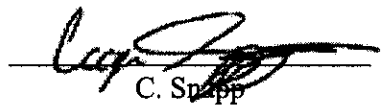
FE-058 KLO-01-007

Mission STS-100
OV-105 Flight 16
Thermal Protection System
Post-Flight Assessment

October 2001

P.O. 1970483303

Prepared by:



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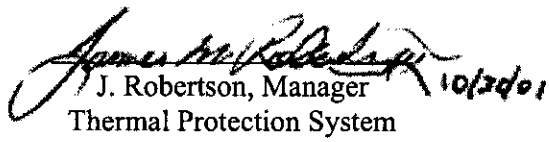

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Mission STS-100

OV-105 Flight 16

Thermal Protection System Post-Flight Assessment

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AETB-8	Alumina-Enhanced Thermal Barrier - 8 pcf
AFRSI	Advanced Flexible Reusable Surface Insulation
EOTF	Engineering Order to Follow
ET	External Tank
FI	Flexible Insulation
FRCI-12	Fibrous Refractory Composite Insulation - 12 pcf
FRCS	Forward Reaction Control System
FRSI	Felt Reusable Surface Insulation
Keq	Normalized Equivalent Roughness
LESS	Leading Edge Structural Subsystem
LI-900	Lockheed Insulation - 9 pcf
LRSI	Low-Temperature Reusable Surface Insulation
MCR	Master Change Record
MLGD	Main Landing Gear Door
MRB	Material Review Board
NC	Numerically Controlled
NLGD	Nose Landing Gear Door
OMI	Operations and Maintenance Instruction
OML	Outer Mold Line
OMRSD	Operations and Maintenance Requirements and Specifications Document
OMS	Orbital Maneuvering System
pcf	Pounds Per Cubic Foot
PLBD	Payload Bay Door
PPE	Personal Protective Equipment
PRT	Problem Resolution Team
RCC	Reinforced Carbon-Carbon
RCG	Reaction Cured Glass
RSI	Reusable Surface Insulation
RTV	Room-Temperature Vulcanized
SIP	Strain Isolator Pad
SSME	Space Shuttle Main Engine
TUFI	Toughened Uni-Piece Fibrous Insulation
WLE	Wing Leading Edge

Acknowledgment

Several personnel contributed to this report. The engineering inspections were performed at the Edwards Air Force Base, Dryden Flight Research Facility in California by Karrie Hinkle and in the Orbiter Processing Facility High Bay 2 by the authors noted. Preflight data was provided by SFOC personnel. Flight temperature data was provided by Gerald Kinder, Boeing Reusable Space Systems. Post-landing debris assessment was provided by the Debris Inspection Team. Publication and editorial assistance was provided by L. Koenig and K. Cochran. The assistance of all who helped prepare this report is greatly appreciated.

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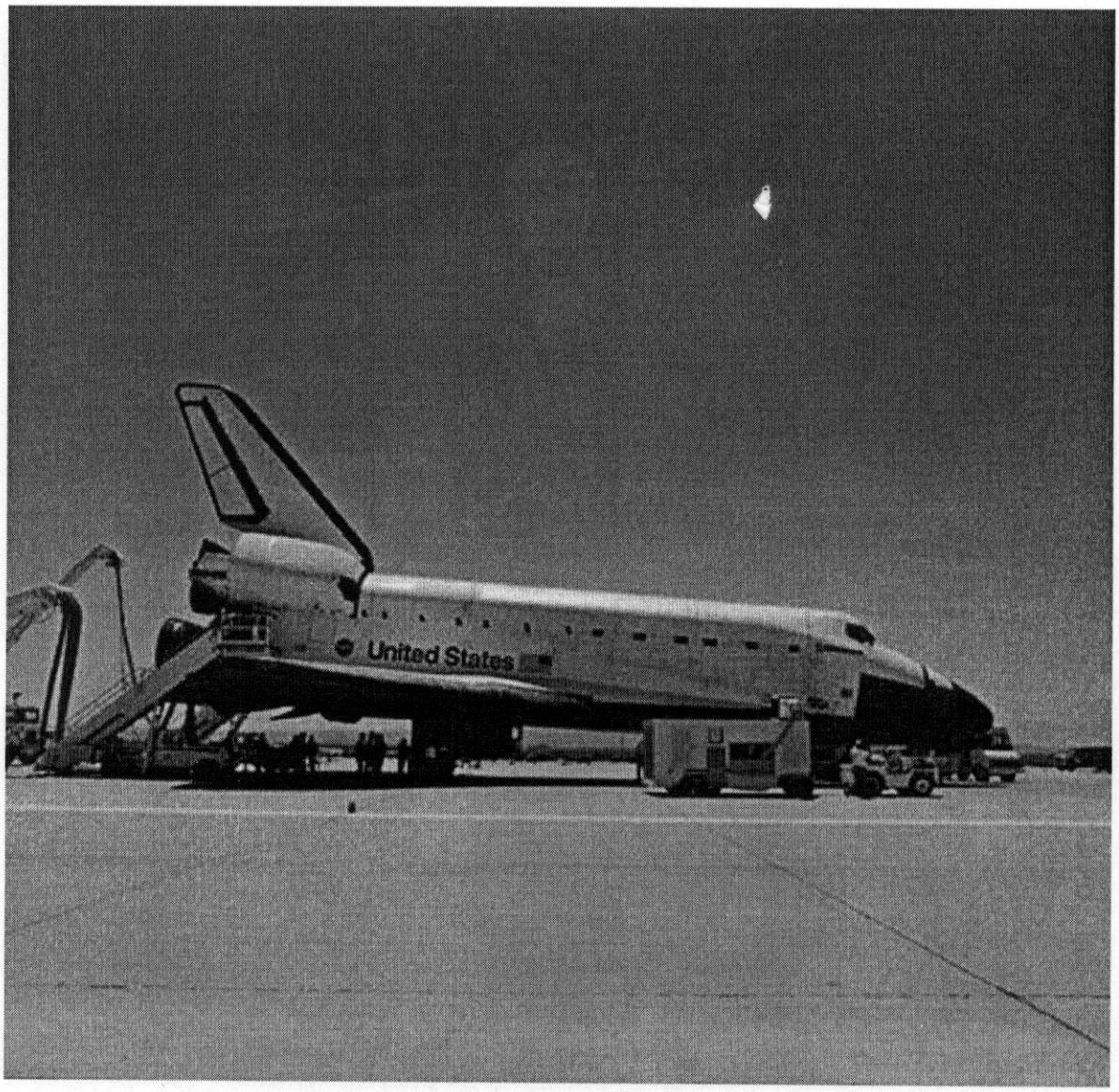

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Photo 1. Overall View, Right Hand Side

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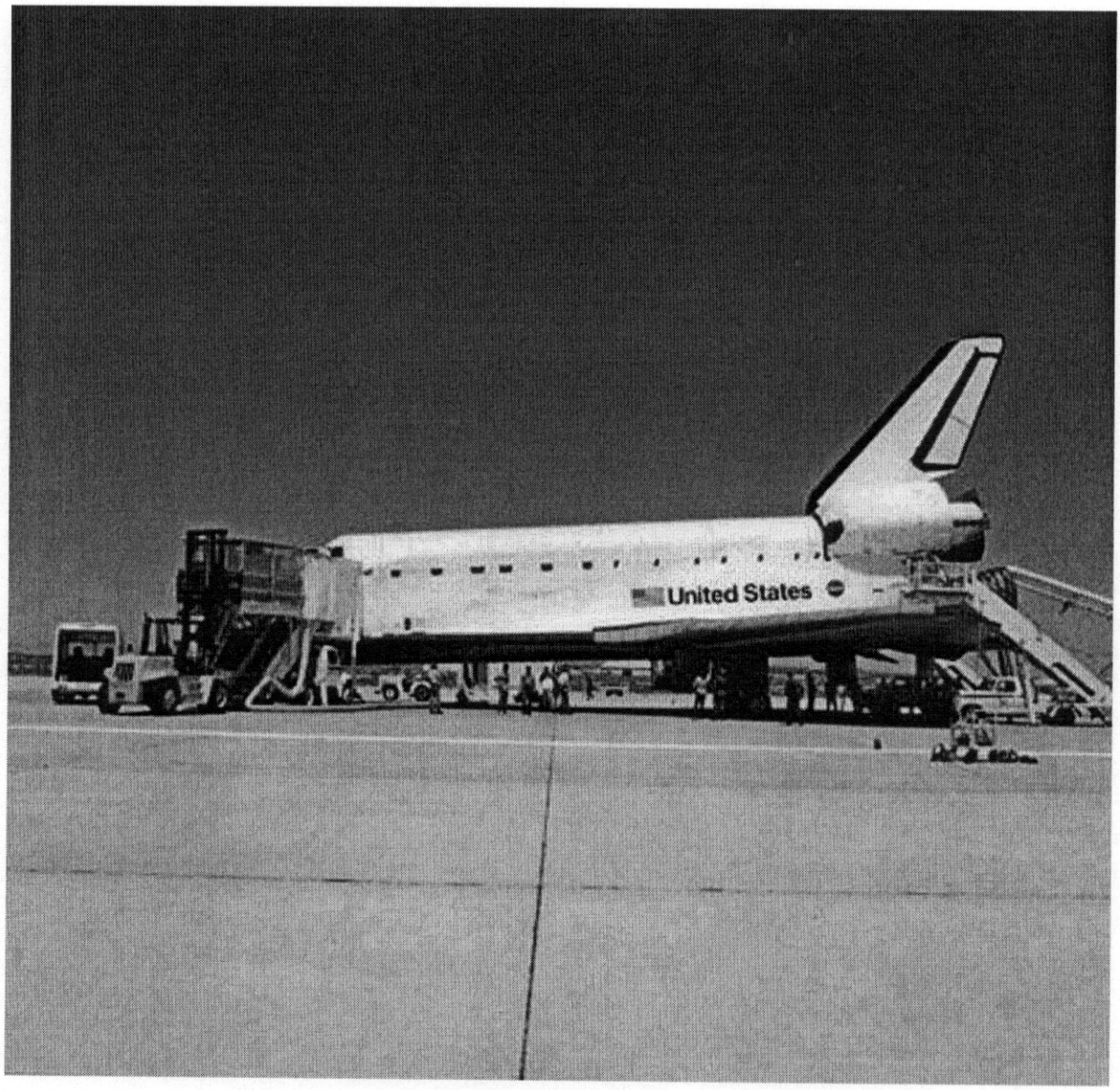

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Photo 2. Overall View, Left Hand Side

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Photo 3. Overall View, Front

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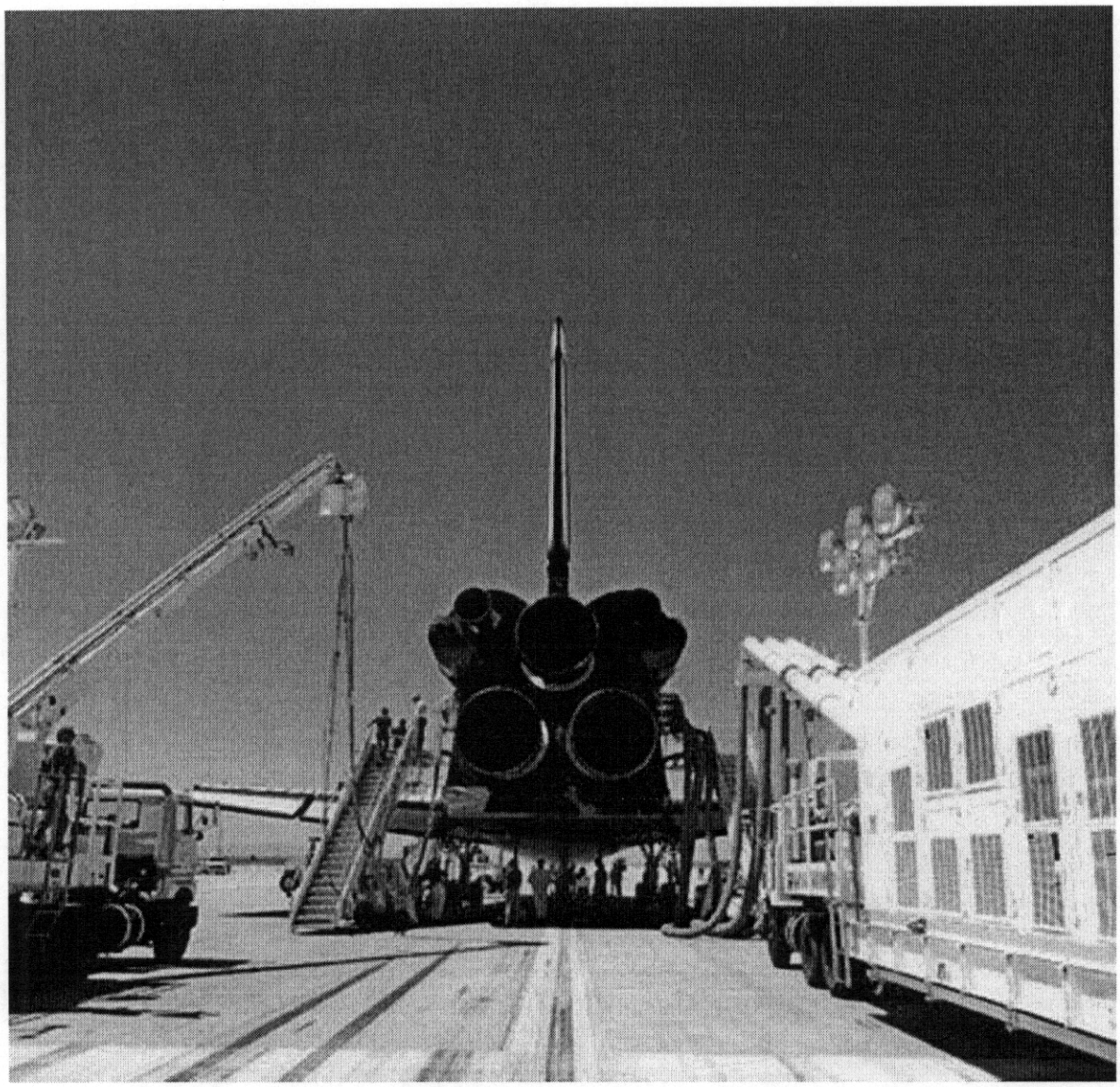

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Photo 4. Overall View, Aft

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1.0 PURPOSE

This report summarizes the results of engineering inspections conducted on the orbiter TPS following flight 16 of OV-105.

2.0 BACKGROUND

The previous flights of OV-105 and the associated report numbers are documented in table 1.

Table 1. Flight History

MISSION NUMBER	FLIGHT NUMBER	LAUNCH DATE	LANDING DATE	REPORT NUMBER
STS-49	105/1	05/07/92	05/16/92	KLO-92-008
STS-47	105/2	09/12/92	09/20/92	KLO-92-011
STS-54	105/3	01/13/93	01/19/93	KLO-93-004
STS-57	105/4	06/21/93	07/01/93	KLO-93-008
STS-61	105/5	12/02/93	12/13/93	KLO-94-003
STS-59	105/6	04/09/94	04/20/94	KLO-94-005
STS-68	105/7	09/30/94	10/11/94	KLO-95-002
STS-67	105/8	03/02/95	03/18/95	KLO-95-005
STS-69	105/9	09/07/95	09/18/95	KLO-95-007
STS-72	105/10	01/11/96	01/20/96	KLO-96-003
STS-77	105/11	05/19/96	05/29/96	KLO-97-008
STS-89	105/12	01/22/98	01/31/98	KLO-98-007
STS-88	105/13	12/04/98	12/15/98	KLO-99-004
STS-99	105/14	02/11/00	02/2200	KLO-00-004
STS-97	105/15	11/30/00	12/11/00	KLO-00-002

In preparation for STS-100, OV-105 and associated OMS pods had 52 tiles and 10 FI blankets removed and replaced. Of these 62 RSI component replacements, 7 were related to TPS modifications performed in support of flight 16 (refer to table 2) and 6 of the blankets were related to the drag chute, which are expendable items. Preflight vehicle roughness (Keq) values and locations are documented in table 3.

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Table 2. Summary of Tile and FI Blanket Part Replacements and TPS Modifications Performed for Flight 16 of OV-105

MCR	MCR/WORK TITLE	PARTS/WORK INVOLVED	PERFORMED AT
12999	MATERIAL UPGRADE	1 LI-900 TILE REMOVED AND REPLACED WITH FRCI-12 DENSITY MATERIAL ON 0.115 SIP TO INCREASE TENSILE STRENGTH AND STABILIZE TILE INSTALLATION (ATTRITION CHANGE)	KSC
13210	TPS - DAMAGE-PRONE LRSI REPLACEMENT WITH WHITE FRCI-12/ALTERNATE RSI	1 LI-900 TILE REMOVED AND REPLACED WITH FRCI-12 DENSITY MATERIAL (ATTRITION CHANGE)	KSC
14222	TPS - 6.0 LOADS NEGATIVE MARGIN TILE REDESIGN	1 LI-900 TILE REMOVED AND REPLACED WITH FRCI-12 DENSITY MATERIAL (ATTRITION CHANGE)	KSC
17177	MATERIAL UPGRADE	1 LI-900 TILE REMOVED AND REPLACED WITH FRCI-12 DENSITY MATERIAL ON 0.115 SIP TO INCREASE TENSILE STRENGTH AND STABILIZE TILE INSTALLATION (ATTRITION CHANGE)	KSC
18563	TPS - FLEET MODIFICATION AND MATERIAL UPGRADE	1 BLANKET REPLACED TO A SIZE THAT PREVENTS BLANKET PROTRUSION BEYOND THE EDGE OF ADJACENT TILE (ATTRITION CHANGE) 2 LI-900 TILES REMOVED AND REPLACED WITH FRCI-12 DENSITY MATERIAL ON 0.115 SIP TO INCREASE TENSILE STRENGTH AND STABILIZE TILE INSTALLATION (ATTRITION CHANGE)	KSC

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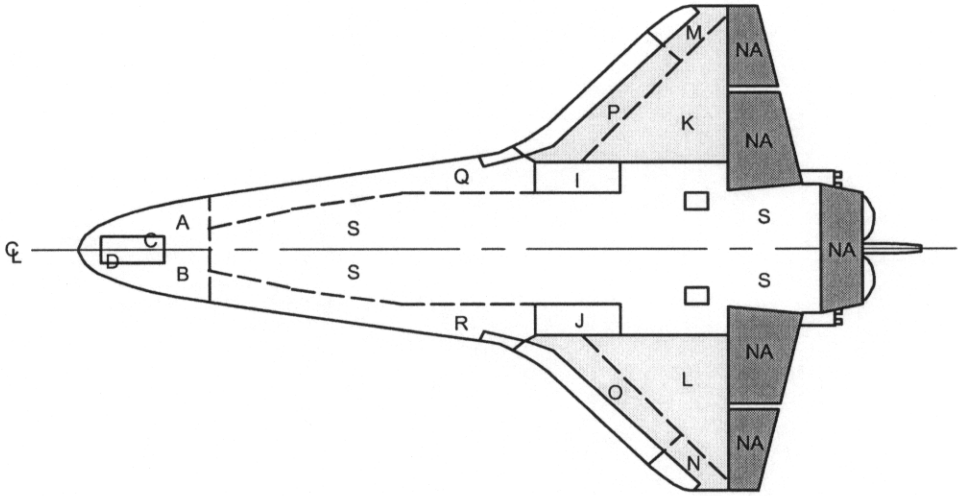
Table 3. Keq Values



NUMBER OF LOCATIONS OVER NOTED KEQ VALUES					
VEHICLE LOCATION	≤110	>110	>120	>128	>136
A	0	5	3	2	1
B	4	3	1	0	0
C	0	6	1	0	0
D	0	9	4	0	0
I	0	0	0	0	0
J	0	0	0	0	0
K	0	0	0	0	0
L	0	0	0	0	0
M	0	0	0	0	0
N	0	0	0	0	0
O	0	0	0	0	0
P	0	0	0	0	0
Q	0	0	0	0	0
R	0	0	0	0	0
S	0	0	0	0	0
KEQ TOTALS	4	23	9	2	1
PREVIOUS FLIGHT	6	9	4	3	1
OV-105 AVERAGE	4.6	13.6	5.1	1.1	0.6
FLEET AVERAGE	7.4	18.8	9.8	2.3	0.5

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3.0 SUMMARY

(C. Snapp)

Post-flight 16 inspections and evaluations for OV-105 showed nominal overall TPS performance. The total number of impacts was below fleet average with impacts greater than 1 inch also below fleet average. The largest damage was located on the leading edge of the vertical tail that caused one tile to be removed and replaced. There were two protruding Ames found that produced no downstream or local overtemperature. The vehicle landed at Edwards Air Force Base, Dryden Flight Research Facility in California. Several large tile damages resulted from ground handling during ferry flight preparations. A strap connected to the white room damaged an area of tiles under the crew hatch and several tiles on the left hand ET door were damaged during the ET ferry door installation.

4.0 FLIGHT DATA

(C. Snapp)

OV-105 was launched at 2:40 p.m. EDT on April 19, 2001 from launch pad LC-39A. The orbiter touched down at 9:10 a.m. PDT on May 1, 2001 at Edwards Air Force Base, Dryden Flight Research Facility in California, on runway 22. For the STS-100 mission, OV-105 was assigned left OMS pod LP04 (flight 23) and right OMS pod RP01 (flight 30).

The number of overall debris impacts (92) and impacts over 1 inch (13) were average when compared to previous flights of OV-105 and were significantly below average when compared to the vehicle fleet (refer to table 4 and table 5, and figures 1 through 3).

Protruding gap filler locations are shown in table 6, and the reentry summary data is provided in table 7.

The structural delta and peak temperatures (refer to figure 4), Tempilabel® readings (refer to figures 5 through 10), and the boundary layer transition times (refer to table 8) indicate that the vehicle experienced a normal transition from laminar to turbulent flow. Charred filler bar history and data for this flight are shown in table 9, and current charred filler bar locations are shown in figure 11. The amount of charred filler bar was much higher than the average for previous flights of OV-105.

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Table 4. Debris Damage Assessment Summary

	IMPACTS > 1"	TOTAL
LOWER SURFACE	4	42
UPPER SURFACE	0	0
WINDOW AREA	8	48
RIGHT SIDE	0	0
LEFT SIDE	0	0
RIGHT OMS POD	1	2
LEFT OMS POD	0	0
TOTALS	**13**	**92**

Table 5. Debris Damage and Flight Comparison - OV-105 Only

MISSION	IMPACTS > 1"	TOTAL IMPACTS
STS-49/FLT 1	11	114
STS-47/FLT 2	11	108
STS-54/FLT 3	14	131
STS-57/FLT 4	14	131
STS-61/FLT 5	13	120
STS-59/FLT 6	19	77
STS-68/FLT 7	15	110
STS-67/FLT 8	13	76
STS-69/FLT 9	27	198
STS-72/FLT 10	6	55
STS-77/FLT 11	17	81
STS-89/FLT 12	40	138
STS-88/FLT 13	25	116
STS-99/FLT 14	25	87
STS-97/FLT 15	10	84
STS-100/FLT 16	13	92
OV-105 AVERAGE	**17.1**	**107.4**
FLEET AVERAGE	**30.8**	**146.1**

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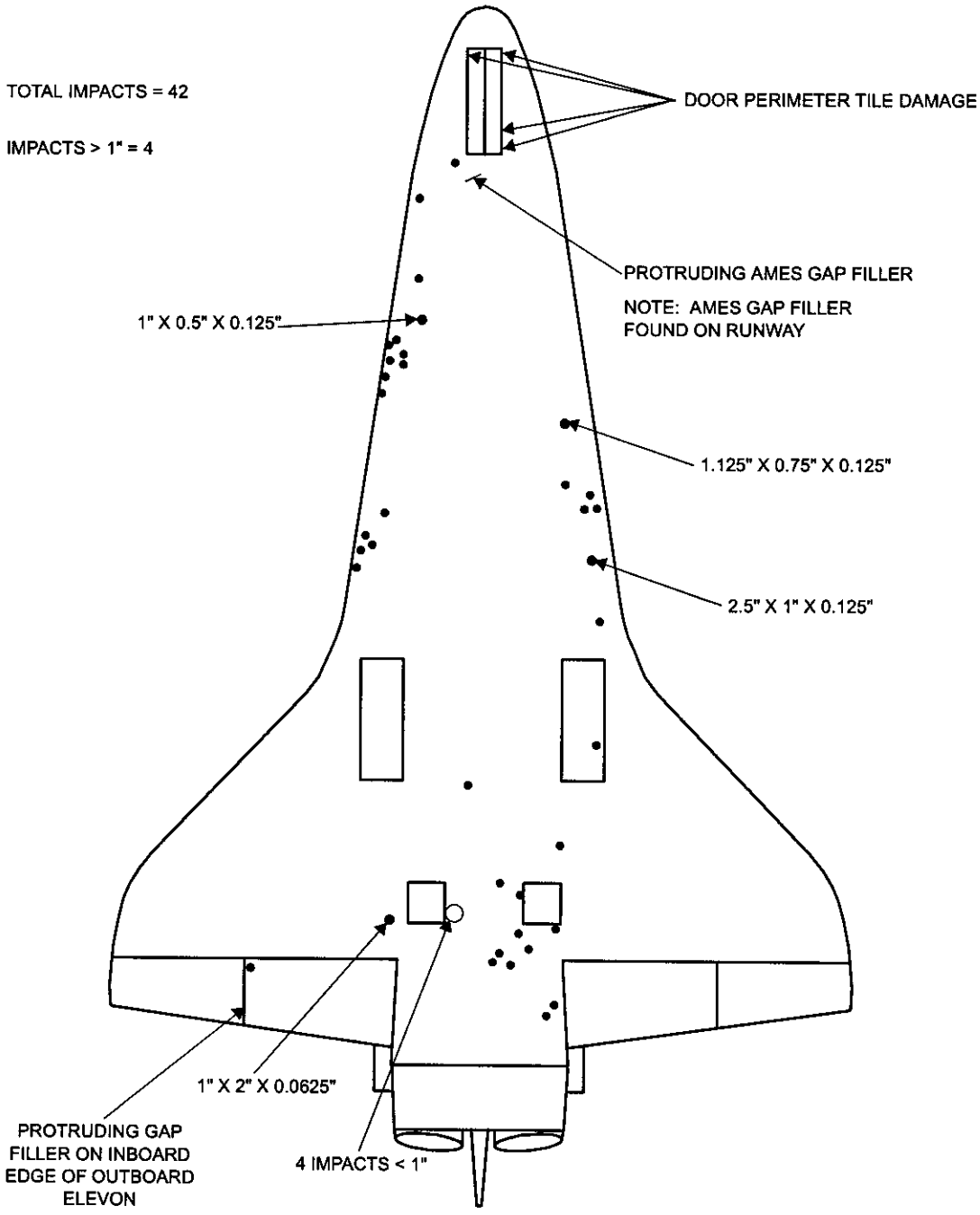

Figure 1. Lower Surface Debris Damage

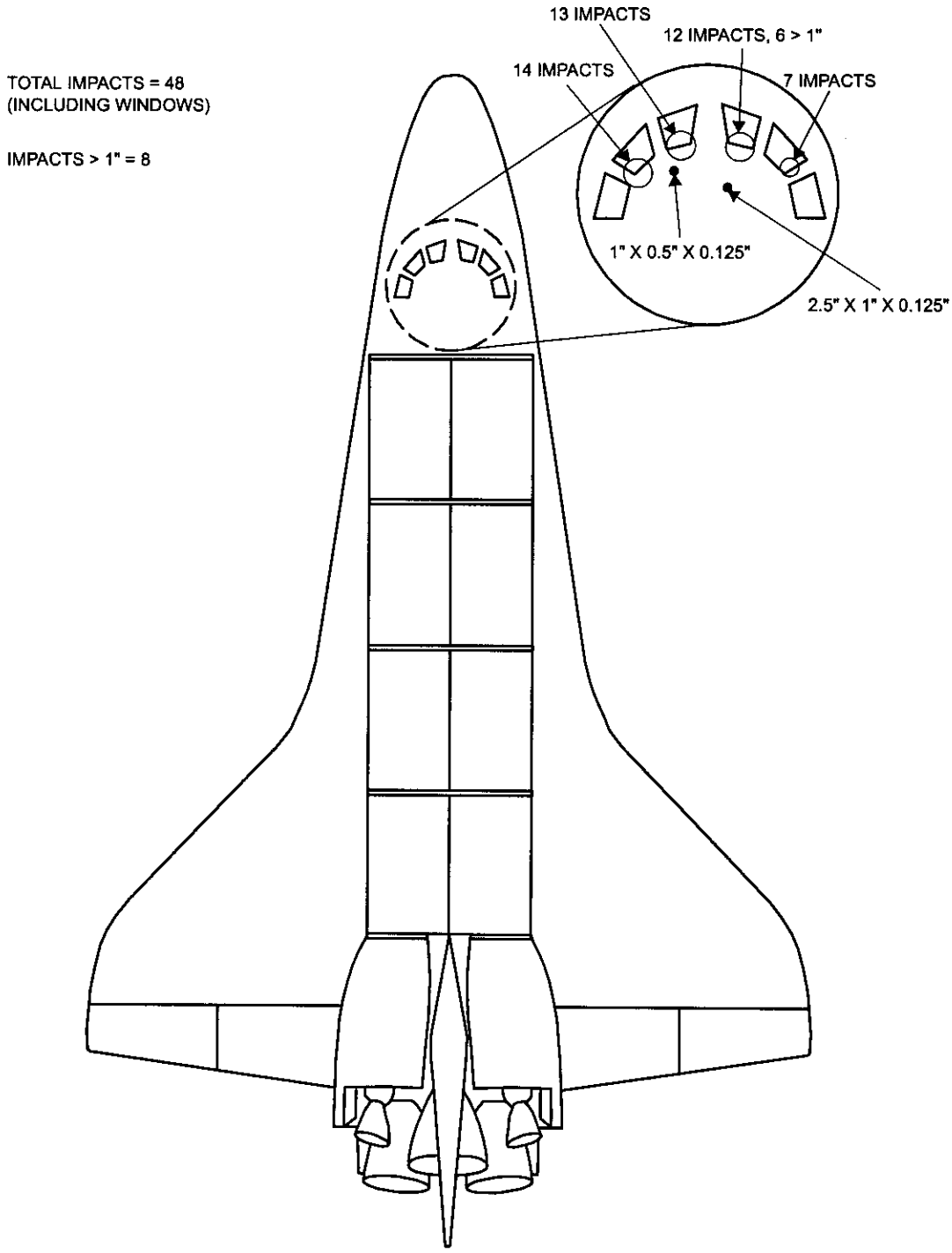

Figure 2. Upper Surface Debris Damage

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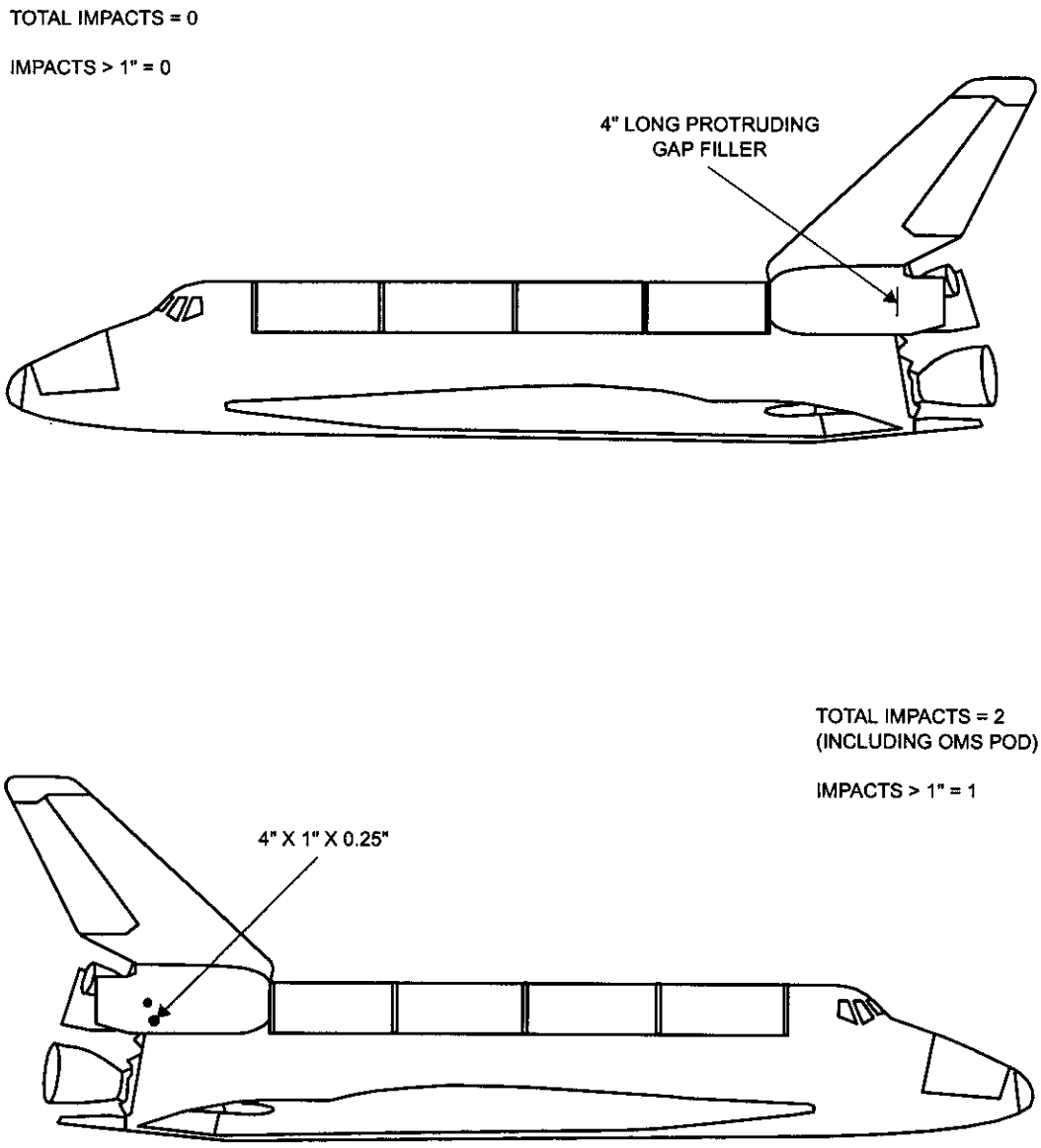

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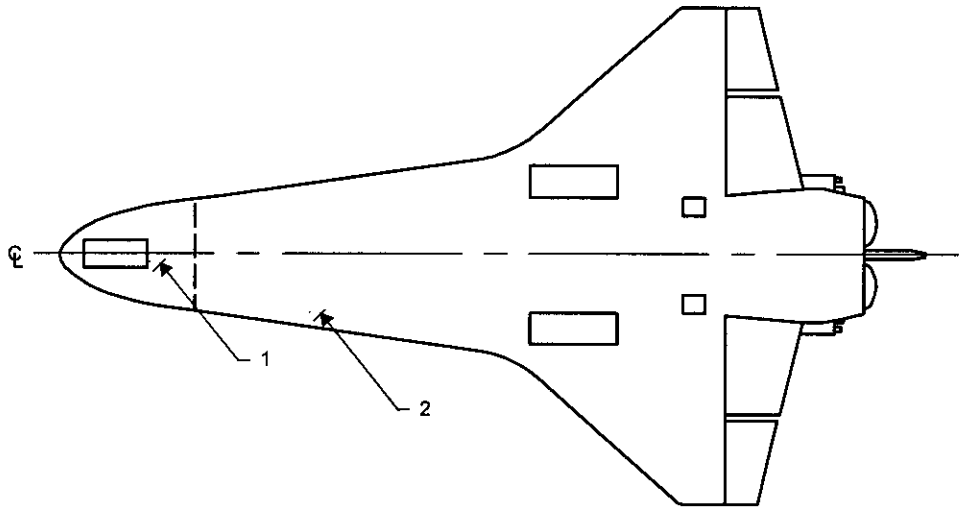
Figure 3. Fuselage Debris Damage

Table 6. Protruding Gap Filler Locations



LOCATION NUMBER	X	Y	ADJACENT TILE NUMBERS	AMOUNT PROTRUDED
1	388	19	V070-391017-280/V070-391017-014	0.300"
2	622	97	V070-394502-220/V070-394502-222	0.100"

Table 7. Summary of Reentry Data

ORBITAL INCLINATION: ***51.6°***
ANGLE OF ATTACK: ***40°***
CROSSRANGE, NM: ***527.2***
WEIGHT AT ENTRY INTERFACE, LBS X 1000: ***221.2***
CENTER OF GRAVITY AT ENTRY INTERFACE, INCH: X_o = ***1083***
ELEVON POSITION*: ***1.77°***
BODY FLAP POSITION*: ***-4.23°***
*POSITION AT TIME OF PEAK HEATING DURING REENTRY. UP IS INDICATED BY (-), DOWN IS INDICATED BY (+).

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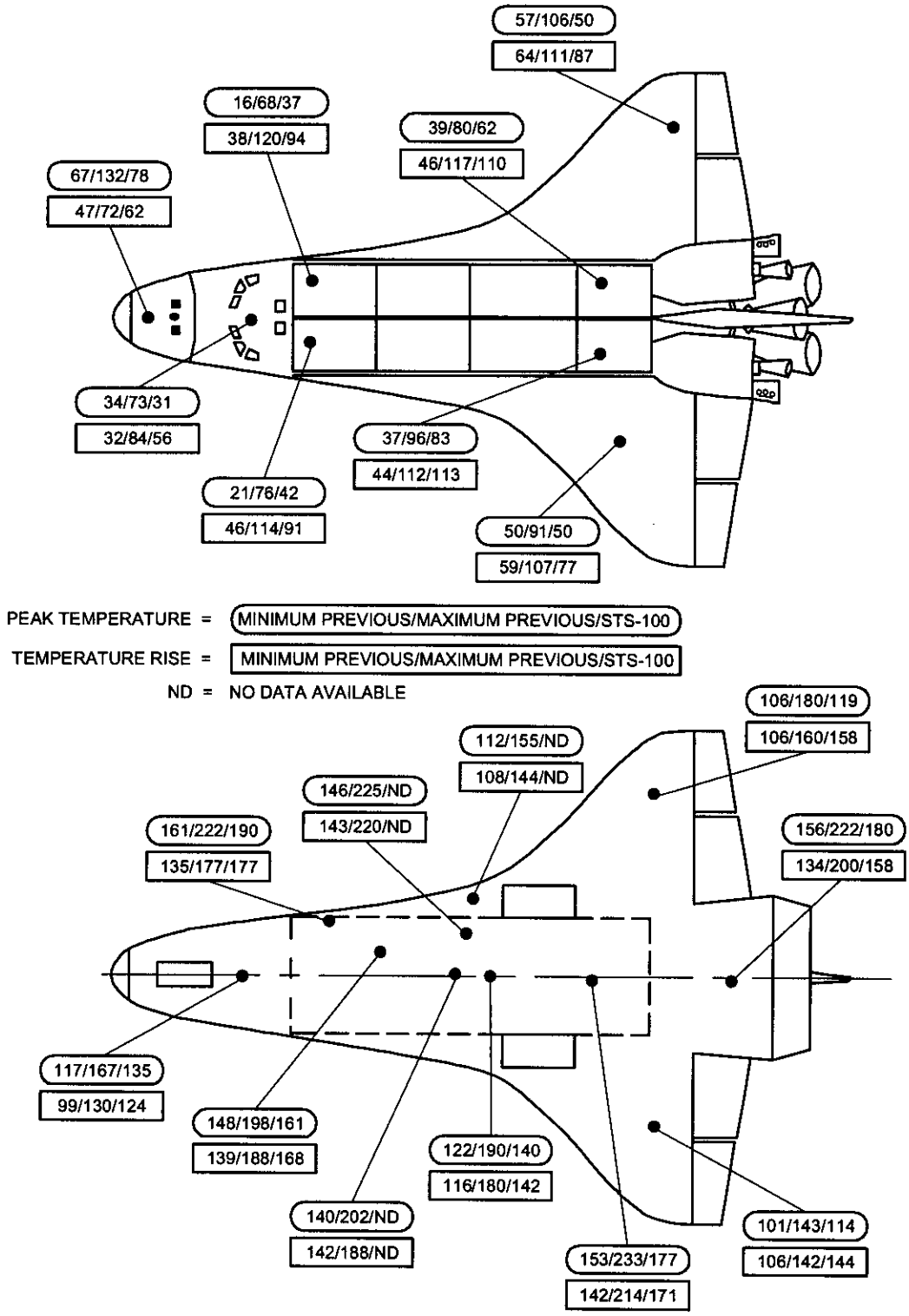

Figure 4. Peak and Structural Temperature Rises (°F)

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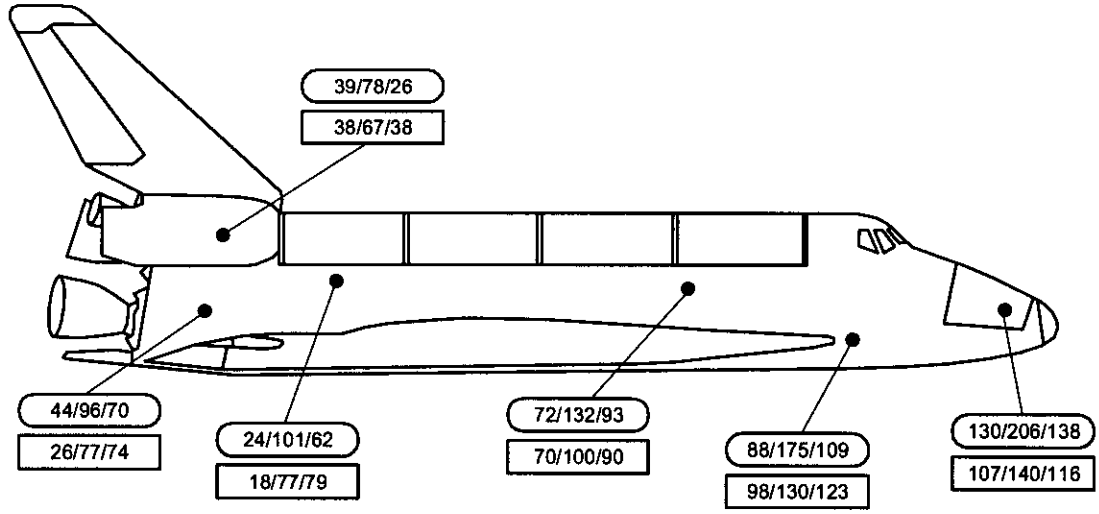

PEAK TEMPERATURE = MINIMUM PREVIOUS/MAXIMUM PREVIOUS/STS-100

TEMPERATURE RISE = MINIMUM PREVIOUS/MAXIMUM PREVIOUS/STS-100

ND = NO DATA AVAILABLE

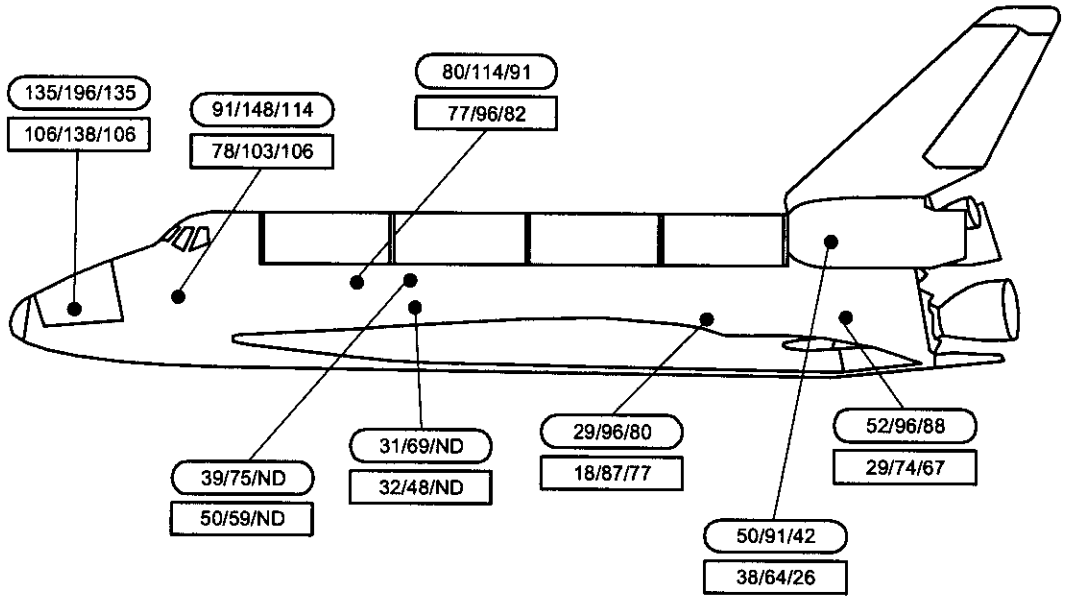

Figure 4. Peak and Structural Temperature Rises (°F) (cont'd)

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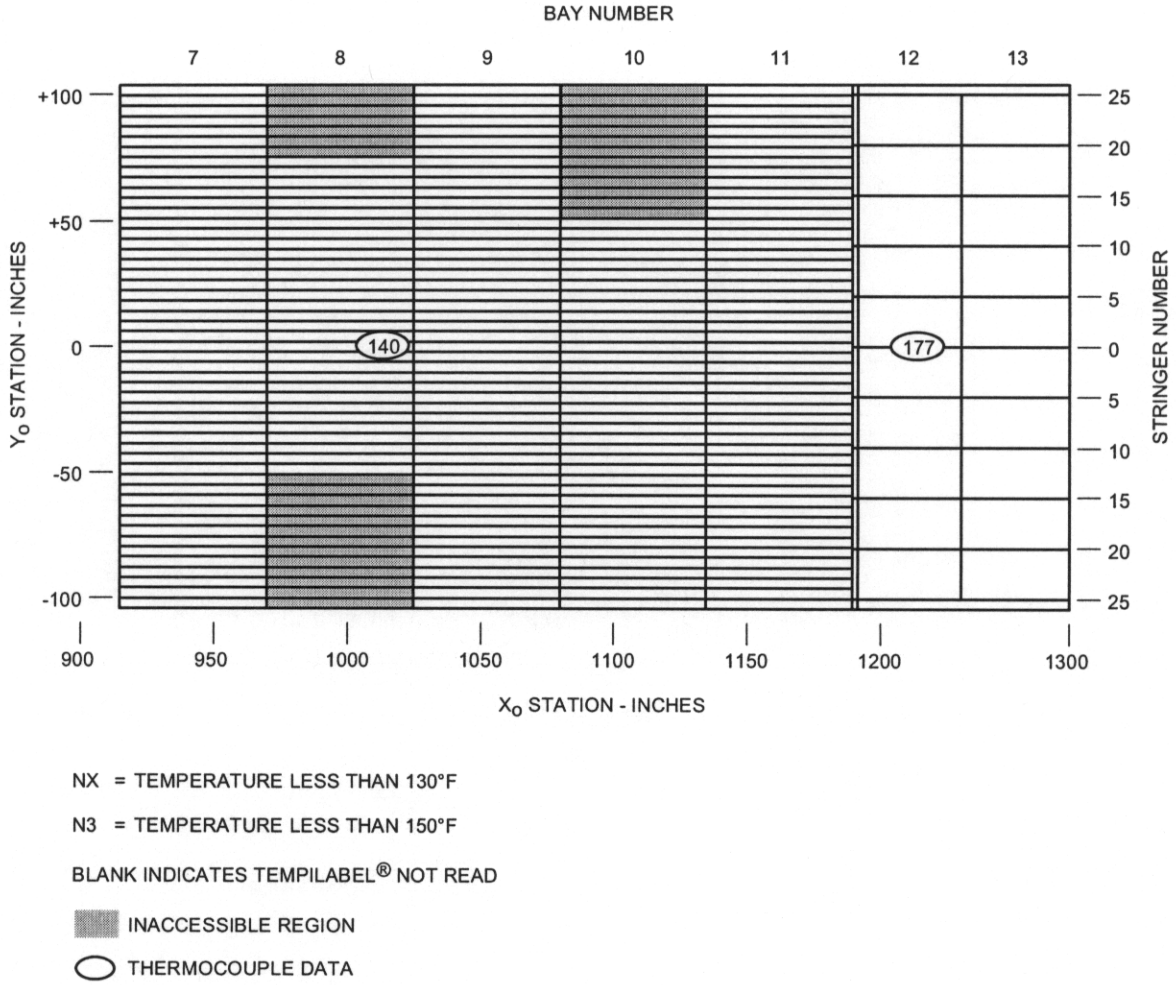

Figure 5. Midfuselage (with Wing Carry Through) Lower Skin Structure Tempilabel® Data

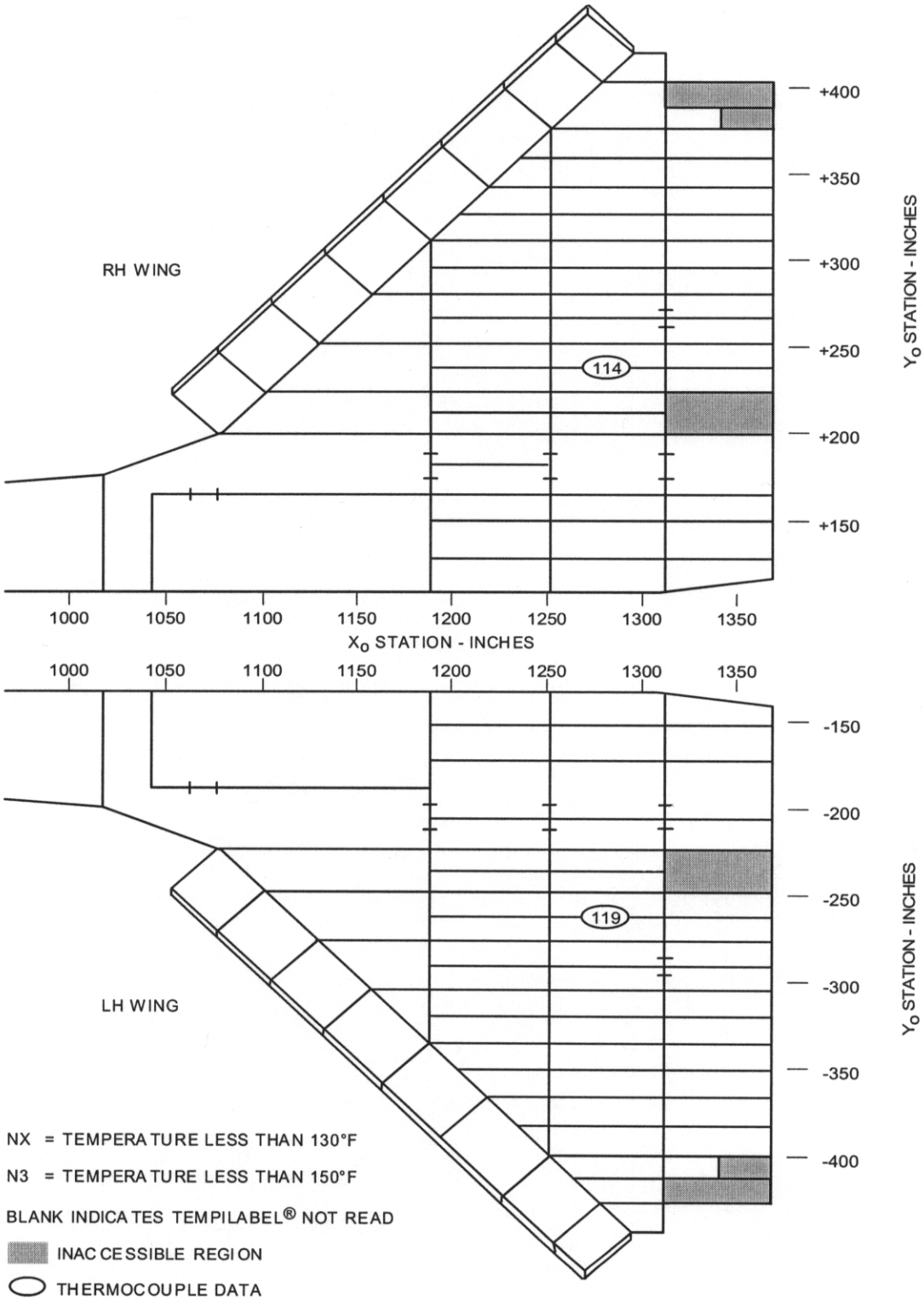

Figure 6. Lower Wing Structure Tempilabel® Data

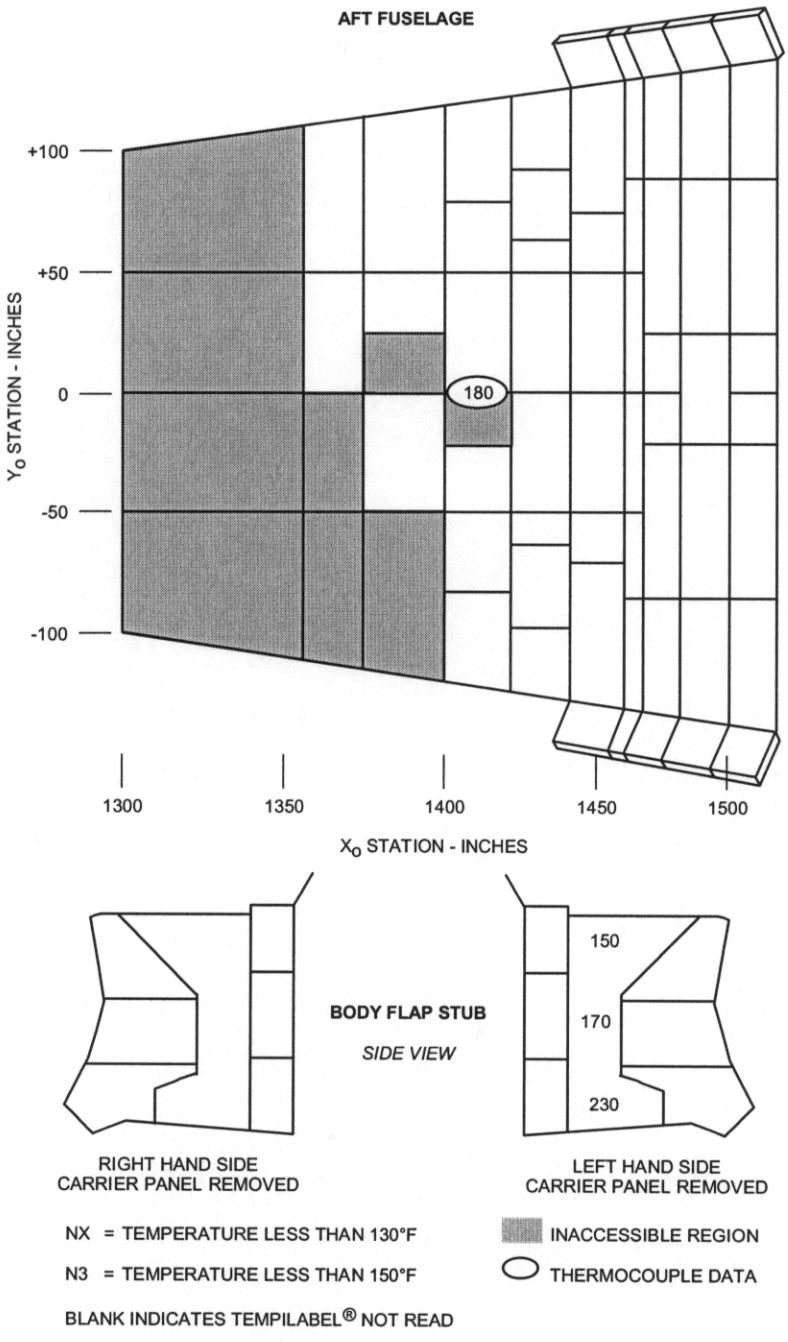

Figure 7. Aft Fuselage Lower Skin and Body Flap Stub Structure Tempilabel® Data

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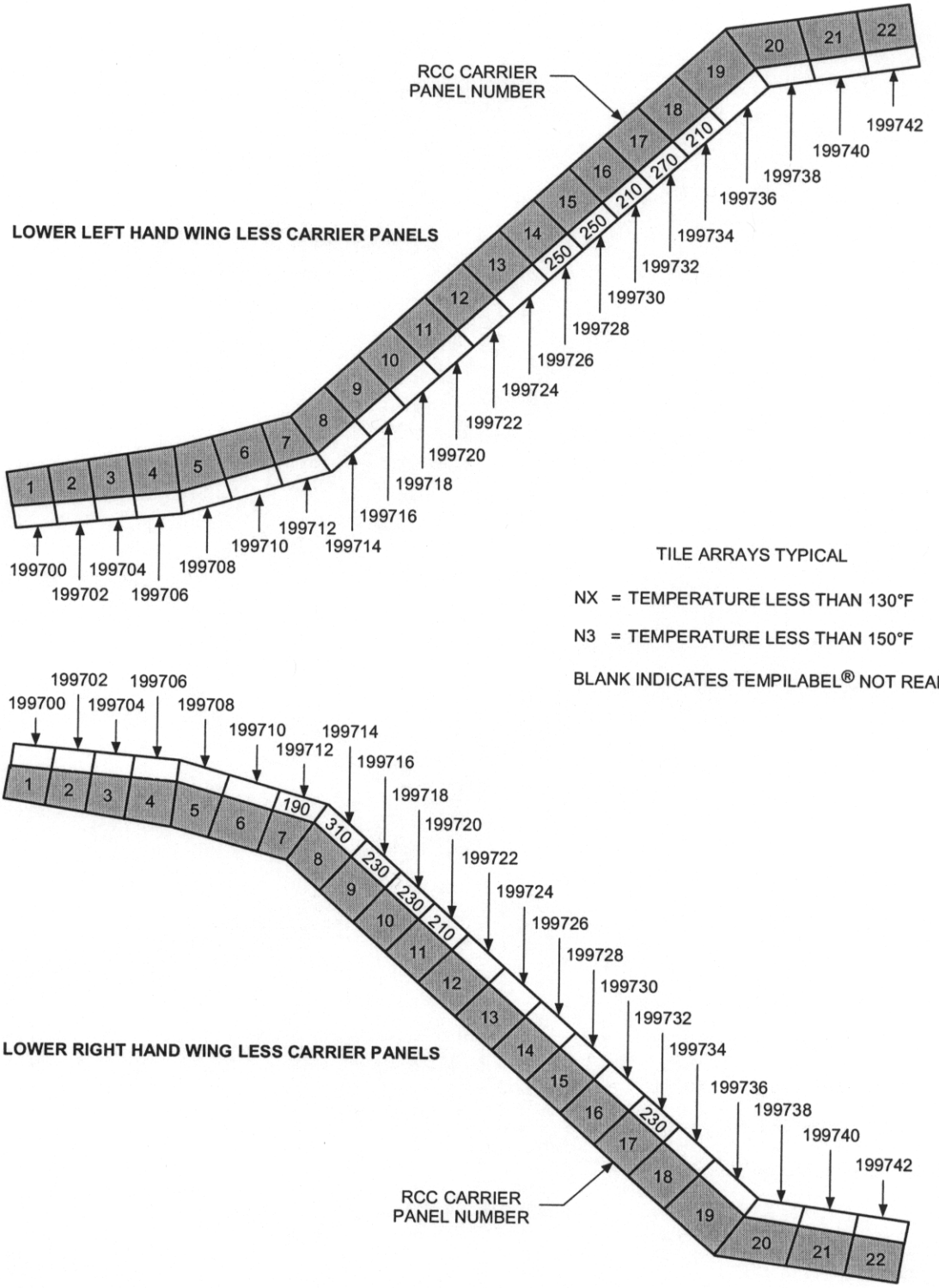

Figure 8. Lower Wing LESS Carrier Panels Tempilabel®Data

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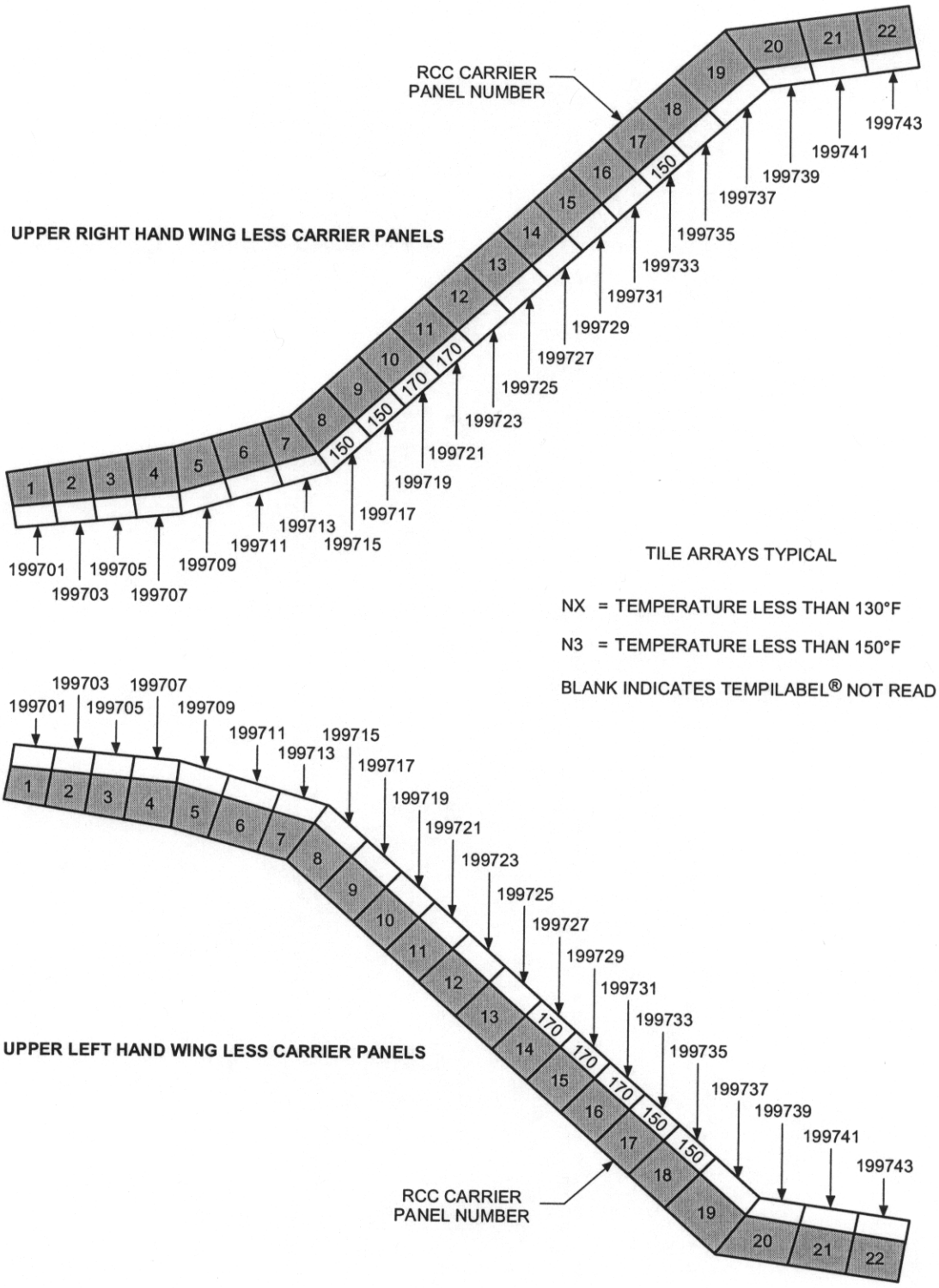

Figure 9. Upper Wing LESS Carrier Panels Tempilabel®Data

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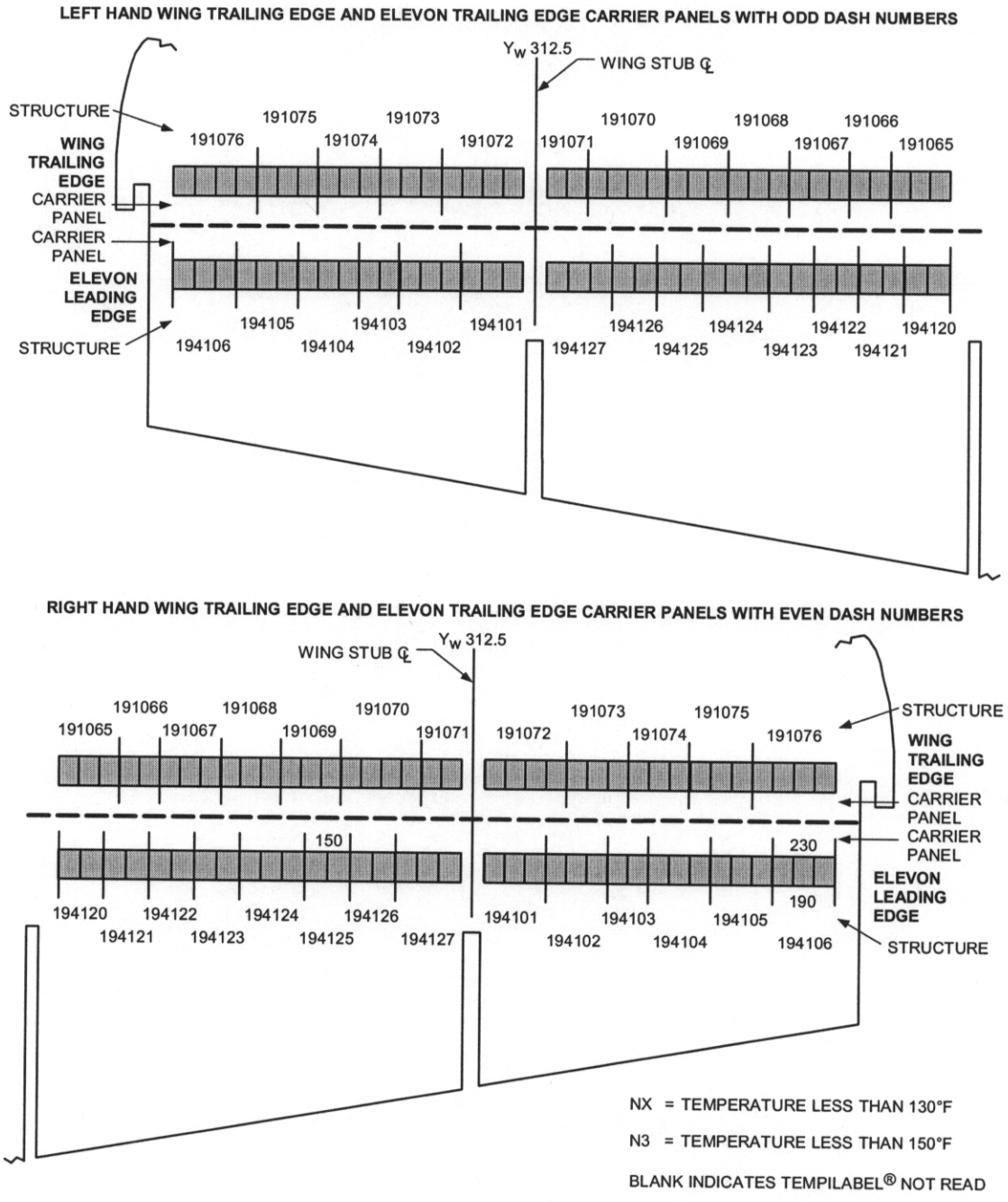

Figure 10. Wing-Elevon Lower Cove Tempilabel® Data

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Table 8. Boundary Layer Transition Flight Comparison - OV-105 Only

TRANSITION TIME IN SECONDS (SINCE ENTRY INTERFACE) AT THE MOST CONSISTENT FORWARD AND AFT THERMOCOUPLE LOCATIONS				
MISSION	VEHICLE	FLIGHT	FORWARD @ X/L=0.3 (V07T9468)	AFT @ X/L=0.6 (V07T9478 & EQUIVALENT)
STS-49	OV-105	1	1275	1275
STS-47	OV-105	2	1320	1210
STS-54	OV-105	3	1225	1200
STS-57	OV-105	4	1280	1270
STS-61	OV-105	5	1213	1170
STS-59	OV-105	6	NO DATA	NO DATA
STS-68	OV-105	7	1378	1320
STS-67	OV-105	8	1291	1272
STS-69	OV-105	9	1292	1285
STS-72	OV-105	10	1289	1279
STS-77	OV-105	11	1324	1323
STS-89	OV-105	12	1308	1291
STS-88	OV-105	13	1290	1290
STS-99	OV-105	14	1024	1013
STS-97	OV-105	15	1228	1227
STS-100	OV-105	16	1279	1279
OV-105 AVERAGE			**1267.7**	**1246.9**
FLEET AVERAGE			**1188.3**	**1171.7**

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Table 9. OV-105 Charred and Damaged Filler Bar History

MISSION	CAT 1	CAT 2	CAT 3	OTHER	TOTAL
STS-49/FLT 1	17	26	2	0	45
STS-47/FLT 2	1	96	3	0	100
STS-54/FLT 3	19	8	1	0	28
STS-57/FLT 4	7	18	2	0	27
STS-61/FLT 5	13	116	3	0	132
STS-59/FLT 6	11	22	0	0	33
STS-68/FLT 7	20	17	0	0	37
STS-67/FLT 8	19	9	0	0	28
STS-69/FLT 9	1	6	0	0	7
STS-72/FLT 10	3	16	0	0	19
STS-77/FLT 11	1	9	1	0	11
STS-89/FLT 12	5	9	2	0	16
STS-88/FLT 13	1	1	0	0	2
STS-99/FLT 14	4	28	2	0	34
STS-97/FLT 15	12	116	1	7	136
STS-100/FLT 16	10	60	6	17	93
OV-105 AVERAGE	**8.7**	**27.2**	**1.1**	**0.0**	**46.8**
OV-105 MEDIAN	**6.0**	**16.5**	**1.0**	**0.0**	**30.5**
FLEET AVERAGE	**72.1**	**45.8**	**3.9**	**4.9**	**126.6**
FLEET MEDIAN	**30.0**	**26.0**	**2.0**	**0.0**	**79.0**

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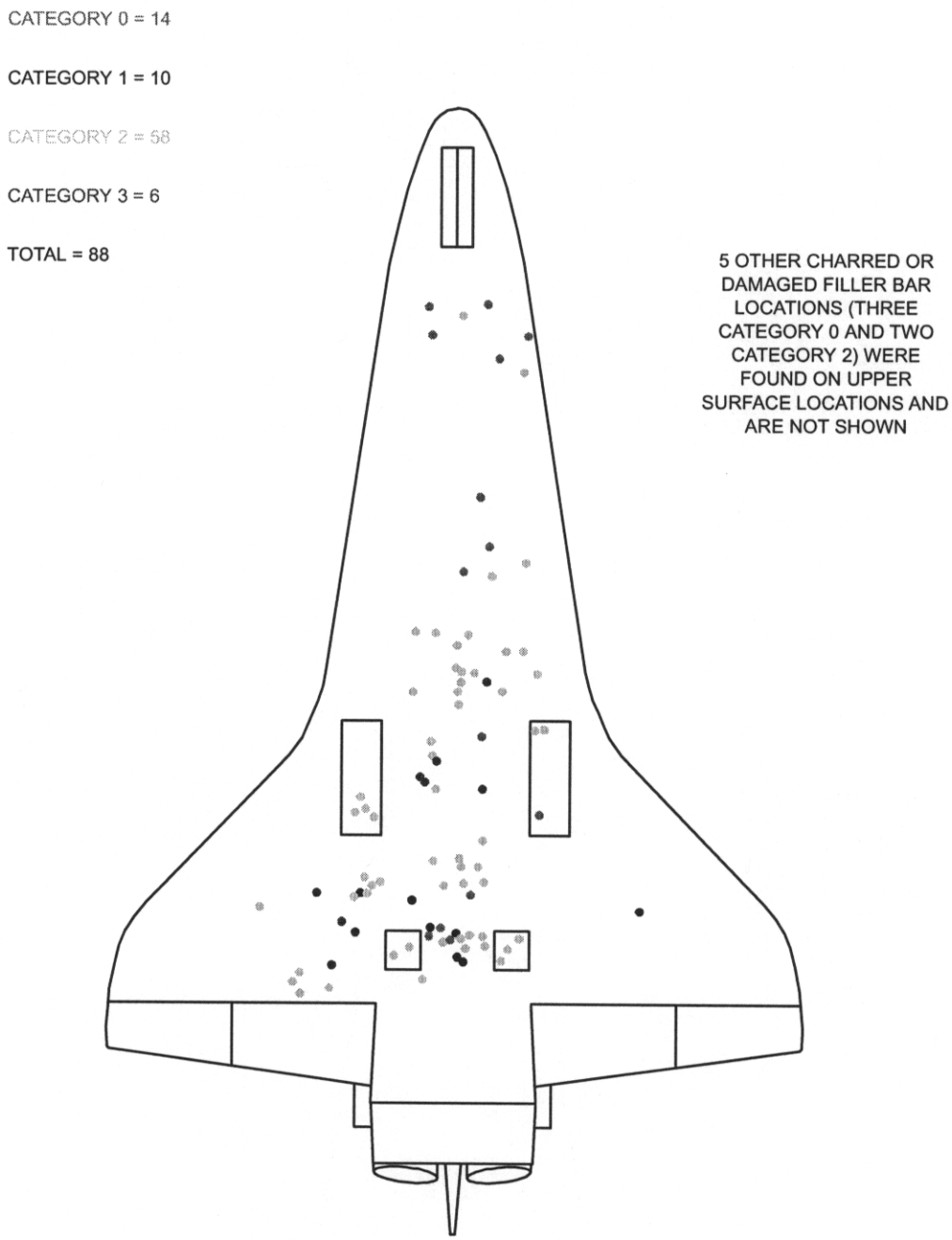

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Figure 11. Charred Filler Bar Locations

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5.0 EVALUATION

5.1 Lower Fuselage and Wings

5.1.1 General

(C. Snapp)

The TPS on the lower surface was in good overall condition. The lower surface sustained only 42 impacts total, 4 of which were greater than 1 inch. The damage distribution on the lower surface was consistent side to side. The right side of the vehicle had a higher concentration of impacts aft of the NLGD while the left side had a higher concentration around the external tank doors. The previous flight of Endeavour showed a high concentration of impacts on the right hand lower surface. The largest impacts were along the LESS and aft of the right hand external tank doors.

The amount of category 2 charred filler bar was lower than the last flight of OV-105 while the amount of category 3 charred filler bar significantly increased (refer to table 9). There were a total of six locations that category 3 charred filler bar was found. Charred filler bar designated as category 3 requires removal of a tile adjacent to the location to assess the total impact and potential spread of the charring. Thus, the six locations drove the removal and replacement of the following tiles: V070-394027-090, V070-394028-115, V070-394029-135, V070-394029-134, V070-394029-080, and V070-191010-185. After removal of the V070-191010-185 tile the charred condition was found to extend into the SIP of the adjacent V070-191013-058 tile. This warranted removal and replacement of that tile. No overtemperature to the structure was found at any of the locations. With the exception of the V070-191013-058 and V070-191010-185 tiles, all of the remaining locations of category 3 charred filler bar were located between the MLGD.

There were two protruding Ames gap filler on the lower surface. The first was located between tiles V070-391017-280 and V070-391017-014 (refer to photo 5). The gap filler protruded 0.300 inch and measured 4 inches in length. The second was located between the V070-394502-220 and V070-394502-222 tiles. The gap filler protruded 0.100 inch and was 4 inches in length.

The largest damage on the lower surface was to the V070-191001-037 tile (refer to photo 6) located on the left hand wing glove. The damage to the tile was approximately 2 inches by 1.2 inches by 0.100 inch in dimension. The damage was repairable per standard repair procedures.

Three left hand side elevon ablator tiles (V070-193017-498, -497, and -499) and one right hand side tile (V070-193017-506) showed signs of slight slumping. This has been typical in previous flights. However, none of the slumping was severe enough to require replacement. Several of the smaller slumped areas adjacent to the design gap fillers did not show signs of splitting or enlargement of the gap and were accepted as is with MRB concurrence on an unrestricted basis. The remaining slumped areas were repaired per standard repair procedures.

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Photo 5. Protruding Ames Gap Filler

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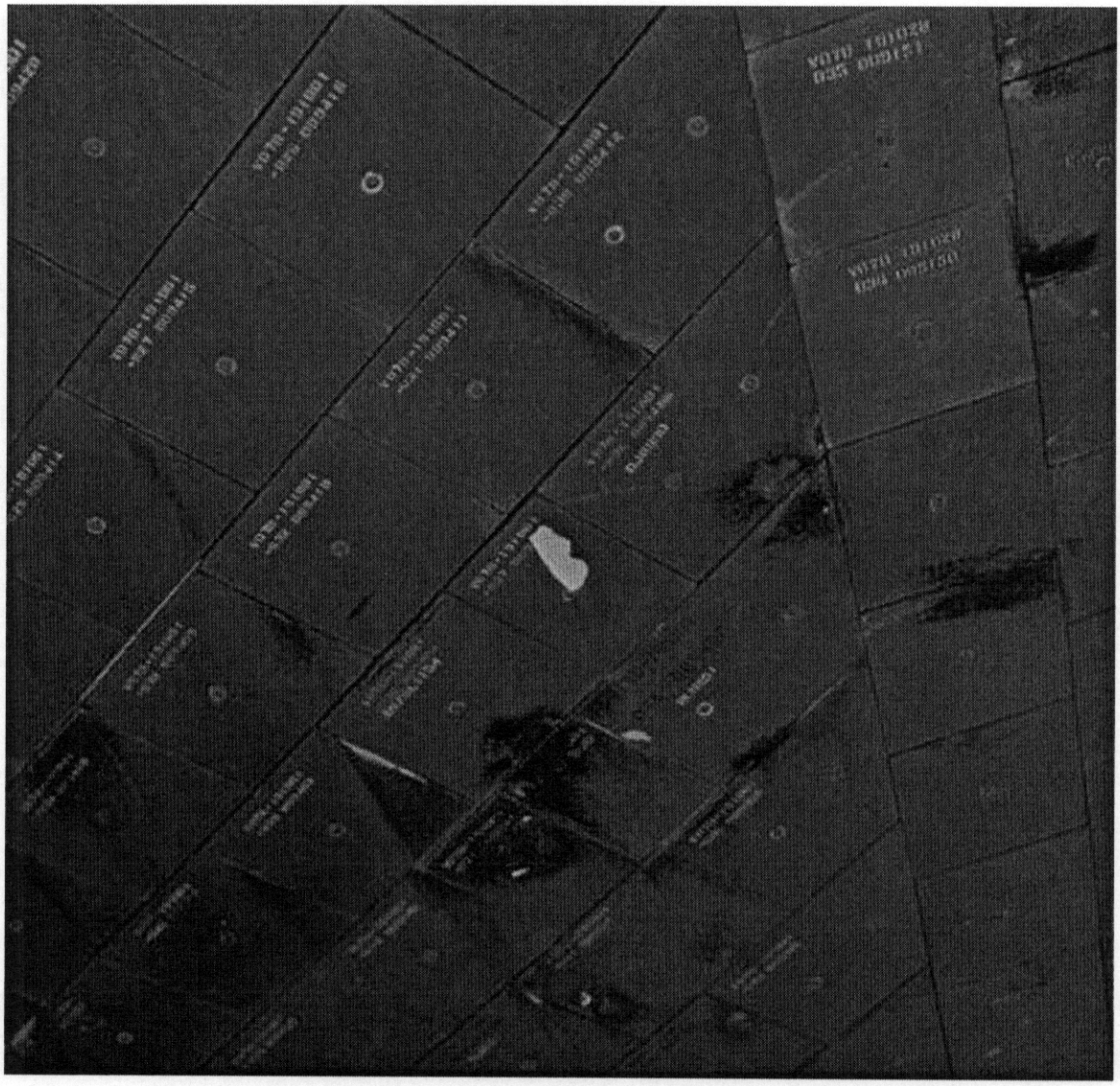

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Photo 6. Large Damage On the V070-191001-037 Tile

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5.1.2 Nose Landing Gear Door Area

(C. Snapp)

The overall condition of the nose landing gear door (NLGD) TPS was nominal. Several tiles on the NLGD had damages large enough to require the removal and replacement of the tiles. These damages were concentrated at the aft section of the left hand gear door. Approximately four other tiles were removed from the periphery of the NLGDs due to an out-of-tolerance roughness (Keq) condition (V070-391044-052, -054, -057, and V070-391042-047). Upon prefitting of the NC patterns for these tiles it was determined that four additional tiles would need to be removed to maintain step and gap conditions within limitations. The four additional tiles that were removed and replaced were V070-391025-051, -052, -053, and -054.

The NLGD thermal barriers were in average condition. Several barriers had frays and tears that required the removal and replacement of the thermal barriers (refer to table 10 for thermal barrier replacement history). Several other frays on the thermal barriers were repaired per standard repair procedures.

Several tiles around the periphery of the NLGD had large damages. The V070-391040-141 and -142 tiles on the forward of the NLGD had large corner damages that were within limitations for standard repair procedures (refer to photo 7 and photo 8).

The performance of the forward LESS components was also nominal. Refer to photo 9 for an overall view of the chin panel and nose cap area. The tadpole gap filler, which was a limited life repair to ramp out the step from the chin panel to the V070-399415-134 tile, experienced some shrinkage and was brittle post flight. Thermal evaluation determined that the tadpole gap filler is in nominal condition and still protects the lip of the V070-399415-134 tile. The compression-recession measurements at the outboard locations raised questions about internal flow to the structure. Engineering evaluation of the underlying structure showed no signs of overtemperature thus the chin panel installation will fly another flight with this step condition. Concern was raised over the black discoloration on the V070-399441 gap filler (refer to photo 10). This black discoloration was determined to be degraded RTV material and was previously MR accepted for unrestricted use based on thermal evaluation.

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Table 10. OV-105 NLGD Thermal Barrier Replacement History

BARRIER	POST-FLIGHT NUMBER									
	11	12	13	14	15	16	17	18	19	20
C1 - OML	P	NR	D	P	NR	NR				
C1 - PRIMARY	P	NR	NR	P	NR	NR				
C1 - SECONDARY	P	NR	NR	P	NR	NR				
C2 - OML	A	NR	B	NR	NR	D				
C2 - PRIMARY	A	NR	B	NR	D	NR				
C2 - SECONDARY	NR	B	NR	NR	NR	NR				
C3 - PRIMARY	X	NR	NR	NR	NR	NR				
C4 - OML	NR	NR	NR	NR	NR	NR				
C4 - PRIMARY	NR	NR	NR	NR	NR	NR				
C5 - OML	NR	D	NR	A	NR	NR				
R1 - OML	P	NR	D	P/D	A	NR				
R1 - PRIMARY	P	NR	NR	P	A	NR				
R1 - SECONDARY	P	NR	NR	P	A	NR				
R2 - OML	NR	NR	NR	P	A	NR				
R2 - PRIMARY	A	NR	NR	P	A	NR				
R2 - SECONDARY	A	NR	NR	P	A	NR				
R3 - OML	D	NR	NR	NR	NR	NR				
R3 - PRIMARY	NR	NR	D	NR	NR	NR				
R3 - SECONDARY	D	NR	NR	NR	NR	NR				
R4 - OML	D	NR	NR	NR	D	NR				
R4 - PRIMARY	NR	NR	NR	NR	NR	NR				
R4 - SECONDARY	D	D	NR	NR	NR	NR				
R5 - OML	NR	NR	D	NR	NR	NR				
R5 - PRIMARY	NR	NR	NR	NR	NR	NR				
R6 - OML	NR	NR	D	NR	A	NR				
R6 - PRIMARY	NR	NR	NR	NR	NR	NR				
L1-OML	P	NR	NR	P/D	A	NR				

(B) DEBOND
(D) DAMAGE
(G) DEGRADED
(P) CHIN PANEL SUPPORT
(A) ACCESS TO ADJACENT COMPONENT
NR - NO REPLACEMENTS TOOK PLACE

NOTE:
REFER TO FIGURE 12 FOR NLGD THERMAL BARRIER LOCATION REFERENCES.

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Table 10. OV-105 NLGD Thermal Barrier Replacement History (cont'd)

BARRIER	POST-FLIGHT NUMBER									
	11	12	13	14	15	16	17	18	19	20
L1 - PRIMARY	P	NR	NR	P	A	NR				
L1 - SECONDARY	P	NR	NR	P	A	NR				
L2 - OML	NR	NR	NR	P	A	D				
L2 - PRIMARY	A	NR	NR	P	A	NR				
L2 - SECONDARY	A	NR	NR	P	A	NR				
L3 - OML	NR	NR	NR	NR	NR	D				
L3 - PRIMARY	NR	NR	NR	NR	NR	NR				
L3 - SECONDARY	NR	NR	NR	NR	NR	NR				
L4 - OML	D	NR	NR	D	NR	D				
L4 - PRIMARY	NR	NR	NR	NR	NR	NR				
L4 - SECONDARY	NR	NR	NR	NR	NR	NR				
L5 - OML	D	NR	NR	NR	A	D				
L5 - PRIMARY	NR	NR	D	NR	NR	NR				
L6 - OML	NR	NR	D	NR	A	NR				
L6 - PRIMARY	NR	NR	NR	NR	NR	NR				

(B) DEBOND
(D) DAMAGE
(G) DEGRADED
(P) CHIN PANEL SUPPORT
(A) ACCESS TO ADJACENT COMPONENT
NR - NO REPLACEMENTS TOOK PLACE

NOTE:
REFER TO FIGURE 12 FOR NLGD THERMAL BARRIER LOCATION REFERENCES.

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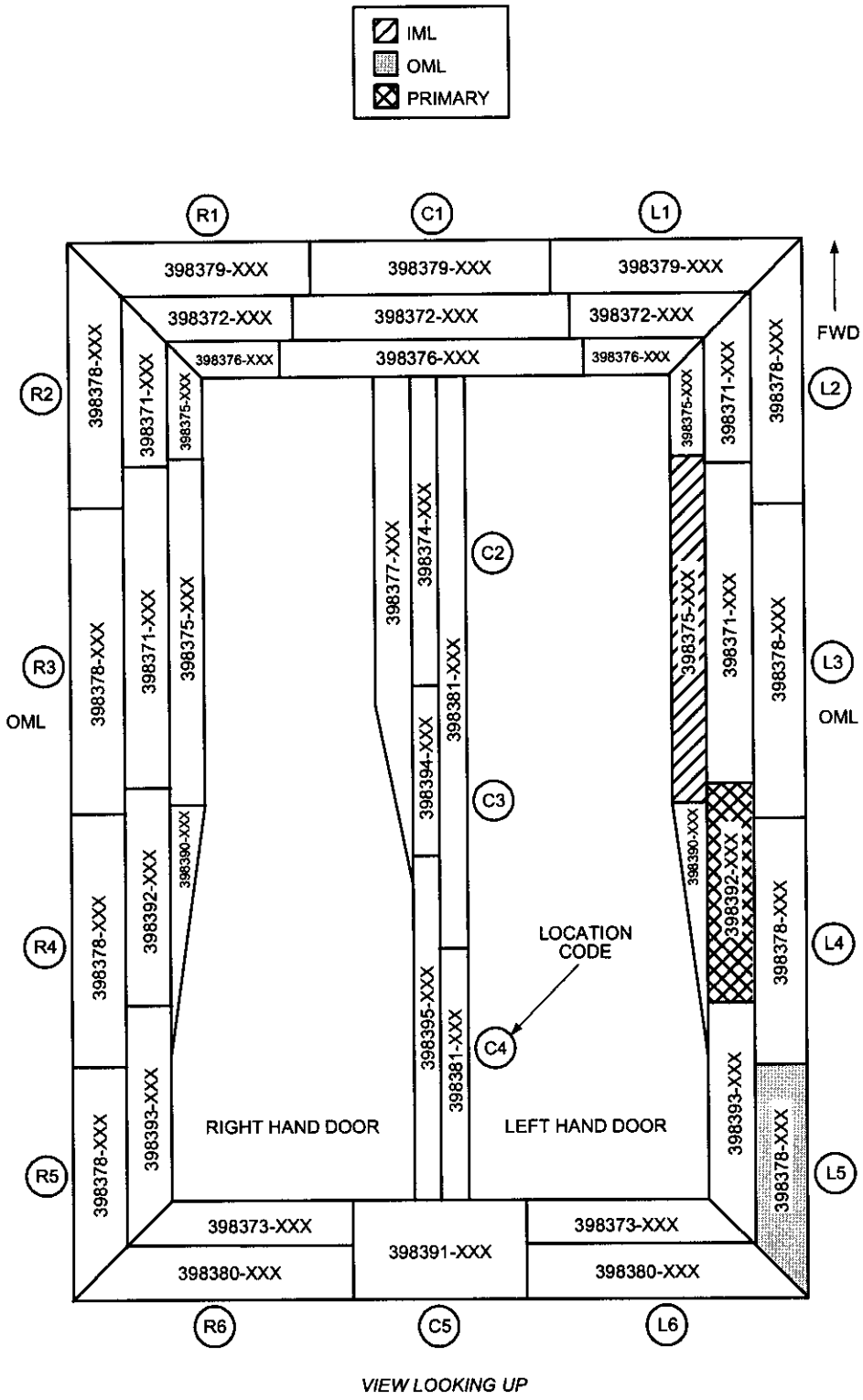

Figure 12. Nose Landing Gear Door Thermal Barrier Location References

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Photo 7. Damage to the V070-391040-141 Tile On the NLGD

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Photo 8. Damage to the V070-391040-142 Tile On the NLGD

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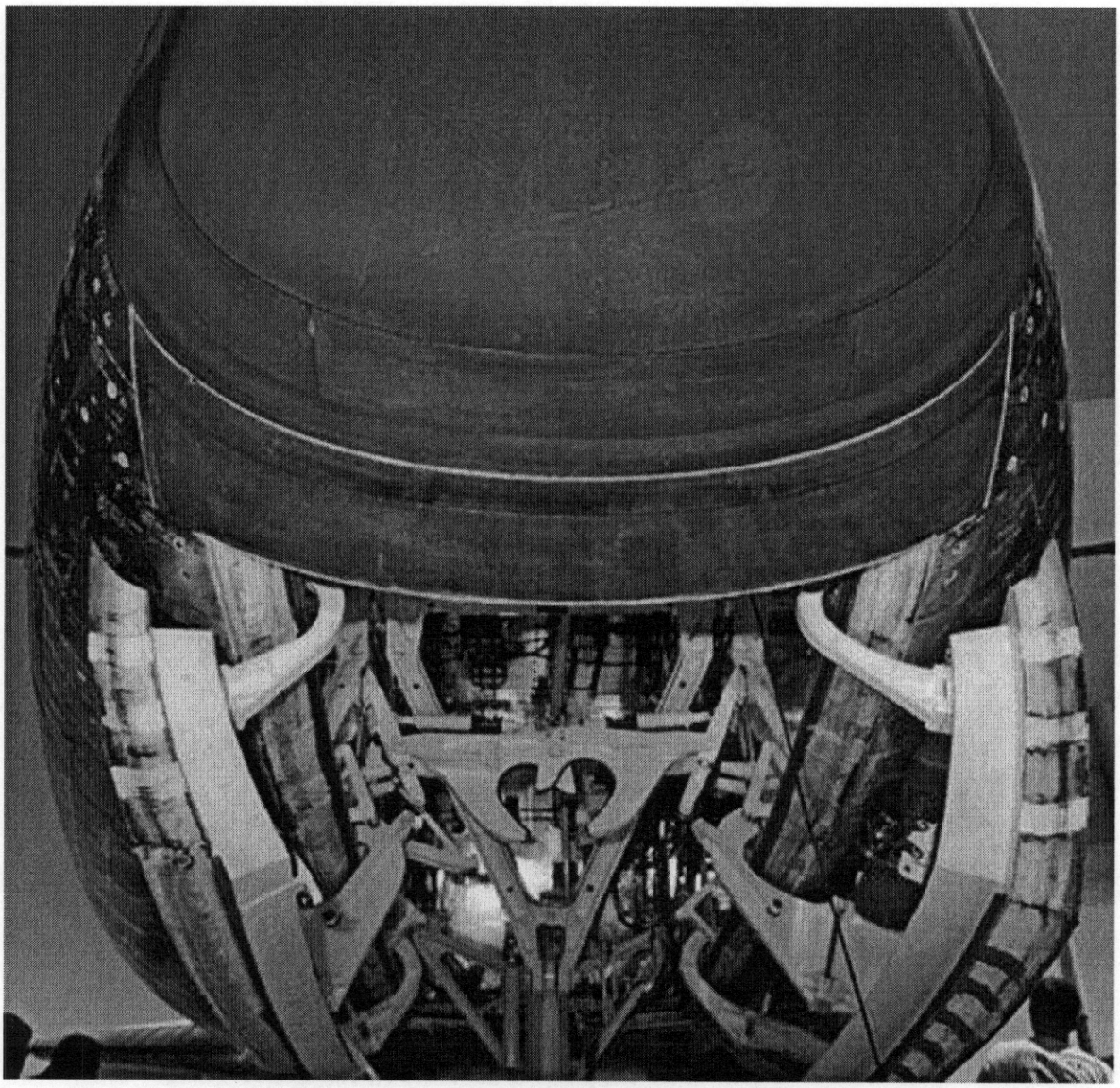

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Photo 9. RCC Nosecap-to-Chin Panel Interface, Overall View

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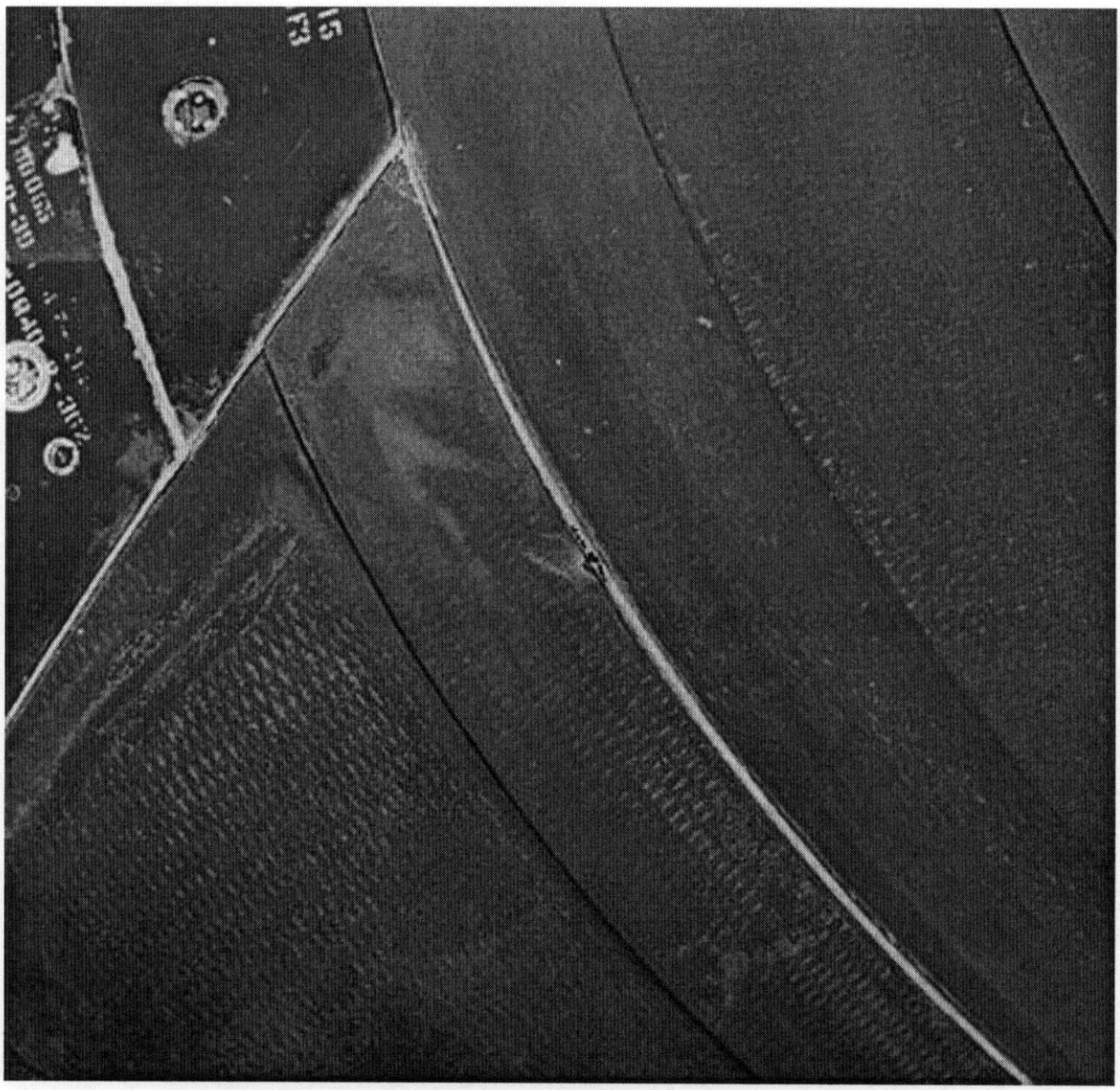

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Photo 10. Chin Panel V070-399441 Gap Filler Discoloration

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5.1.3 Main Landing Gear Door Area

(C. Snapp)

Several thermal barriers around the periphery of the main landing gear doors (MLGDs) had torn OML fabric that required the removal and the replacement of the damaged parts. Several additional thermal barriers were removed for access to the adjacent structure (refer to table 11 for the MLGD thermal barrier replacement history).

The largest lower surface tile damage site, located on the center line immediately forward of the main landing gear, measured 3 inches long by 1 inch wide by 0.5 inch deep, spanning two tiles. The damage was repaired per standard repair procedures. The V070-191104-046 tile was slumped on the right hand MLGD which was removed and replaced.

Table 11. OV-105 MLGD Thermal Barrier Replacement History

BARRIER	POST-FLIGHT NUMBER									
	11	12	13	14	15	16	17	18	19	20
L1	D	NR	NR	NR	D	D				
L2	NR	NR	NR	NR	NR	NR				
L3	NR	NR	NR	D	NR	D				
L4	NR	NR	NR	NR	D	D				
L5	D	NR	NR	NR	NR	D				
L6	NR	NR	NR	NR	NR	NR				
L7	NR	NR	NR	NR	NR	NR				
L8	NR	NR	NR	NR	NR	NR				
L9	NR	NR	NR	NR	NR	D				
L10	NR	NR	NR	NR	NR	NR				
L11	NR	NR	NR	D	NR	NR				
L12	NR	NR	NR	D	NR	NR				
L13	NR	NR	NR	D	NR	A				
L14	NR	NR	NR	D	NR	A				
L15	NR	NR	NR	NR	D	A				
L16	NR	NR	NR	NR	NR	NR				
L17	D	NR	NR	NR	NR	NR				
L18	D	NR	NR	NR	NR	NR				

(B) DEBOND
(D) DAMAGE
(G) DEGRADED
(A) ACCESS TO ADJACENT COMPONENT
NR - NO REPLACEMENTS TOOK PLACE

NOTE:
REFER TO FIGURE 13 AND FIGURE 14 FOR MLGD THERMAL BARRIER LOCATION REFERENCES.

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Table 11. OV-105 MLGD Thermal Barrier Replacement History (cont'd)

BARRIER	POST-FLIGHT NUMBER									
	11	12	13	14	15	16	17	18	19	20
L19	NR	NR	NR	D	NR	NR				
L20	NR	NR	NR	NR	NR	NR				
L21	NR	D	NR	NR	NR	D				
R1	NR	NR	NR	NR	D	D				
R2	NR	D	NR	NR	D	D				
R3	NR	NR	NR	NR	NR	NR				
R4	NR	NR	NR	NR	D	NR				
R5	NR	NR	NR	NR	D	NR				
R6	NR	NR	NR	NR	NR	NR				
R7	D	D	NR	NR	NR	NR				
R8	D	NR	NR	NR	NR	NR				
R9	D	NR	NR	NR	NR	NR				
R10	D	NR	NR	NR	NR	D				
R11	NR	NR	NR	NR	D	NR				
R12	D	NR	NR	NR	NR	NR				
R13	NR	NR	D	D	NR	D				
R14	NR	D	NR	NR	NR	D				
R15	D	NR	NR	D	D	NR				
R16	NR	NR	NR	NR	NR	NR				
R17	NR	NR	NR	NR	NR	NR				
R18	NR	NR	NR	NR	NR	NR				
R19	NR	NR	D	NR	NR	NR				
R20	NR	D	D	NR	D	NR				
R21	NR	NR	D	D	NR	NR				

(B) DEBOND
(D) DAMAGE
(G) DEGRADED
(A) ACCESS TO ADJACENT COMPONENT
NR - NO REPLACEMENTS TOOK PLACE

NOTE:
REFER TO FIGURE 13 AND FIGURE 14 FOR MLGD THERMAL BARRIER LOCATION REFERENCES.

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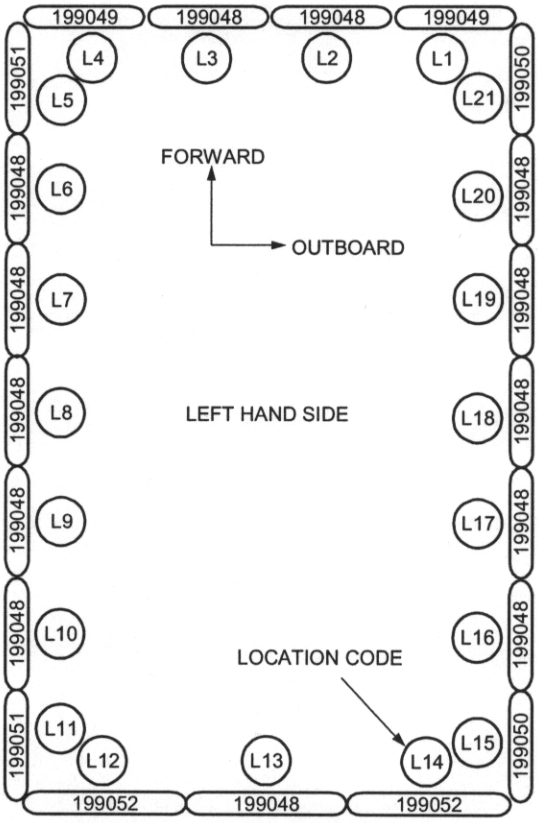

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Figure 13. Main Landing Gear Door Thermal Barrier Location References, Left Hand Side

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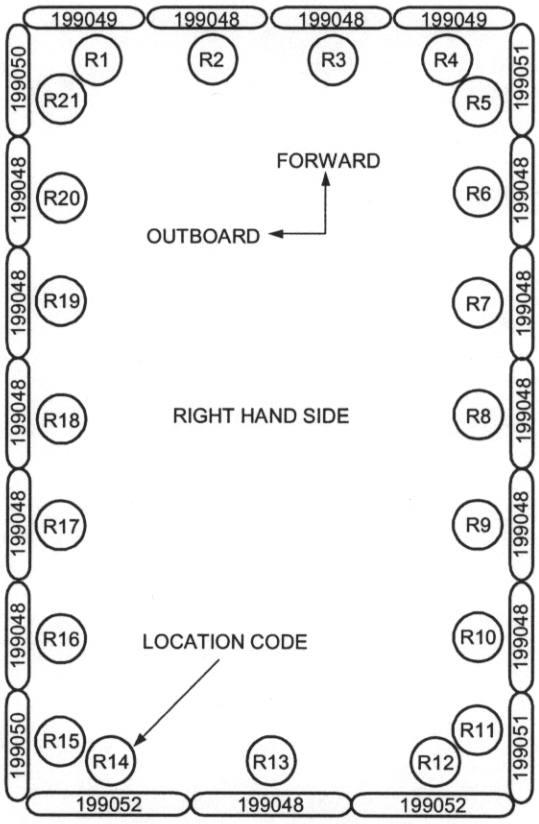

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Figure 14. Main Landing Gear Door Thermal Barrier Location References, Right Hand Side

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5.1.4 Reinforced Carbon-Carbon/Leading Edge Structural Subsystem

(M. Gordon/G. Grant)

In general, the leading edge structural subsystem (LESS) was in excellent post-flight condition with the major event being damage to the left wing tip reinforced carbon-carbon (RCC) that required a restricted field repair.

The second flight of the V070-399441 gap filler installation was within expectations with minimal change from the preflight measurements as depicted in figure 15. The measurements along the nose-chin interface follow a general trend that is well below the trends from previous flights. This condition was accepted for another flight and will continue to be monitored.

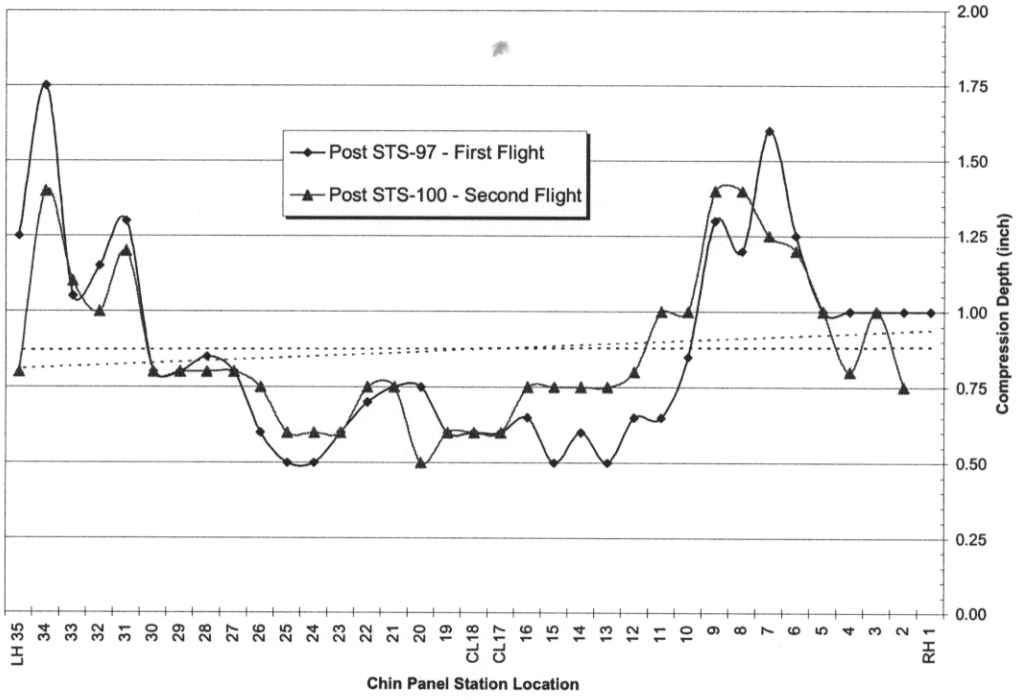

Figure 15. V070-399441 Gap Filler Compression Recession Measurements

The wing leading edge RCC panels and tees continue to perform within technical expectations with one damage to left hand panel 22. The noted damage measured 0.090 inch by 0.090 inch by 0.040 inch with exposed carbon and was located 13.9 inches from the upper edge and 1.4 inches from the slip-side gap. The damage dimensions and location were reviewed by the LESS PRT and was deemed acceptable for a ML0601-9026 procedure TPS-365 method A repair with flight-to-flight monitoring to be performed per TES-5-A0032. There was also a small chip on the trailing edge of left WLE rib splice number 3 that was repaired per ML0601-9026 procedure TPS-365 method A.

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STS-100 marked the sixth flight of both the 34AH001 forward and 28AH002 aft arrowhead plates. Both of these plates continue to perform without problems.

The lower LESS access carrier panel TPS installations were in reasonable post-flight condition. The engineering walkdown was performed to satisfy OMRSD inspections to verify the integrity of the interface. Several carrier panels were removed to help facilitate Structures engineering activity. A handful of locations had unacceptable (low) horsecollar gap filler compression and were reworked using the appropriate standard repair. A summary of carrier panel removal activity, which were all required to support structures rework or inspection, is included in table 12.

Table 12. LESS Carrier Panel Removal/Rework History

POST-STS	FLIGHT	LESS CARRIER PANEL NO.	DISCREPANCY	ACTION TAKEN
100	105/16	LH 1	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199700-061 ON LEADING EDGE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
		LH 9	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199716-048 ADJACENT TO WING SPAR).	INSTALL AMES GAP (TO INCREASE COMPRESSION) PER TPS-316.
		LH 14-18	REMOVED TO FACILITATE ACCESS FOR STRUCTURE WORK.	REMOVE CARRIER PANELS; VERIFY STRUCTURE WORK COMPLETE; REINSTALL CARRIER PANELS.
		RH 3	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199704-052 ADJACENT TO WING SPAR).	INSTALL AMES GAP (TO INCREASE COMPRESSION) PER TPS-316.
		RH 7-11, 17	REMOVED TO FACILITATE ACCESS FOR STRUCTURE WORK.	REMOVE CARRIER PANELS; VERIFY STRUCTURE WORK COMPLETE; REINSTALL CARRIER PANELS.

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5.1.5 External Tank Door Area

(C. Snapp)

The external tank door (ET) TPS showed only minor damage with mostly chips and small gouges. The area aft of the right hand ET door had a small area of damages that were repaired per standard repair procedures. Some damage sites around the LO_2 ET/ORB umbilical were most likely caused by portions of the umbilical purge barrier (baggie seal) flailing in the air stream and contacting adjacent tiles before the Mylar film separated and fell free from the vehicle.

The ET door soft goods performed nominally, with only minimal frayed areas on each side. Typical charring was seen on the thermal barriers (refer to photo 11). Purge barriers being trapped in the door during closure generally results in charring of the exposed Mylar baggie film due to reentry heating. The resulting trapped purge barrier did not cause any flow or overtemperature to the substrate. All the barriers were removed post-flight 16 due to installation of a redesigned thermal barrier for evaluation purposes. The current design barriers were installed for flight 17 of OV-105 after the test set of barriers were removed (refer to table 13 for ET door replacement history).

The right side ET door hinge thermal barrier, V070-398822-002, adjacent to the forward hinge had torn stitches and was protruding. (refer to photo 12). The barrier was removed and replaced.

The largest tile damage that occurred due to flight in the ET door area was the V070-395037-154 tile (refer to photo 13). Several additional tiles were damaged by the installation of the ferry flight door prior to ferry flight from Dryden. These were the V070-395055-175, -176, -177 tiles on the left side ET door. Due to the damage on these tiles a shop aid request was initiated to fabricate a cover to protect these periphery tiles during installation of the ET ferry flight door.

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Photo 11. ET Door Thermal Barrier Umbilical Purge Barrier Charring

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Table 13. OV-105 External Tank Door Replacement History

BARRIER	POST-FLIGHT NUMBER									
	11	12	13	14	15	16	17	18	19	20
L1	L	NR	D	L	A	T				
L2	L	NR	NR	L	NR	T				
L3	L	NR	NR	L	NR	T				
L4	L	NR	NR	L	NR	T				
L5	L	NR	NR	L	NR	T				
L6	L	NR	NR	L	NR	T				
L7	L	NR	NR	L	NR	T				
R1	L	NR	NR	L	NR	T				
R2	L	NR	NR	L	NR	T				
R3	L	NR	NR	L	A	T				
R4	L	NR	NR	L	A	T				
R5	L	NR	NR	L	NR	T				
R6	L	NR	NR	L	NR	T				
R7	L	NR	NR	L	NR	T				

(B) DEBOND
(D) DAMAGE
(G) DEGRADED
(L) 3 FLIGHT CYCLE LIMIT
(A) ACCESS TO ADJACENT COMPONENTS
(T) REPLACED DUE TO ENGINEERING EVALUATION OF TEST PARTS
NR - NO REPLACEMENTS TOOK PLACE

NOTE:
REFER TO FIGURE 16 FOR ETD THERMAL BARRIER LOCATION REFERENCES.

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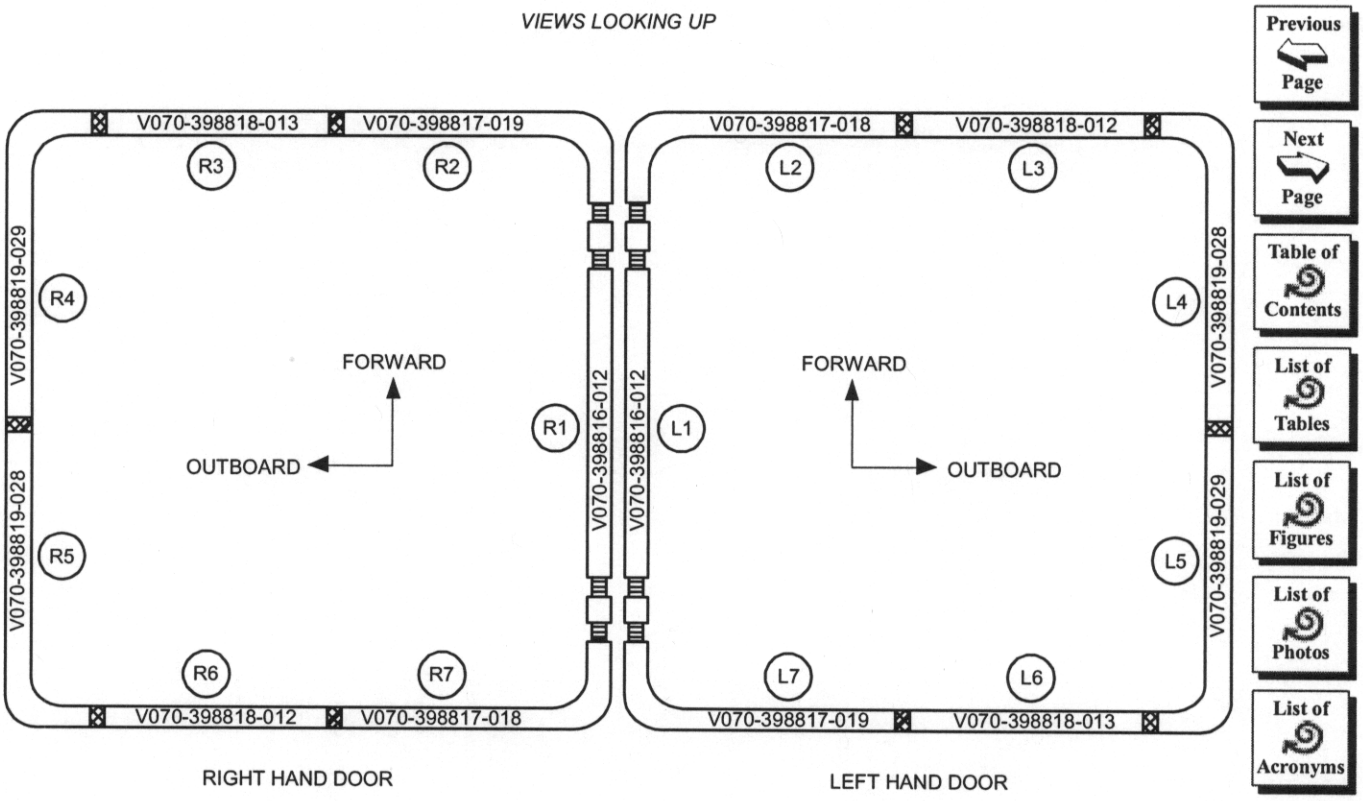

Figure 16. External Tank Thermal Barrier Location References

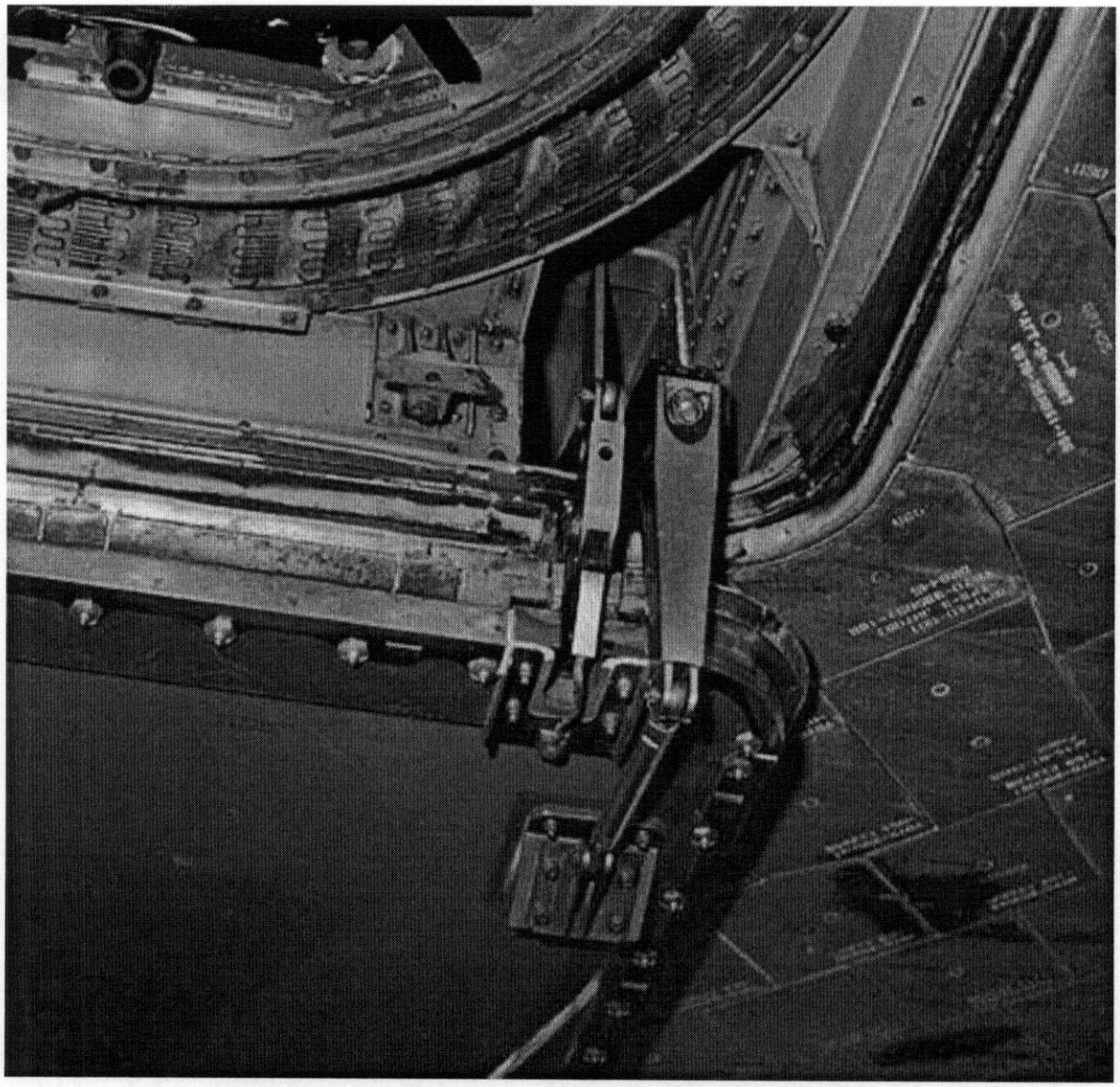

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Photo 12. ET Door Hinge Thermal Barrier Damage

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Photo 13. Damage to the V070-395037-154 Tile Adjacent to the ET Door

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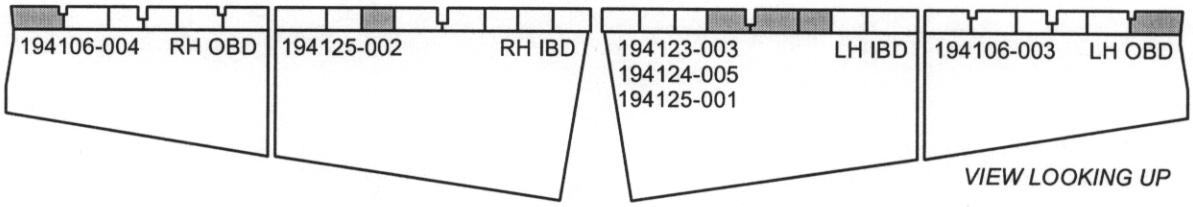
5.1.6 Elevon Area

(G. Grant)

The overall condition of the elevon cove was very good. Only two carrier panel removals were in support of TPS operations other than the OMRSD inspection requirements. One right hand elevon panel (V070-194125-002) was removed due to a gap filler that was reported to be scorched and contaminated. Due to the captive lip design of these gap fillers, left inboard carrier panel 194123-003 was removed to facilitate adequate inspection access at the discretion of Quality and Engineering personnel. Also, on the left inboard elevon, a couple of carrier panels were removed to allow Structures to repair their outer sealing system. A complete listing of elevon cove carrier panel removals and associated information is included in table 14 for historical purposes. No excessive damage was noted in the ablator areas on the outboard elevons. All reported conditions were routine with problems being addressed using standard repair processes. In summary, the performance of the TPS in all elevon areas (ablator, acreage, and cove) was very good.

Table 14. Summary of Lower Elevon Cove Carrier Panel Removal History



ELEVON	PANEL NUMBER	ASSOCIATED WAD	PART NUMBER (V070-)	REASON REMOVED	RESOLUTION
RH INBOARD	194125-002	RWNG-5-17-1383	V070-194141-090	GAP FILLER BETWEEN 193023-044/-046 TILES WAS SCORCHED AND CONTAMINATED	PANEL WAS REMOVED AND GAP FILLER WAS REPLACED
RH OUTBOARD	194106-004	V6059.004	NA	OMRSD INSPECTION	ROUTINE REFURBISHMENT; REINSTALLATION

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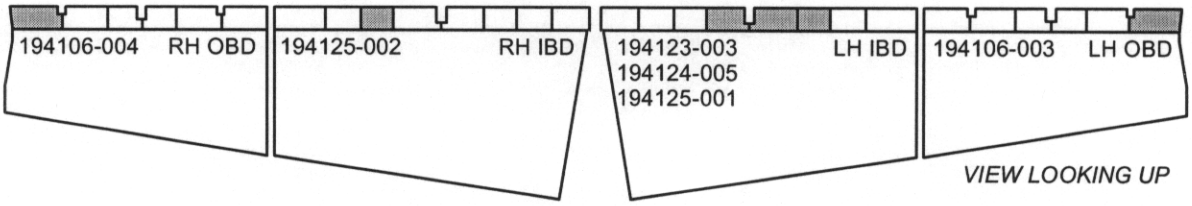
Table 14. Summary of Lower Elevon Cove Carrier Panel Removal History (cont'd)



ELEVON	PANEL NUMBER	ASSOCIATED WAD	PART NUMBER (V070-)	REASON REMOVED	RESOLUTION
LH INBOARD	194123-003	V6059.004	NA	QC/ENGINEERING CHOSE TO REMOVE PANEL TO EVALUATE POST-FLIGHT CONDITION DURING V09AK0.035	ROUTINE REFURBISHMENT; REINSTALLATION
	194124-005	V6059.004 & STR-5-17-3645	NA	INITIALLY REMOVED FOR SAME REASON AS 194123-003 CARRIER PANEL & AGAIN TO ALLOW ACCESS TO CORRECT STR-5-17-3645 (REFER TO 194125-001 ENTRY BELOW FOR PR DETAIL)	ROUTINE REFURBISHMENT; REINSTALLATION
	194125-001	STR-5-17-3645	V070-198050-017	ALLOW ACCESS TO EVALUATE/ADDRESS STR-5-17-3645. THIS PR WAS GENERATED DUE TO FAILED LEAK CHECK (HIGH FLOW RATE) ON OUTER SEALING SYSTEM (INBOARD ELEVON SECONDARY SEAL) OF LH INBOARD ELEVON.	ROUTINE REFURBISHMENT; REINSTALLATION
LH OUTBOARD	194106-003	V6059.004	NA	OMRSD INSPECTION	ROUTINE REFURBISHMENT; REINSTALLATION

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5.2 Upper Fuselage and Upper Wings

5.2.1 General

(C. Snapp)

Overall, the performance of the TPS on the upper surfaces was nominal. The amount of impacts was much higher than during previous flights. There were 48 impacts total, 8 of which were larger than 1 inch and all were concentrated in the window area. The largest area of damage occurred on the carrier panels adjacent to window number 4 (refer to photo 14). These damages resulted in the removal and replacement of three tiles (V070-390067-166, -172, and -174). Several other window carrier panel tile damages were large enough to require removal and replacement of the tiles (V070-390066-190 tile on window number 5, and the V070-390067-220 tile on window number 3).

There was a torn and protruding design gap filler on the right hand outboard elevon (refer to photo 15). The protruding portion of the gap filler (the OML sleeving) was trimmed for ferry flight from Dryden to KSC. The remainder of the gap filler was removed and replaced post ferry flight.

5.2.2 Forward Reaction Control System

(C. Snapp)

TPS on the FRCS experienced typical post-flight degradation and was in nominal post-flight condition. The V070-398300-002 thermal barrier (adjacent to thruster F2D) had a previous MR patch tear open approximately 2 inches in length. Removing and replacing the patch with a new MR patch repaired the thermal barrier. The MR patch was bonded to the outer fabric of the thermal barrier and then was stitched in line to adequately secure the patch. The V070-398308-001 thermal barrier (adjacent to thruster F5L) also had a patch with loose stitches that was replaced per detailed steps. Upon landing at Dryden the V070-391134-048 FI blanket had a previously installed patch blown loose (refer to photo 16). The patch was repaired per standard repair procedures. Thermal barriers around the periphery of the FRCS exhibited typical post-flight degradation of the black RTV coating. This coating was reworked per standard repair procedures.

Various other minor anomalies such as broken ceramic plugs and missing putty-type repairs were also detected on FRCS TPS components. Several blankets and thermal barriers had minor frays and tears which were repaired per standard repair procedures.

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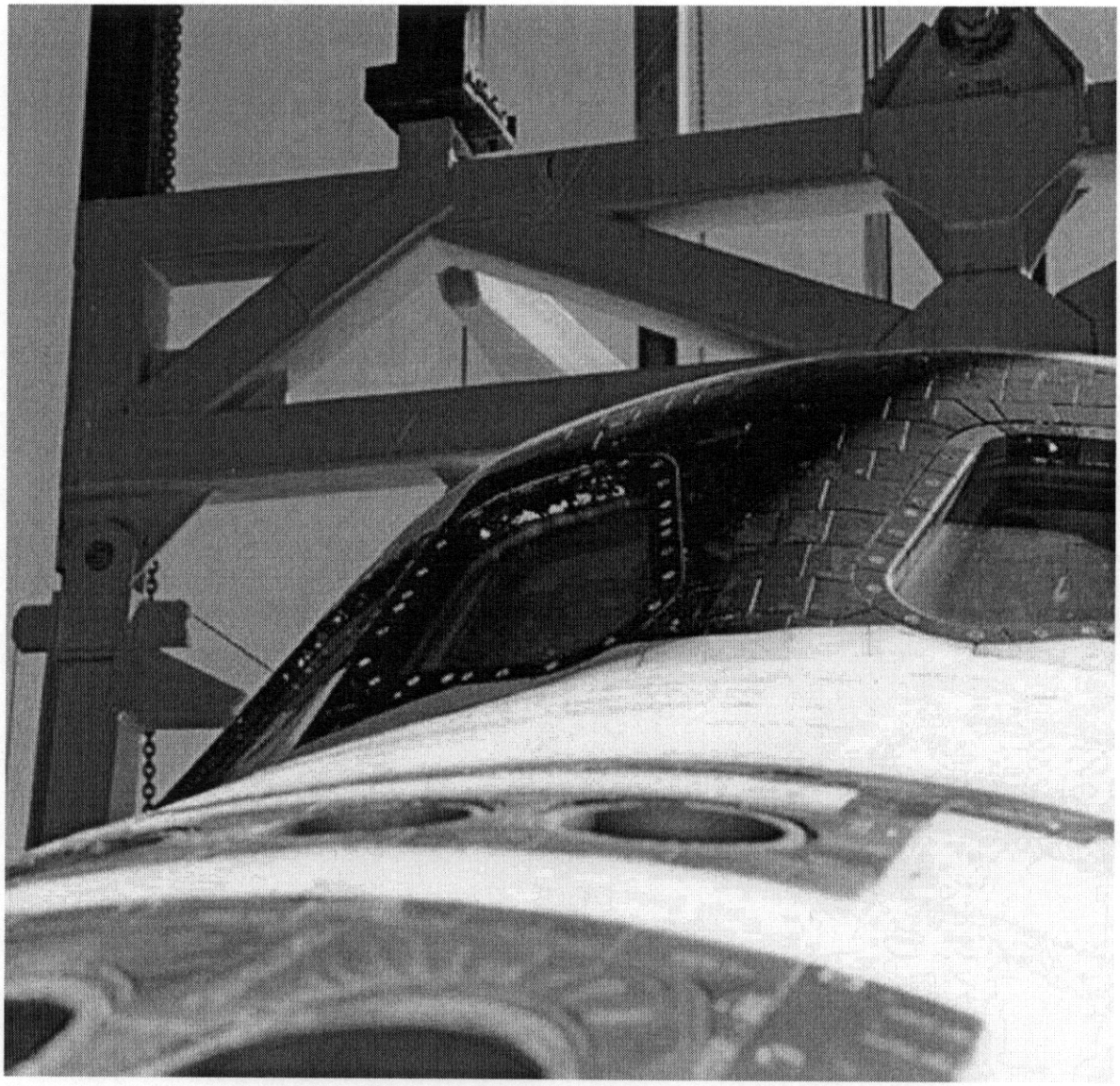

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Photo 14. Window Number 4 Carrier Panel Tile Damages

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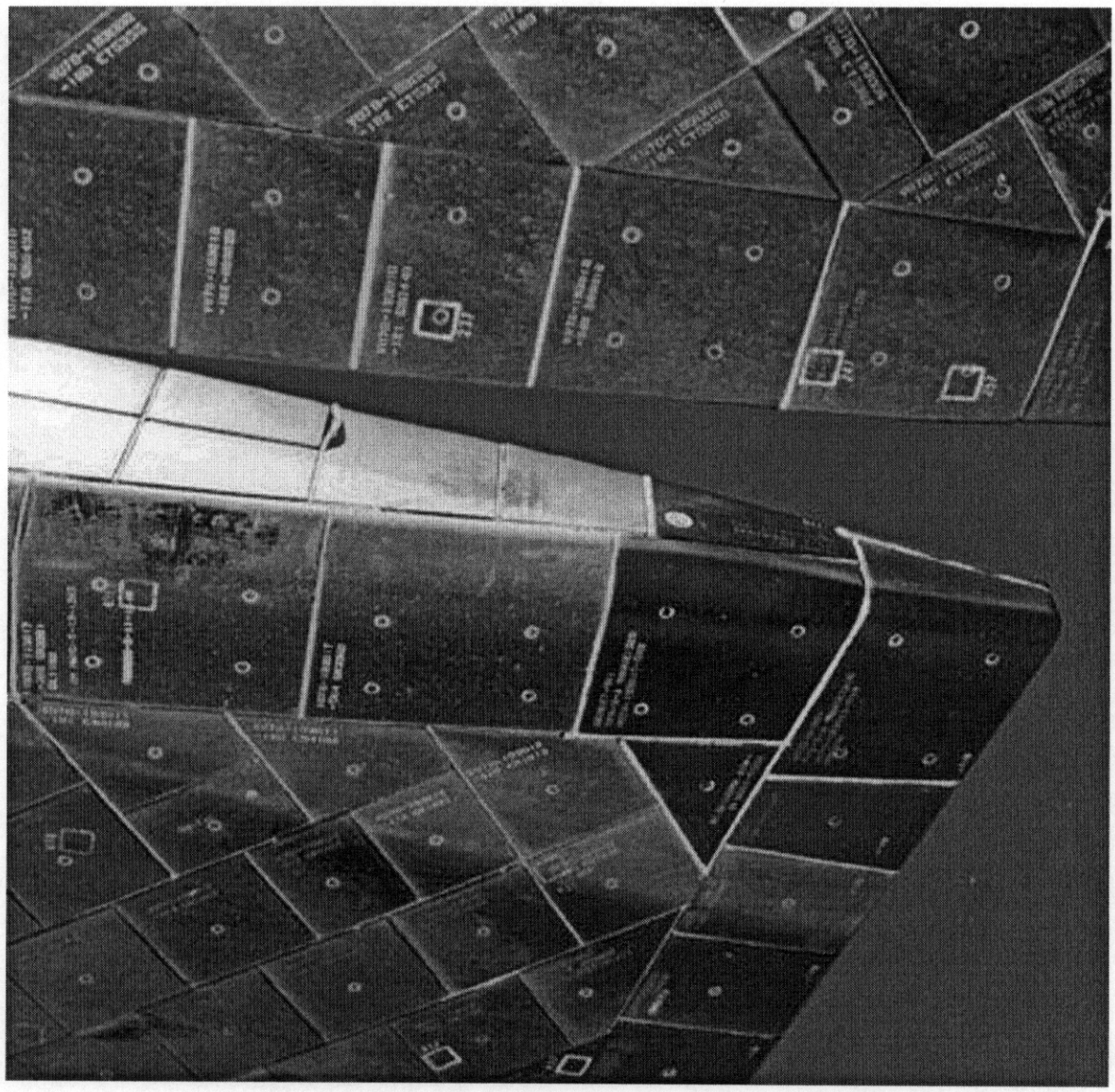

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Photo 15. Protruding Gap Filler Sleeving On Right Hand Outboard Elevon

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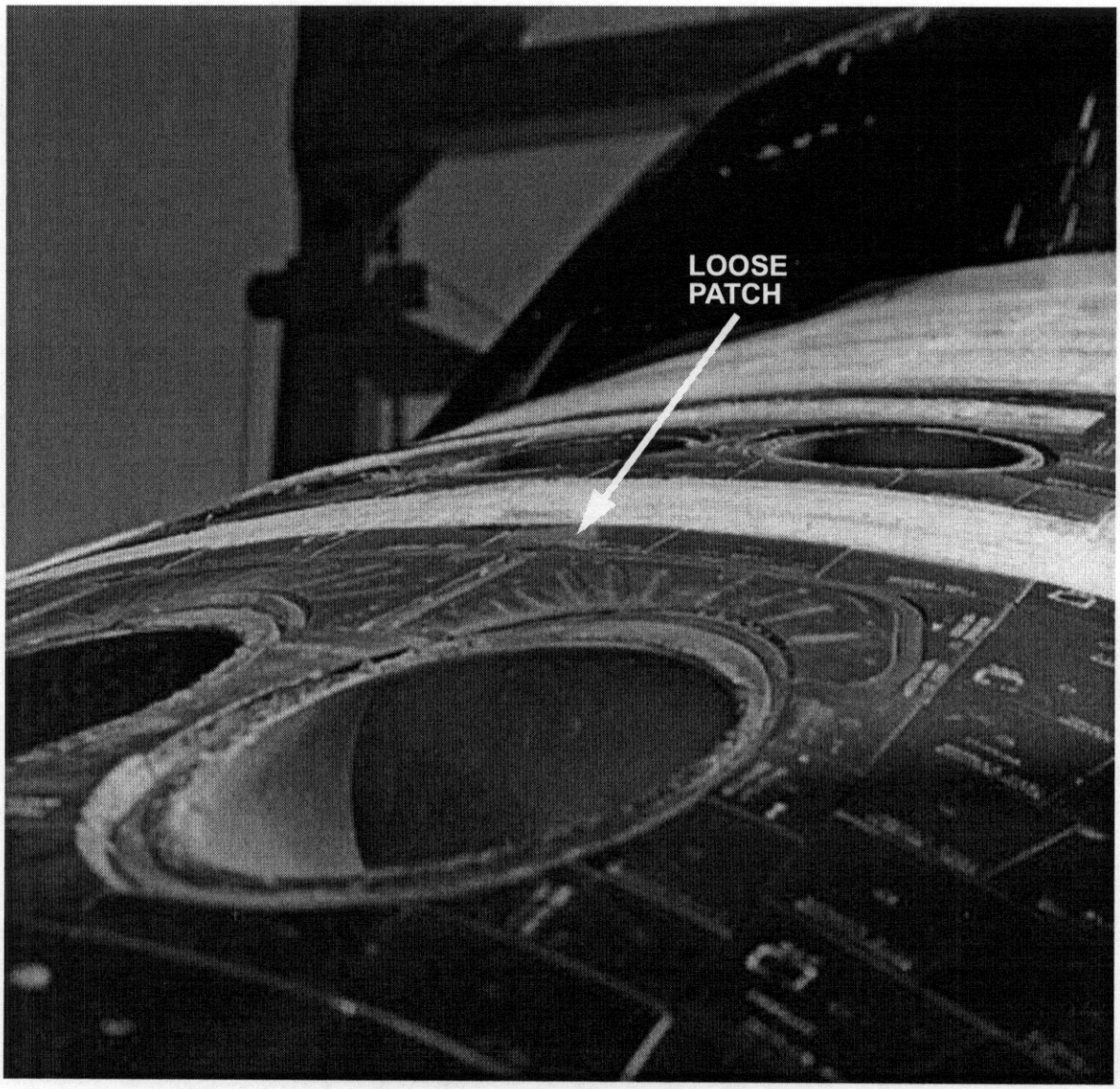

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Photo 16. Torn Blanket Patch On FRCS

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5.2.3 Windows

(E. Marchitti)

Post-flight inspections revealed a total of 65 flight-related damages spread over 5 orbiter windows as a result of the STS-100 mission. Impact flaws detected on the crew hatch (W11, 6 impacts) thermal pane were sufficiently deep to require window removal. New flight damages were also detected on the left hand side (W1, 2 impacts), left hand forward (W3, 8 impacts), right hand forward (W4, 27 impacts) and right hand middle (W5, 22 impacts) thermal panes. All impact flaws to these windows were shown by Stress analysis to be acceptable for unrestricted use. After the STS-100 mission, the left hand middle (W2) window reached its eight flight hazing limit and will be replaced as required by the OMRSD. A complete OV-105 window flight damage history is shown in table 15.

Table 15. OV-105 Window Flight Damage History

POST-STS	FLIGHT	DATE	WINDOW NUMBER	DAMAGE	DISPOSITION
49	105/1	05/92	1 2	PIT 2 PITS	SCRAP ACCEPTABLE
47	105/2	09/92	2 5 6 7	PIT PIT 2 PITS PIT	ACCEPTABLE SCRAP SCRAP SCRAP
54	105/3	01/93	4 5	PIT PIT	ACCEPTABLE ACCEPTABLE
57	105/4	06/93	9	PIT	ACCEPTABLE
61	105/5	12/93	2 3 4 5 6 8 9	2 PITS 2 PITS 7 PITS 3 PITS PIT PIT PIT	ACCEPTABLE ACCEPTABLE ACCEPTABLE SCRAP SCRAP SCRAP ACCEPTABLE
59	105/6	04/94	2 6 11	4 PITS PIT PIT/BRUISE	ACCEPTABLE SCRAP SCRAP
68	105/7	10/94	2 3 4 6	5 PITS PIT 6 PITS PIT	ACCEPTABLE ACCEPTABLE ACCEPTABLE SCRAP
67	105/8	03/95	1 2 3 4 11	2 PITS BRUISE 3 PITS 14 PITS BRUISE	SCRAP SCRAP ACCEPTABLE/ REMOVE SCRAP SCRAP

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Table 15. OV-105 Window Flight Damage History (cont'd)

POST-STS	FLIGHT	DATE	WINDOW NUMBER	DAMAGE	DISPOSITION
69	105/9	09/95	1	2 PITS	SCRAP
			2	PIT	ACCEPTABLE
			5	4 PITS	ACCEPTABLE
			6	2 PITS	SCRAP
72	105/10	01/96	NA	NONE	NA
77	105/11	05/96	1	2 PITS	REMOVE
			3	5 PITS	ACCEPTABLE
			4	3 PITS	ACCEPTABLE
			5	1 PIT	ACCEPTABLE
			6	2 PITS	REMOVE
89	105/12	01/98	1	PIT	SCRAP
			2	64 PITS	ACCEPTABLE
			3	BRUISE	SCRAP
			4	124 PITS/BRUISE	SCRAP
			5	84 PITS	ACCEPTABLE
			7	2 PITS	ACCEPTABLE
			8	PIT	REMOVE
88	105/13	12/98	2	5 PITS	ACCEPTABLE
			3	PIT	ACCEPTABLE
			4	2 PITS	ACCEPTABLE
			6	PIT	SCRAP
			7	2 PITS	REMOVE
			8	PIT	SCRAP
99	105/14	02/00	1	3 PITS	REMOVE
			2	15 PITS	ACCEPTABLE
			4	19 PITS	ACCEPTABLE
			5	6 PITS	ACCEPTABLE
			7	2 PITS	SCRAP
			8	1 PIT	REMOVE
			10	1 PIT	ACCEPTABLE
97	105/15	11/00	1	3 PITS	SCRAP
			2	8 PITS	ACCEPTABLE
			3	PIT	ACCEPTABLE
			4	23 PITS	ACCEPTABLE
			5	10 PITS	ACCEPTABLE
			6	PIT	SCRAP
100	105/16	04/01	1	2 PITS	ACCEPTABLE
			2	8 FLIGHTS/HAZE	REMOVE
			3	8 PITS	ACCEPTABLE
			4	27 PITS	ACCEPTABLE
			5	22 PITS	ACCEPTABLE
			11	6 PITS	REMOVE

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5.2.4 Upper Midfuselage/Payload Bay Doors

(C. Snapp)

The TPS on the midfuselage sidewall and payload bay door (PLBD) acreage was in excellent condition. The blanket area around the number 45 door had several large damage areas that were incurred during removal of the carrier panels. This resulted in the removal and replacement of six blankets and the installation of a blanket plug on two blankets. The blankets that were removed and replaced were V070-394066-068 and V070-364068-014, -015, -020, -021, and -025. The blankets that had plugs installed per standard repair procedures were V070-364066-028 and -026. Other discrepancies noted included FI blanket frays, tears adjacent to and on carrier panel blankets, and degraded edge members. The FI blanket damages were repaired per standard repair procedures. Several FI blankets and FRSI debonds and voids were detected, mostly on carrier panels. The debonds and voids were also repairable by rebonding per standard repair procedures.

Prior to flight 16 there was an out-of-tolerance gap noted from the V070-397516-120 blanket to the adjacent carrier panel while on the launch pad. Due to limited access to the area at the pad, the edge member was reworked per standard repair procedures on the carrier panel to fill the gap as a one flight restricted repair. Post-flight 16 the carrier panel was removed and the gap condition was corrected by installing a new edge member.

The TPS on the PLBD hinges was also in better than typical post-flight condition. Inspection of the PLBD hinge area TPS, performed per OMI V6049.009, revealed 18 areas of scraped and missing MB0125-063 Pyromark coating. There were two locations of filler bar erosions and minimal adjacent tile damages. All Pyromark coating anomalies were technically evaluated and subsequently repaired with application of pyromark coating per standard repair procedures. All adjacent tile damages and filler bar erosions were within standard repair procedure limitations. Refer to table 16 for a complete inspection summary.

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Table 16. Payload Bay Door Hinge Cover Inspection Summary

HINGE NUMBER	PISTON GAP (INCHES)	BOUND PISTON	ADDITIONAL DISCREPANCIES (REFER TO FIGURE 17 FOR DISCREPANCY LOCATIONS)
LEFT HAND #1 Xo 602.300	FORWARD: 0.000 CONST AFT: 0.020 TO 0.030	N N	* SCRAPING IN PYROMARK 1.2" x 0.5" (LOC B) * SCRAPING IN PYROMARK 1.8" x 2.0" (LOC C) * FILLER BAR EROSION 0.4" x 0.15" (LOC 1) * FILLER BAR EROSION 0.5" x 0.20" (LOC 8)
LEFT HAND #2 Xo 669.800	FORWARD: 0.000 TO 0.010 AFT: 0.000 CONST	N Y	* SCRAPING IN PYROMARK 2.0" x 1.5" (LOC A) * SCRAPING IN PYROMARK 2.0" x 0.5" (LOC C)
LEFT HAND #3 Xo 737.300	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* SCRAPING IN PYROMARK 1.0" x 2.0" (LOC B) * SCRAPING IN PYROMARK 2.5" x 2.0" (LOC C)
LEFT HAND #4 Xo 783.550	FORWARD: 0.000 CONST AFT: 0.000 TO 0.005	N N	* SCRAPING IN PYROMARK 1.0" x 0.5" (LOC A) * SCRAPING IN PYROMARK 1.0" x 1.0" (LOC B) * SCRAPING IN PYROMARK 2.0" x 0.4" (LOC C)
LEFT HAND #5 Xo 850.600	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* SCRAPING IN PYROMARK 1.3" x 0.4" (LOC A) * SCRAPING IN PYROMARK 1.0" x 0.3" (LOC B)
LEFT HAND #6 Xo 917.650	FORWARD: 0.000 CONST AFT: 0.000 TO 0.010	N N	* NO DISCREPANCIES TO REPORT
LEFT HAND #7 Xo 966.350	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #8 Xo 1033.400	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #9 Xo 1100.450	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #10 Xo 1144.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #11 Xo 1204.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #12 Xo 1264.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
LEFT HAND #13 Xo 1297.000	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT

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Table 16. Payload Bay Door Hinge Cover Inspection Summary (cont'd)

HINGE NUMBER	PISTON GAP (INCHES)	BOUND PISTON	ADDITIONAL DISCREPANCIES (REFER TO FIGURE 17 FOR DISCREPANCY LOCATIONS)
RIGHT HAND #1 Xo 602.300	FORWARD: 0.000 TO 0.010 AFT: 0.010 TO 0.020	N N	* SCRAPING IN PYROMARK 2.0" x 1.6" (LOC A) * SCRAPING IN PYROMARK 2.0" x 0.8" (LOC B) * SCRAPING IN PYROMARK 2.0" x 1.5 (LOC C)
RIGHT HAND #2 Xo 669.800	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* SCRAPING IN PYROMARK 2.7" x 1.3" (LOC A) * SCRAPING IN PYROMARK 1.0" x 1.0" (LOC B) * SCRAPING IN PYROMARK 2.8" x 1.0" (LOC C)
RIGHT HAND #3 Xo 737.300	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* NO DISCREPANCIES TO REPORT
RIGHT HAND #4 Xo 783.550	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* NO DISCREPANCIES TO REPORT
RIGHT HAND #5 Xo 850.600	FORWARD: 0.000 CONST AFT: 0.000 TO 0.005	N N	* SCRAPING IN PYROMARK 1.0" x 1.0" (LOC B)
RIGHT HAND #6 Xo 917.650	FORWARD: 0.000 CONST AFT: 0.000 CONST	N N	* NO DISCREPANCIES TO REPORT
RIGHT HAND #7 Xo 966.350	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #8 Xo 1033.400	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #9 Xo 1100.450	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #10 Xo 1144.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #11 Xo 1204.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #12 Xo 1264.200	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT
RIGHT HAND #13 Xo 1297.000	FORWARD: NA AFT: NA	NA NA	* NO DISCREPANCIES TO REPORT

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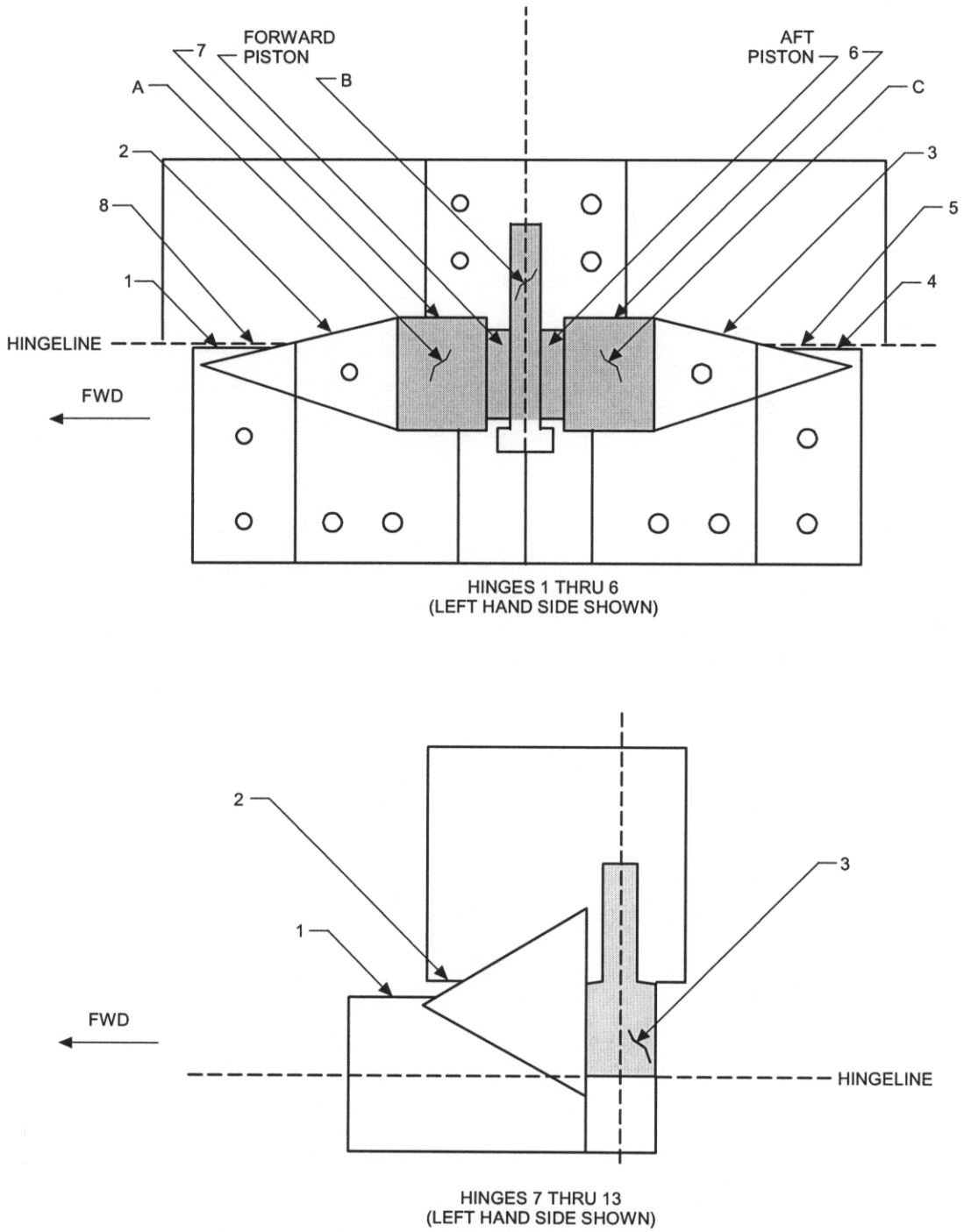

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Figure 17. Payload Bay Door Hinge Cover

5.3 Aft Fuselage

5.3.1 General

(C. Snapp)

The TPS located on the aft fuselage was in nominal condition post-flight 16. The 9-pound tiles on the engine ring domes and base heat shield had typical peppering. The AETB-8/TUFI tiles remained relatively undamaged in the "shotgun blast" area of the base heat shield. All damages were within criteria suitable for repairs per standard procedures.

5.3.2 Base Heat Shield

(X. Dominguez)

TPS on the base heat shield was in nominal post-flight condition. The SSME dome mounted heat shield blankets were all in nominal condition with only one anomaly that occurred at the 10 o'clock position of engine number 3 (refer to photo 17). The blanket was removed and replaced post flight. No obvious defects were present on the AETB-8/TUFI tiles located between engine numbers 1, 2 and 3; typically referred to as the "shotgun blast area". Typical peppering occurred on the dome heat shield tiles and was repairable per standard repair procedures.

5.3.3 Upper Body Flap

(X. Dominguez)

Overall the TPS on the upper body flap performed satisfactorily compared to previous flights. The RTV located on the upper body flap in the thruster impingement area was showing signs of degradation (refer to photo 18). The RTV degradation is acceptable per ML0601-0002. The AETB-8/TUFI tiles that have replaced several of the RTV coated tiles continue to exhibit good impact resistance. Several of the upper body flap cove carrier panels were damaged by the typical "peppering" that occurs in this area (refer to photo 19). All the damages detected were minor and were reworked per standard repair procedures.

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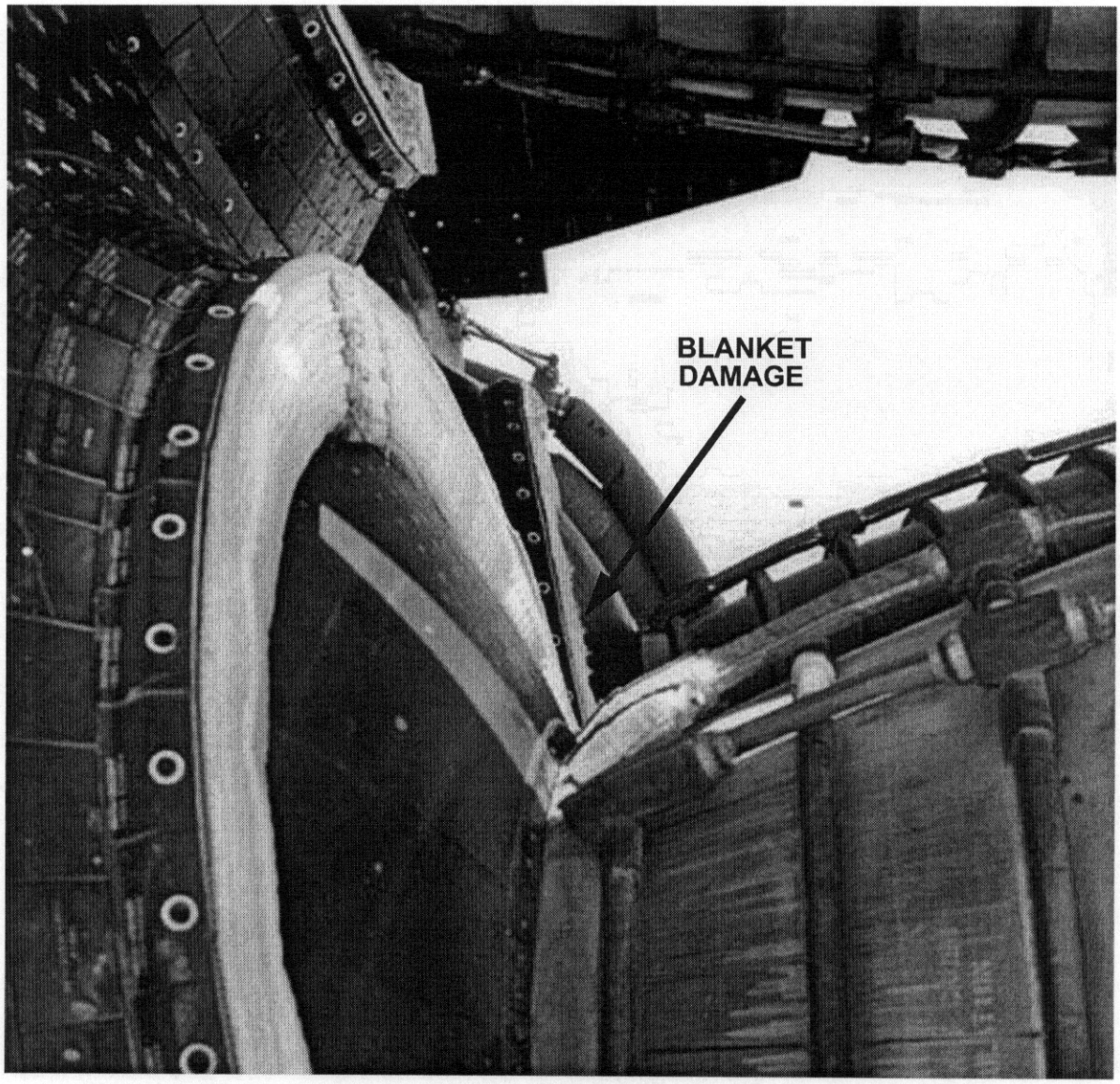

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Photo 17. Aft Base Heat Shield Blanket Damage

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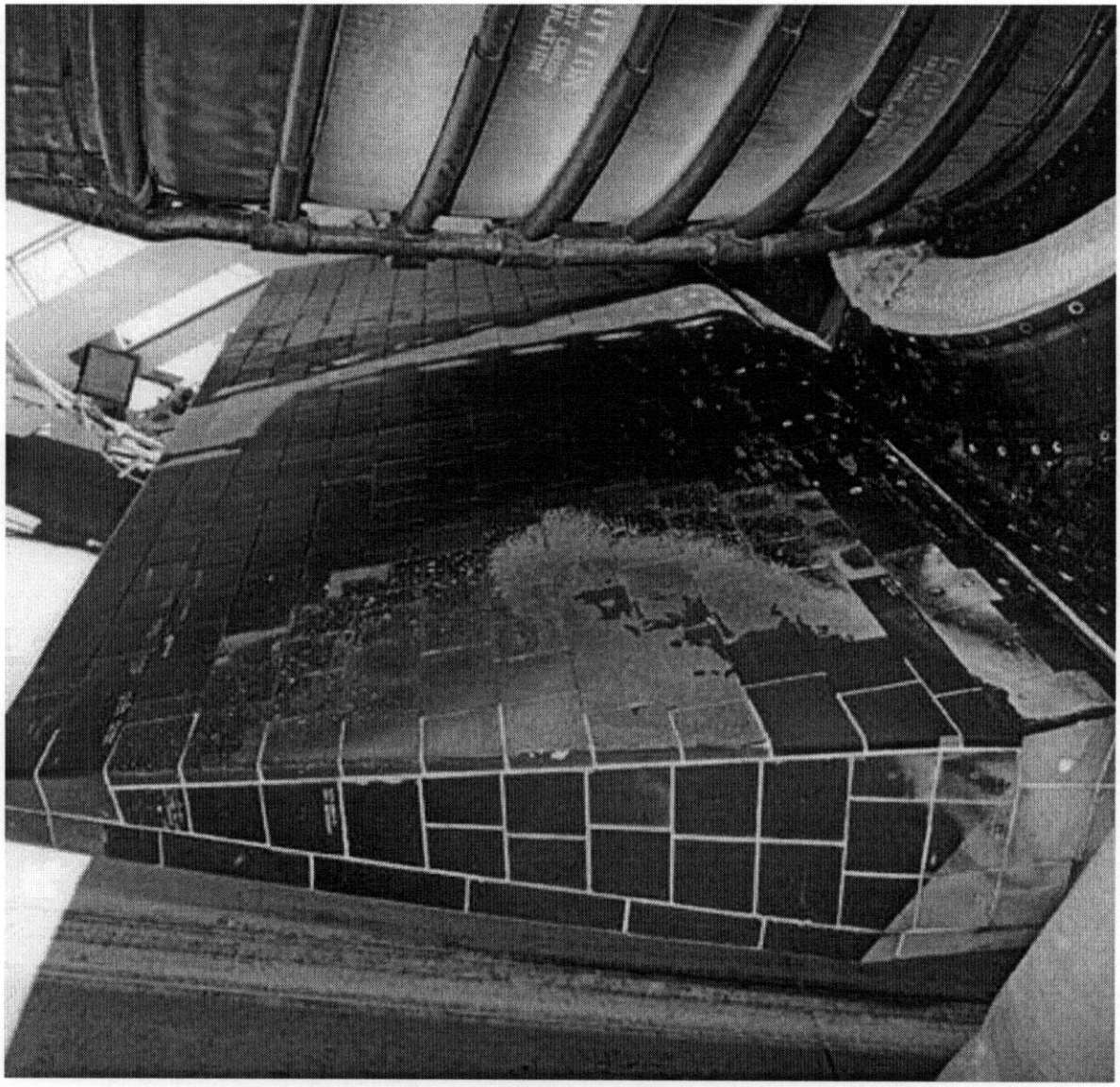

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Photo 18. Degraded RTV On Upper Body Flap

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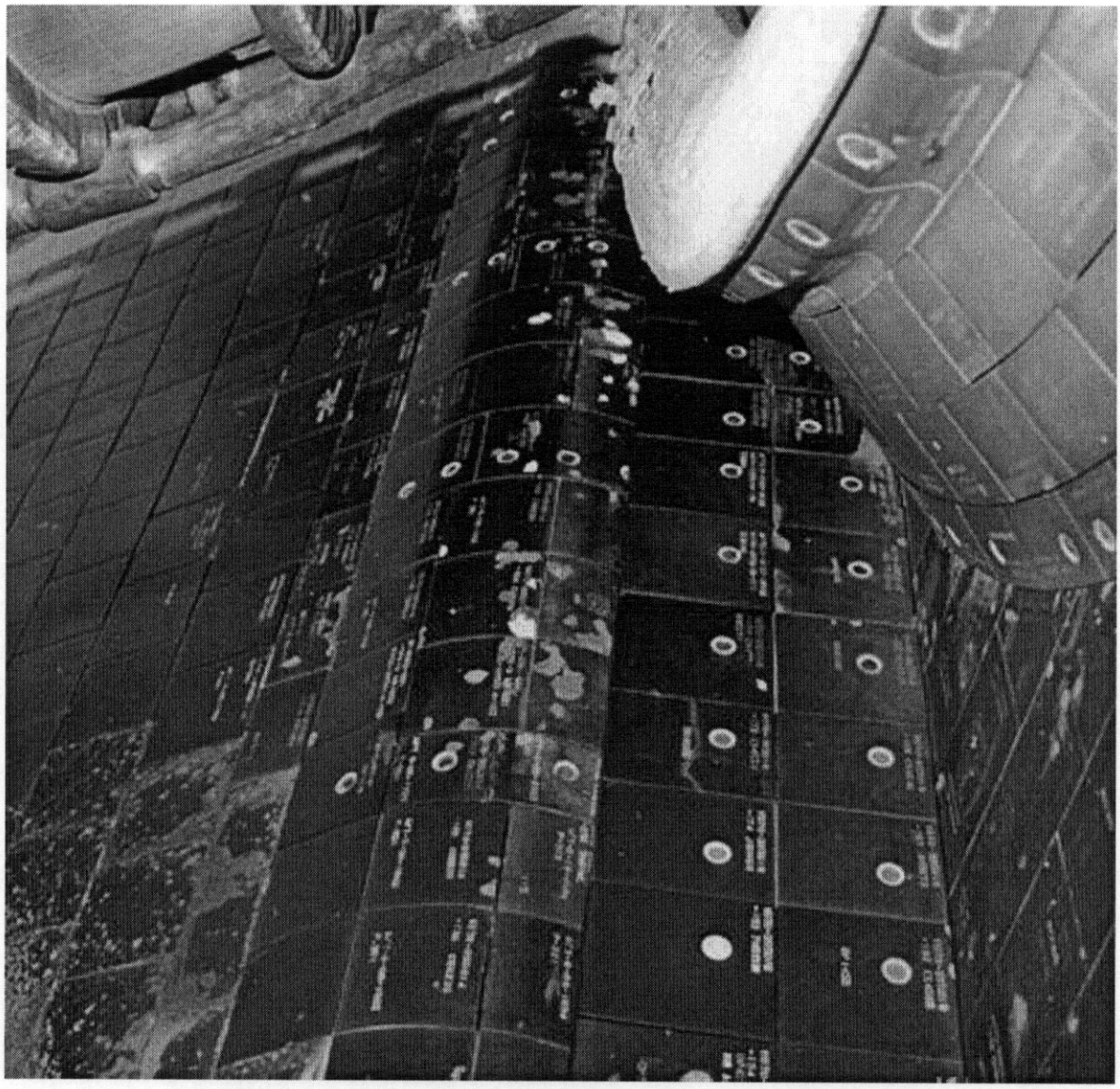

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Photo 19. Peppering Of Upper Body Flap Cove Carrier Panels

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5.3.4 Vertical Stabilizer and Rudder/Speed Brake

(C. Snapp)

TPS on the vertical stabilizer and rudder/speed brake was in nominal post-flight condition. Several additional blankets had minor tears/frays and edge debonds all of which were within standard repair criteria. The V070-298141-002 Macor support for the rudder/speed brake split line thermal barrier was broken and missing a section the entire length of the Macor. The Macor support and the adjacent split line thermal barrier were removed and replaced. Upon installation of the Macor support it had a step to the adjacent tile with SIP exposed. The Macor was shaved 0.100 inch per MR to eliminate the step to the adjacent tile and to keep the underlying SIP from becoming charred. The largest tile damage was to the V070-293021-102 tile that had dimensions of 2 inches by 1 inch by 0.2 inch (refer to photo 20). The tile was slurried prior to ferry flight and repaired per standard procedures post ferry flight. Several additional tiles had also sustained minor damages. All damages were within suitable criteria for standard repair procedures.

5.3.5 OMS Pods

(X. Dominguez)

The TPS on both OMS pods performed satisfactorily compared to previous flights with the exception of minor damages to the tiles and FI blankets. The damage was most likely the result of impact during liftoff. The damages were repaired per standard procedures.

During liftoff a possible flexing of the OMS pod tiles was noted in the launch videos on the left hand OMS pod (refer to photo 21). Post flight, it was determined that three tiles would be removed for an engineering evaluation. The V070-396366-021, -031, and -034 tiles were removed for the evaluation per the hot wire method to prevent damaging the tiles. Each removed tile and adjacent tiles were inspected for in-plane cracking or chatter damage that would have been a result of the suspected flexing of the OMS pod. Engineering evaluation found no evidence of damage to any TPS in the area that the OMS pod flexing occurred. Structures is conducting an engineering evaluation to determine if there was any damage to the underlying structure due to the suspected flexing. The tiles were replaced with new tiles.

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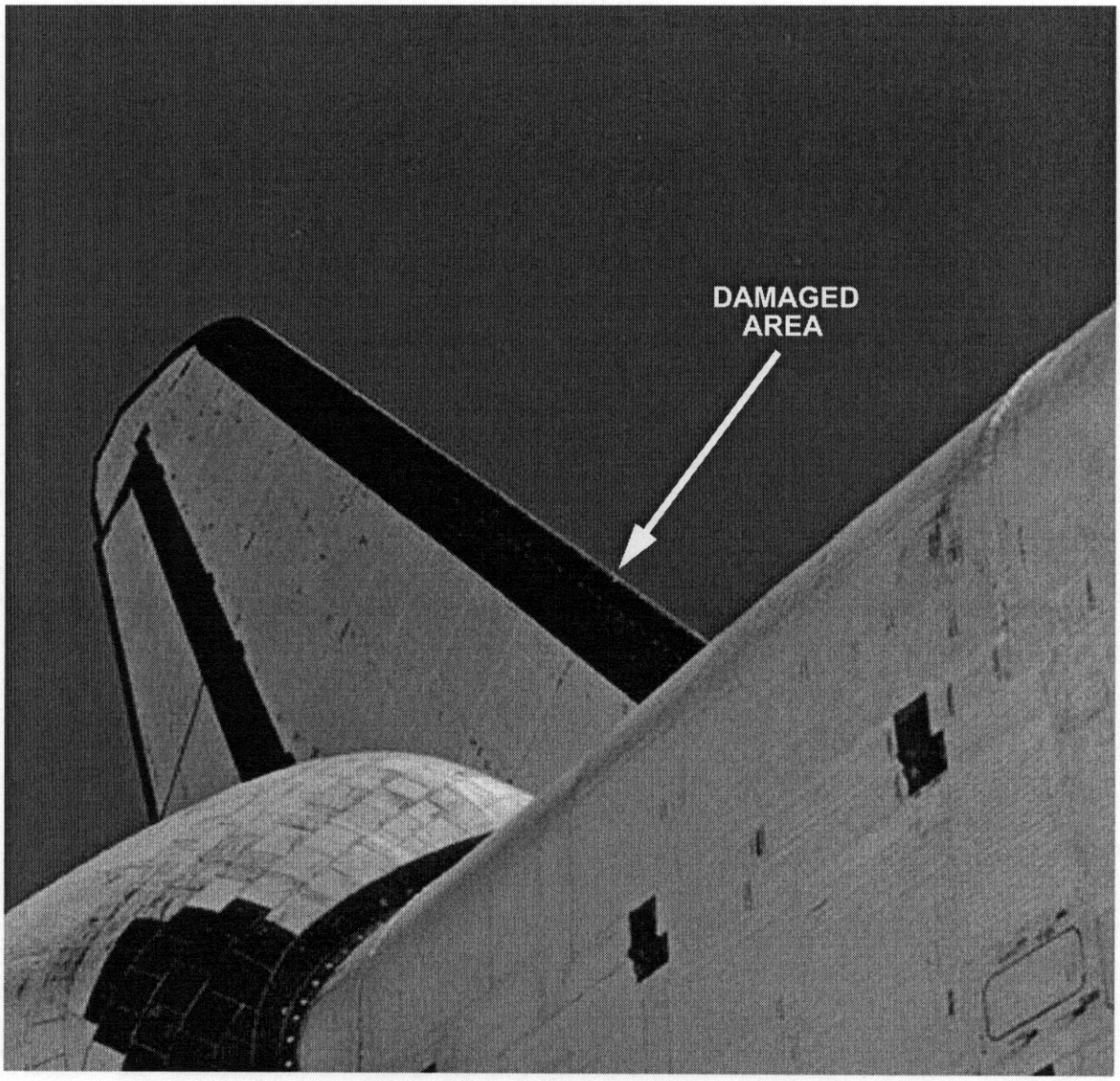

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Photo 20. Large Damage On Vertical Stabilizer Tail

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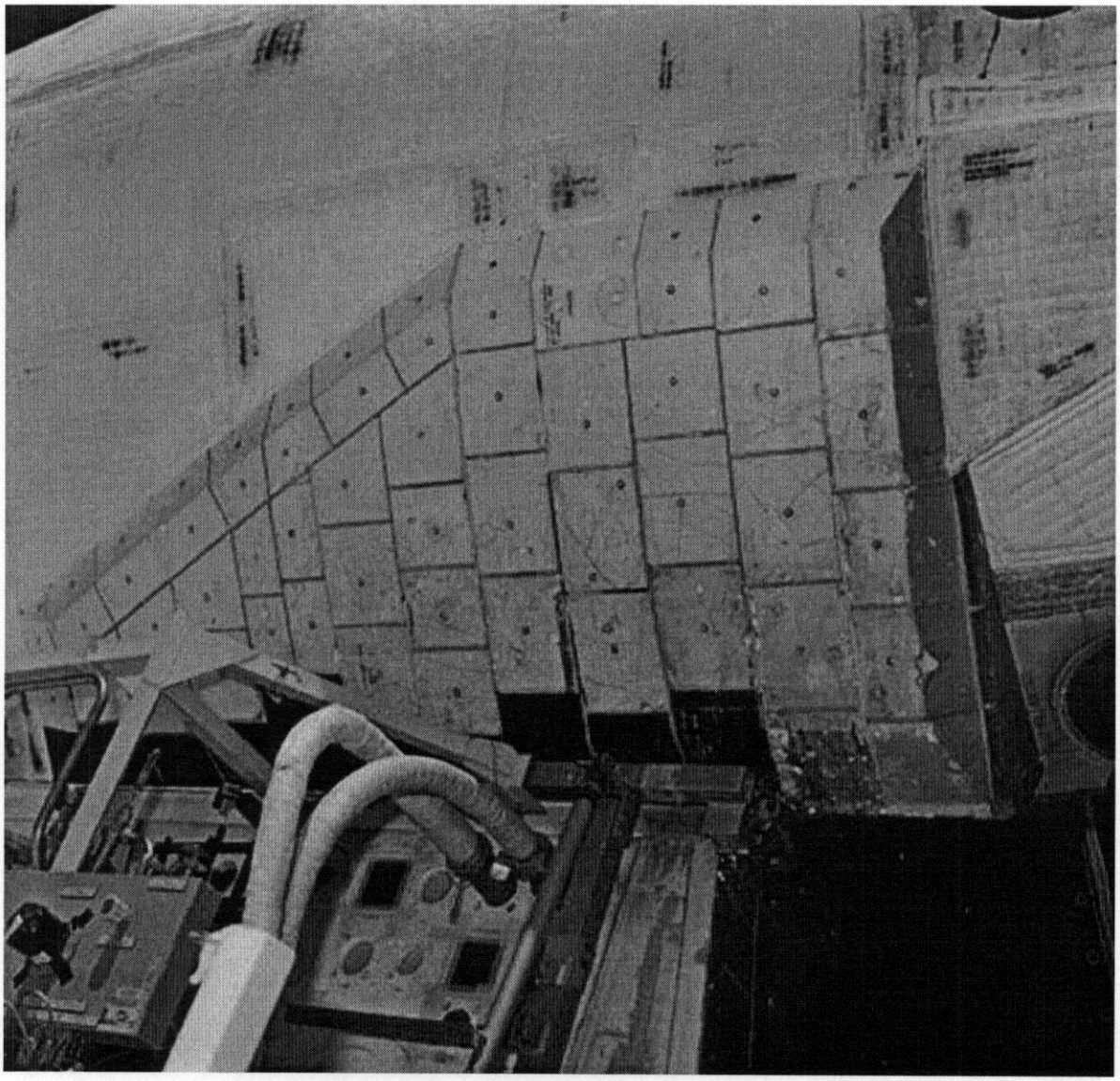

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Photo 21. Area Of Suspected OMS Pod Tile Flexing

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6.0 *SPECIAL TOPICS*

6.1 *Restricted Paper Summary*

(C. Snapp)

A summary of documents and associated conditions that were accepted on a restricted/limited-life usage for flight 16 is listed in table 17.

Table 17. Restricted Paper Summary for STS-100

WAD	PROBLEM/DISCREPANCY	PROPOSED REWORK
AFT-5-A0038	LH ET DOOR TILE HAS OUT-OF-TOLERANCE STEP TO LATCH	REMOVED AND REPLACED TILE
AFT-5-A0039	RH ET DOOR TILES HAVE OUT-OF-TOLERANCE STEP AND GAP	REMOVED AND REPLACED TILES
FWD-5-A0032	STAR TRACKER DOOR TILE TO BOWL TILE OUT-OF-TOLERANCE GAP	RE-RESTRICT; GAP WILL BE REWORKED AT OMDP
FWD-5-A0033	CREW HATCH THERMAL BARRIER HAS OUT-OF-TOLERANCE STEP	POST-FLIGHT ENGINEERING EVALUATION; RE-RESTRICT TO FLIGHT 18
FWD-5-A0038	V070-398374-01 NLGD THERMAL BARRIER FRAYED	REMOVED AND REPLACED THERMAL BARRIER
MID-5-A0006	V070-394068-124 FI BLANKET INSTALLED 4 INCHES HIGHER THAN DRAWING REQUIREMENTS	REMOVE AND REPLACE AT OMDP
PLBD-5-A0003	V070-397516-120 FI BLANKET HAS OUT-OF-TOLERANCE GAP	CORRECTED GAP USING STANDARD REPAIR PROCEDURES
RSI-5-A0019	PPE EOTF TO SPECIFICATIONS NOT INCORPORATED PRIOR TO LAUNCH	INCORPORATED PPE TO SPECIFICATIONS AND CLOSED DOCUMENT
RSI-5-A0022	TILES REPAIRED PER TPS-368 COULD DEGRADE	REMOVE AND REPLACE TILES ON AN OPPORTUNITY OR NECESSARY BASIS
RSI-5-A0023	TRACK LOCATION WITH OUT-OF-TOLERANCE KEQ > 0.110	POST-FLIGHT ENGINEERING EVALUATION; RE-RESTRICT TO FLIGHT 18
RSI-5-A0024	WHITE CONTAMINATION ON RCC	POST-FLIGHT ENGINEERING EVALUATION; CLOSE DOCUMENT
TFRC-5-A0011	TILES DO NOT HAVE REQUIRED FILLER BAR SEAL ZONE	POST-FLIGHT ENGINEERING EVALUATION; RE-RESTRICT TO OMDP
TFRC-5-A0012	THERMAL BARRIER V070-398136-001 INSTALLED ADJACENT TO V070-391028-158 TILE HAS A GAP OF 0.300 INCH WITH EXPOSED FILLER BAR	REMOVE AND REPLACE THERMAL BARRIER UPON REMOVAL OF FRCS
TLP04-A0036	TILES REPAIRED PER TPS-368 COULD DEGRADE	REMOVE AND REPLACE TILES ON AN OPPORTUNITY OR NECESSARY BASIS
TRP01-A0055	TILES REPAIRED PER TPS-368 COULD DEGRADE	REMOVE AND REPLACE TILES ON AN OPPORTUNITY OR NECESSARY BASIS
VERT-5-A0009	RH RUDDER/SPEED BRAKE SPLIT LINE THERMAL BARRIER MACOR IS BROKEN/MISSING	REMOVED AND REPLACED MACOR
VERT-5-A0010	V070-291382-128 FI BLANKET HAS OML FABRIC DEGRADATION REPAIRED PER SCREED	REMOVED AND REPLACED FI BLANKET

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6.2 Deferred/Partial Mods

(C. Snapp)

There were no deferred/partial modifications for STS-100.

6.3 Flight Demonstrations

(C. Snapp)

Seven LI-900 pound tiles were upgraded to AETB-8/TUFI tile on the number 3 engine rings prior to flight 15 of OV-105 as a permanent change that will evaluate resistance to chatter damage on TUFI coated AETB-8 tiles. Refer to section 6.5 for further details on the performance of these tiles.

6.4 Significant Problems

(C. Snapp)

There were no significant problems for STS-100.

6.5 AETB-8/TUFI Performance

(C. Snapp)

Post-flight inspection of the various AETB-8/TUFI tile locations found that the performance of these components was nominal with no signs of impact damages. OV-105 is the only vehicle that does not have the entire thruster impingement area of the upper body flap covered with AETB-8/TUFI tile installations. There are only a few TUFI tiles installed by attrition in this area, and the post-flight condition of these appeared nominal with no signs of impact damages. The base heat shield area of OV-105, however, has more TUFI tiles installed than the other vehicles and these tiles also continue to provide evidence of the impact resistance and reduced maintenance to the OML surface of these upgraded components.

Inspection of the seven AETB-8/TUFI tiles, installed as a demonstration for resistance to sidewall damage in a known chatter prone area of the engine rings, found increased chatter and erosion associated with the previously noted condition associated with the V070-395902-332 tile (refer to OV-105 flight 15 post-flight report number KLO-01-002, section 6.5). The previously identified chatter damage has enlarged from a 0.25 inch diameter to an approximate dimension of 1 inch long by 0.7 inch wide by 0.1 inch deep, and appears to be showing some sign of base silica material as a result of erosion. The gap at the -332 to -327 tile-to-tile interface (damaged location) is approximately 0.050 inch. This makes it notable that the gap between the -332 and -328 is only about 0.025 inch and no chatter damage is associated with the tile-to-tile interface. It is suspected that the smaller SIP footprint of the -327 tile is allowing that tile to have a larger range of movement that contributes to the sidewall chattering condition. The -327 tile is only 3 inches by 6 inches, while the adjacent -331, -332, and -328 tiles are larger 6 inch by 6 inch configurations.

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Inspection/evaluation of the engine ring found significant erosion on the sidewalls of tiles that have no RCG coating as a result of either chatter damage or previous sidewall shaves. Therefore, erosion is expected to some degree when tile sidewall damage does occur in various areas of the engine ring. While some damage and erosion has occurred to the sidewall of these AETB-8/TUFI tiles, the damages are significantly reduced from that typically seen with standard LI-900 material capability in the same circumstances.

The seven AETB-8/TUFI tiles were installed prior to flight 15 of OV-105 on the inboard half of the number 3 SSME engine ring assembly in the V070-395902 array. While this was authorized through MCR 19177 as a demonstration of material performance for resistance to chatter, the change of material for these parts is a permanent change with no limit on flight duration. These AETB-8/TUFI tiles will help define if the damage prone area will eventually be transitioned into this material from LI-900. These tiles continue to exhibit good OML debris impact resistance and would provide a reduction in maintenance repairs if more widely used in the engine ring base heat shield areas.

7.0 OPEN ISSUES FROM PREVIOUS REPORT

(C. Snapp)

There were no open issues from previous reports for STS-100.

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8.0 APPENDICES

8.1 STS-100 TPS Quick Look Runway Inspection, May 1, 2001

(C. Snapp)

General

- Landed at Edwards AFB at 9:10 a.m. PDT, 01 May 2001.
- Landing occurred at Dryden on Runway 22.
- Total downgrade occurred at approximately 10:40 am PDT.
- Overall TPS looked good.
- Approximately 15 to 20 tiles have RCG damages > 1 inch.
- No damage or white residue was seen on the wing leading edge RCC.
- One Ames gap filler was found on the runway; origin unknown.

Fwd

- Chin panel gap at time of access was approximately 0.200 inch from RCC to RCC, and 0.100 inch nose cap to V070-399441 gap filler. Black discoloration was seen on the -441 gap filler right hand side approximately 0.5 inch long.
- Possible damage to chin panel angle seal corner was noted less than 1 inch in diameter.
- NLGD tiles (V070-391040, -141, -142 and V070-391044-053, -160) all have corner chip damage.
- Gap filler was protruding approximately 0.3 inch by 4.0 inch, adjacent to V070-391017-280 tile. No charring was noted.
- Upper surface FRCS AFRSI blanket (V070-391134-048) had torn OML fabric with the forward corner lifted approximately 2 inches by 1 inch.
- Tile aft of window number 4 had a gouge (V070-391020-312).

Mid

- Following lower surface tiles were noted with RCG damage greater than 1 inch: V070-395037-154, 394046-131, 191001-037.
- Charred gap filler was noted between V070-394044-105 and V070-191001-035 tiles.
- Main landing gear door thermal barriers have no visible damage, fraying, or flowpaths.

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Mid (cont'd)

- Lower surface tiles near main landing gear doors have white discoloration outlining RCG coating cracks.
- Gap filler on the lower surface midbody between V070-394502-220 and -222 tiles was protruding slightly and charred.
- Right hand outboard elevon inboard side had a protruding pillow gap filler.

Aft

- Some discoloration but no fraying or visible flowpaths were noted on the ET door thermal barriers.
- One tile on the leading edge of the vertical tail, V070-293021-012, had an impact damage approximately 1 inch in diameter.
- Left hand OMS pod lower aft tiles were inspected and looked normal. Pillow gap filler in this area (thick tile array) between V070-396366-032 and -057 was protruding 0.2 inch by 4 inches long.
- Several large RCG coating damages were noted on both left and right upper body flap leading edge tiles.
- Engine number 3 dome heat shield blanket has fraying at the 10 o'clock position.
- Left hand upper body flap tile appears to have a protruding Ames gap filler.

Runway inspection performed by:

Boeing OE: Karrie Hinkle

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