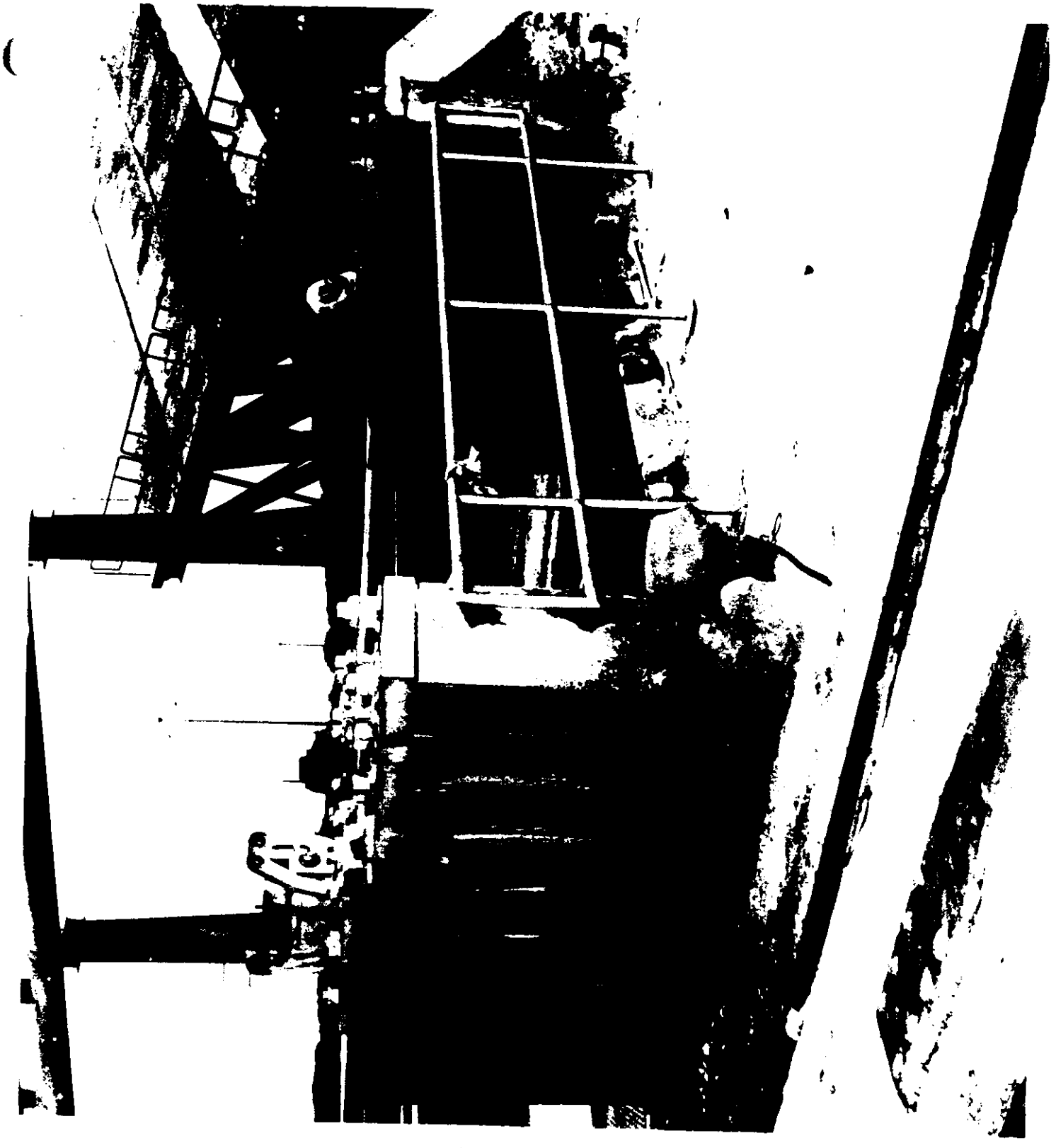

FIGURE 14

LAUNCH DAMAGE TO UNPROTECTED LAUNCHER SUPPORTS. THIS AREA SHOULD BE COATED WITH ABLATIVE.

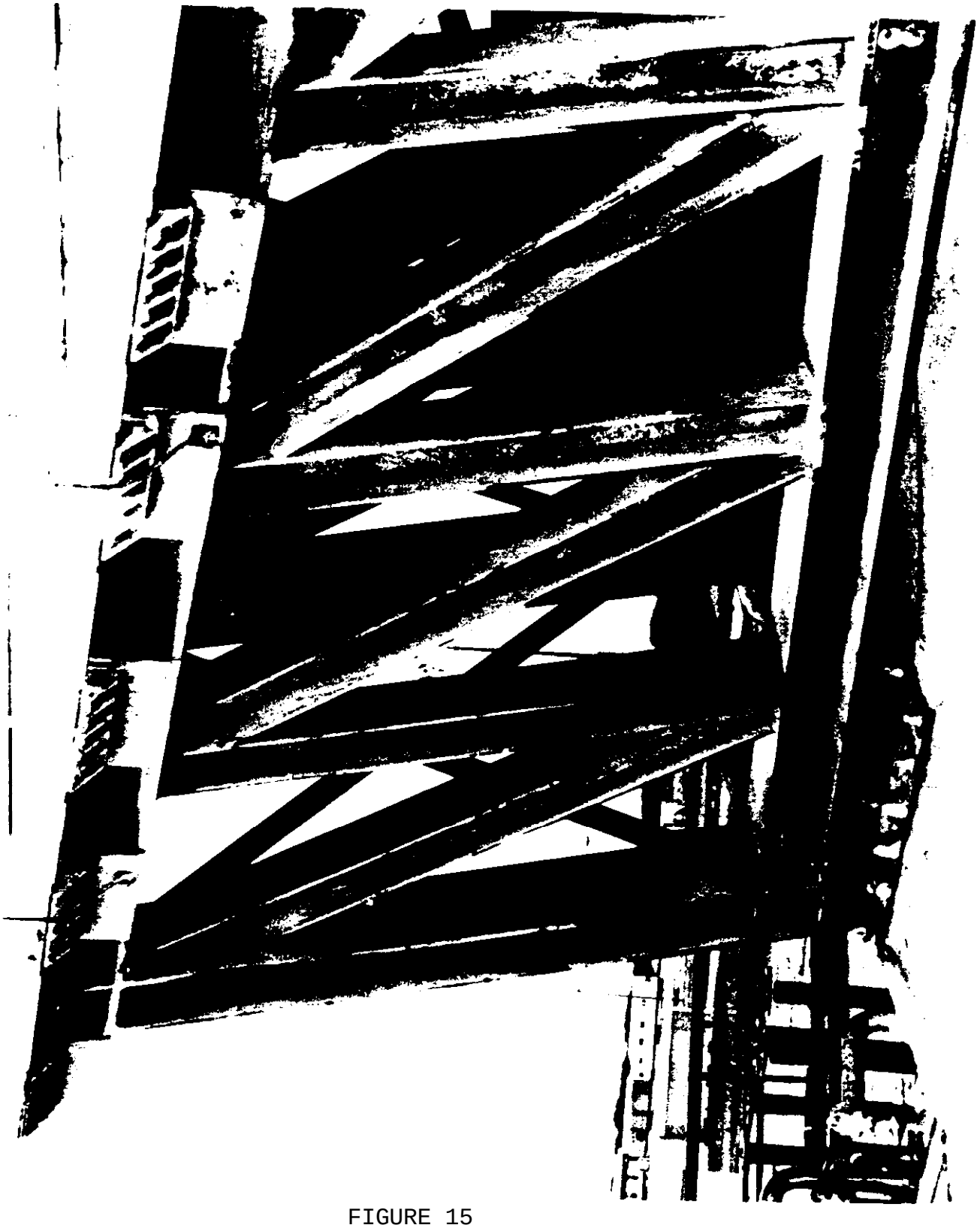

FIGURE 15

LAUNCH DAMAGE TO UNPROTECTED DEFLECTOR SUPPORTS. THIS AREA SHOULD BE COATED WITH ABLATIVE.

FIGURE 16

LAUNCH DAMAGE TO UNPROTECTED MISCELLANEOUS GROUND HARDWARE. THESE AREAS SHOULD BE COATED WITH ABLATIVE.

FIGURE 17

LAUNCH DAMAGE TO UNPROTECTED MISCELLANEOUS GROUND HARDWARE. THESE AREAS SHOULD BE COATED WITH ABLATIVE.