FE-058 KLO-02-004

Mission STS-109
OV-102 Flight 27
Thermal Protection System
Post-Flight Assessment

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Mission STS-109

OV-102 Flight 27

Thermal Protection System Post-Flight Assessment

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List of Acronyms and Definitions

AETB-8	Alumina-Enhanced Thermal Barrier - 8 pcf
AFRSI	Advanced Flexible Reusable Surface Insulation
CAR	Corrective Action Request
DHS	Dome Heat Shield
EOTF	Engineering Order to Follow
ET	External Tank
FI	Flexible Insulation
FOD	Foreign Object Debris
FRCI-12	Fibrous Refractory Composite Insulation - 12 pcf
FRCS	Forward Reaction Control System
HRSI	High-Temperature Reusable Surface Insulation
Keq	Normalized Equivalent Roughness
LESS	Leading Edge Structural Subsystem
LI-900	Lockheed Insulation - 9 pcf
LI-2200	Lockheed Insulation - 22 pcf
LRSI	Low-Temperature Reusable Surface Insulation
MADS	Modular Auxiliary Data Systems
MCR	Master Change Record
MLGD	Main Landing Gear Door
MR	Material Review
NEOM	Nominal End Of Mission
NLGD	Nose Landing Gear Door
OEX	Orbiter Experiment
OMDP	Orbiter Maintenance Down Period
OMI	Operations and Maintenance Instruction
OML	Outer Mold Line
OMM	Orbiter Major Modification
OMS	Orbital Maneuvering System
PLBD	Payload Bay Door
PR	Problem Report
PRT	Problem Resolution Team

List of Acronyms and Definitions *(cont'd)*

QC	Quality Control
RCC	Reinforced Carbon-Carbon
RSB	Rudder/Speed Brake
RSI	Reusable Surface Insulation
RTV	Room-Temperature Vulcanized
SIP	Strain Isolator Pad
TUFI	Toughened Uni-Piece Fibrous Insulation
WLE	Wing Leading Edge

Acknowledgment

Several personnel contributed to this report. The engineering inspections were performed at the Kennedy Space Center Shuttle Landing Facility by Bill McCartin and in the Orbiter Processing Facility High Bay Number 3 by the authors noted. Preflight data was provided by SFOC personnel. Flight temperature data was provided by Jerry Kinder, Boeing Huntington Beach. 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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Photo 1. Overall View, Right-Hand Side

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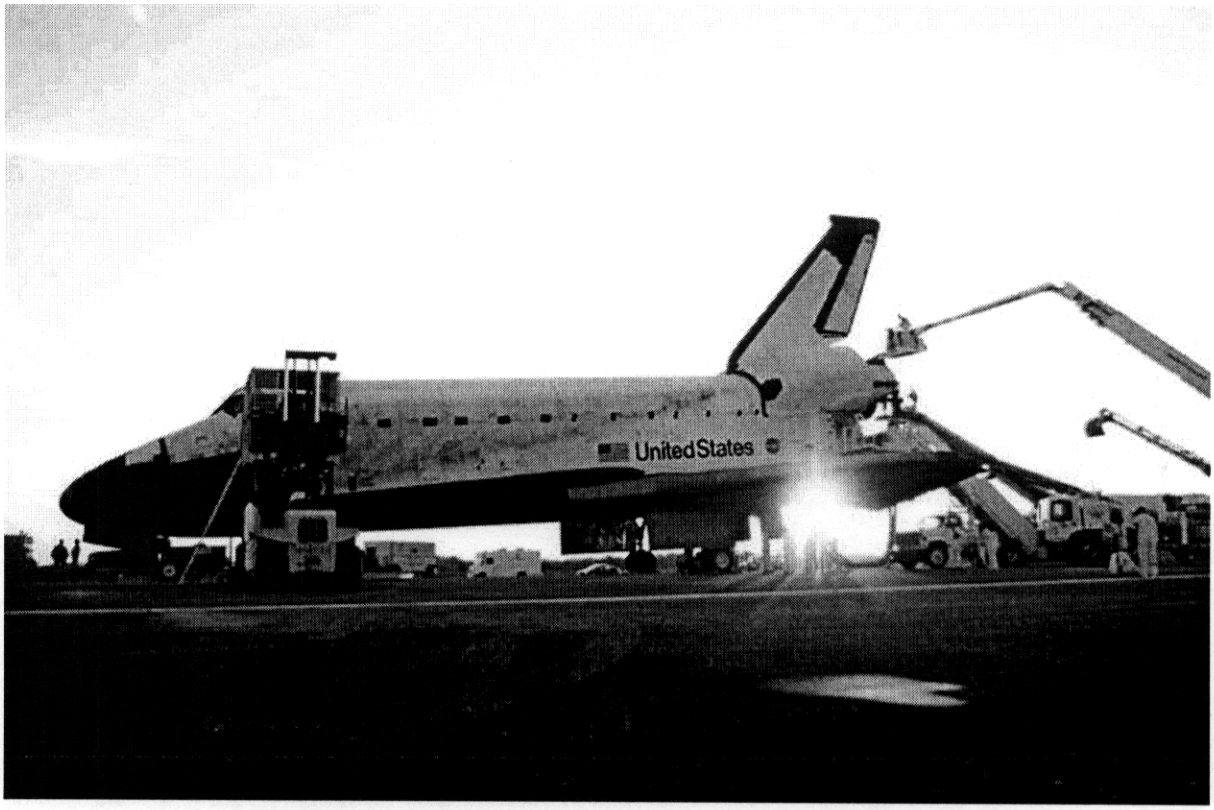

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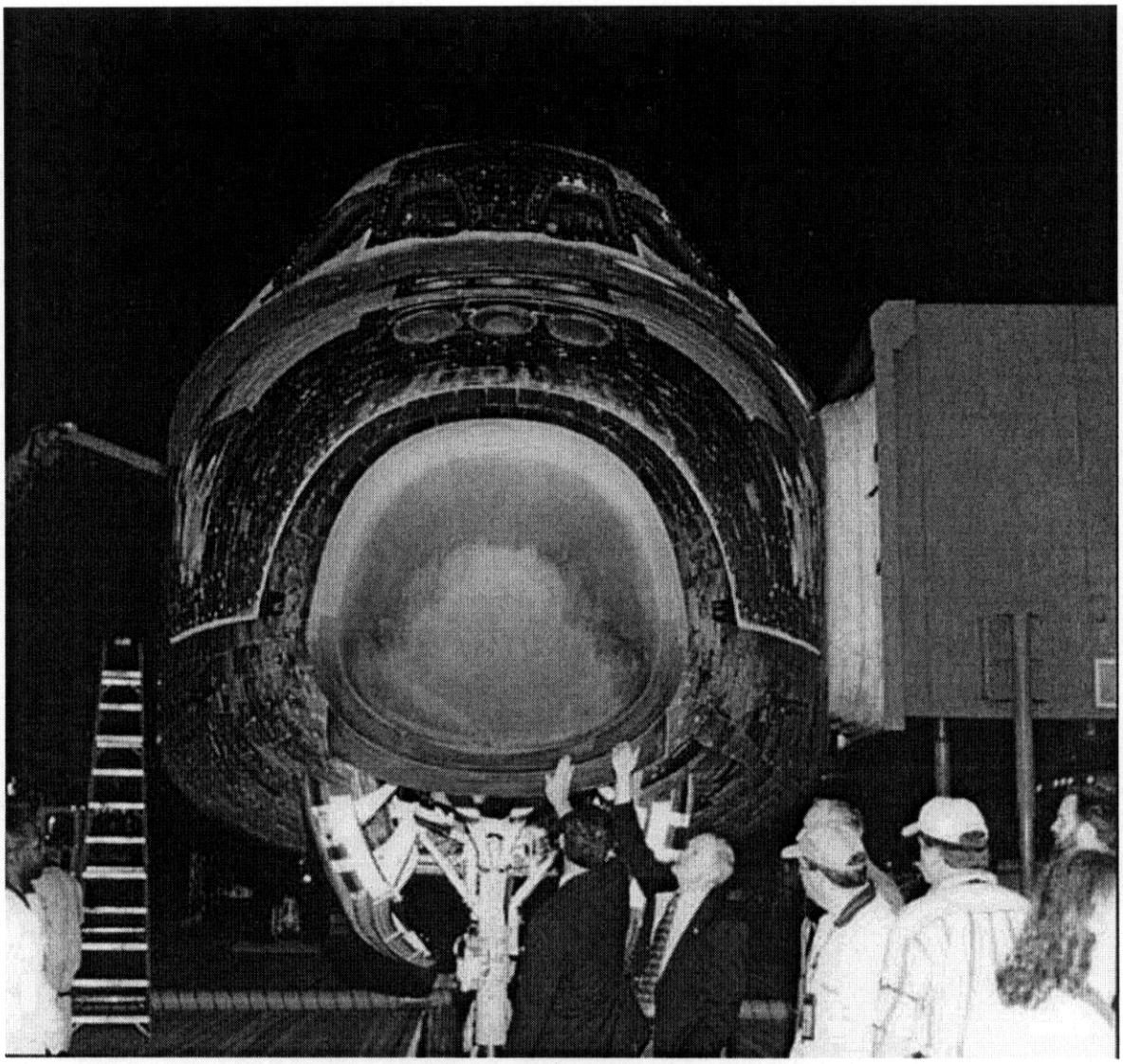

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Photo 3. Overall View, Front

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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 27 of OV-102.

2.0 BACKGROUND

The previous flights of OV-102 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-1	102/1	04/12/81	04/14/81	LTR-1225-4570 LTR-13363-4576
STS-2	102/2	11/12/81	11/14/81	NA
STS-3	102/3	03/22/82	03/30/82	LTR-33363-4598 LTR-33363-4602
STS-4	102/4	06/27/82	07/04/82	NA
STS-5	102/5	11/11/82	11/16/82	NA
STS-9	102/6	11/28/83	12/08/83	NA
STS-32/61C	102/7	01/12/86	01/18/86	LSO-86-001
STS-28R	102/8	08/08/89	08/13/89	KLO-89-004
STS-32R	102/9	01/09/90	01/20/90	KLO-90-004
STS-35	102/10	12/02/91	12/10/90	KLO-90-010
STS-40	102/11	06/05/91	06/14/91	KLO-91-015
STS-50	102/12	06/25/92	07/08/92	KLO-92-009
STS-52	102/13	10/22/92	11/01/92	KLO-93-001
STS-55	102/14	04/26/93	05/06/93	KLO-93-007
STS-58	102/15	10/18/93	11/01/93	KLO-94-001
STS-62	102/16	03/04/94	03/18/94	KLO-94-004
STS-65	102/17	07/08/94	07/23/94	KLO-94-007
STS-73	102/18	10/20/95	11/05/95	KLO-96-001
STS-75	102/19	02/22/96	03/09/96	KLO-96-004
STS-78	102/20	06/20/96	07/07/96	KLO-96-009
STS-80	102/21	11/19/96	12/07/96	KLO-97-001
STS-83	102/22	04/04/97	04/08/97	KLO-97-005
STS-94	102/23	07/01/97	07/17/97	KLO-97-011
STS-87	102/24	11/19/97	12/05/97	KLO-98-002
STS-90	102/25	04/17/99	05/03/99	KLO-99-001

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Table 1. Flight History (cont'd)

MISSION NUMBER	FLIGHT NUMBER	LAUNCH DATE	LANDING DATE	REPORT NUMBER
STS-93	102/26	07/23/99	07/27/99	KLO-01-001

In preparation for STS-109, OV-102 and associated OMS pods had 1,171 tiles and 89 FI blankets removed and replaced. Of these 1,260 RSI component replacements, 484 were related to TPS modifications performed in support of flight 27 (refer to table 2). Preflight vehicle roughness (Keq) values and locations are documented in table 3.

Table 2. Summary of Tile and FI Blanket Part Replacements and TPS Modifications Performed for Flight 27 of OV-102

MCR	MCR/WORK TITLE	PARTS/WORK INVOLVED	PERFORMED AT
6205	NEGATIVE MARGIN TILE REDESIGN	1 TILE UPGRADED FROM CLASS 3 SIP TO CLASS 1 SIP FOR STRESS PURPOSES	KSC
7958	TILE COATING REDESIGN	5 TILES REPLACED WITH REVISED COATING CONFIGURATION	PALMDALE/ KSC
10391	TPS - DAMAGE-PRONE TILE UPGRADE FOR DURABILITY	1 TILE UPGRADED TO FRCI-12 MATERIAL FROM LI-900 ON RSB (ATTRITION CHANGEOUT)	PALMDALE
11451	NEGATIVE MARGIN TILE REDESIGN	10 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC/ PALMDALE
11618	MAKE-WORK ENGINEERING IN SUPPORT OF OV-102 ON PR AND TPS EO-TO-FOLLOW BASIS	15 TILES UPGRADED TO FRCI-12 MATERIAL AND 4 TILES UPGRADED TO AETB-8 MATERIAL FROM LI-900; 8 AFRSI BLANKETS MATERIAL CHANGE	KSC/ PALMDALE
11886	UPPER LESS CARRIER PANEL INTERNAL TILE UPGRADE	14 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 AND CHANGED FROM CLASS 3 SIP TO CLASS 1 SIP (ATTRITION CHANGEOUT)	PALMDALE
12999	TPS - FLEET MODIFICATION	1 TILE UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC
13210	TPS - DAMAGE-PRONE LRSI REPLACEMENT WITH WHITE FRCI-12/ALTERNATE RSI	32 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC/ PALMDALE
16708	TPS - CREW HATCH CARRIER PLATE REDESIGN	32 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	PALMDALE
17177	FLEET MODIFICATION MCR	8 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC/ PALMDALE
17909	TPS - DELETION OF NONFUNCTIONAL CALORIMETERS AND ACOUSTIC SENSORS	15 TILES REPLACED WITH FRCI-12 MATERIAL (NON-INSTRUMENTED TILES) FROM LI-900 AND LI-2200	PALMDALE
18563	TPS - FLEET MODIFICATION MCR	47 FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT); 2 TILES FOR T-0 MOD ON LP05; 7 FI BLANKETS TO ELIMINATE PROTRUSION ON DRAG CHUTE CARRIER PANELS	KSC/ PALMDALE

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Table 2. Summary of Tile and FI Blanket Part Replacements and TPS Modifications Performed for Flight 27 of OV-102 (cont'd)

MCR	MCR/WORK TITLE	PARTS/WORK INVOLVED	PERFORMED AT
18855	TPS - ADVANCED TILE ON THE BASE HEAT SHIELD AND UPPER BODY FLAP	204 TILES UPGRADED TO AETB-8 MATERIAL FROM LI-900 AND LI-2200 (199 ATTRITION CHANGEOUT)	KSC/ PALMDALE
19178	TPS - THRUSTER ACCESS PANEL TILE CHANGE	25 OMS POD TILES UPGRADED TO AETB-8 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC
19220	OV-102 J3 MAJOR MODIFICATION AT PALMDALE	1 LI-2200 TILE CHANGED TO ALLOW FOR VENT TUBE CLEARANCE	PALMDALE
19292	TPS - NEGATIVE MARGIN TILES DUE TO PERFORMANCE ENHANCEMENTS LOAD EVALUATION	35 TILES UPGRADED TO FRCI-12 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC/ PALMDALE
19309	TPS - FAST-TRACK MCRs (BUCKET)	1 LI-2200 TILE REPLACED LI-900 IN LOWER SURFACE DEBRIS AREA (ATTRITION CHANGEOUT)	KSC
19310	REPLACE LI-900 TILES ON CLASS 1/11 SIP WITH AETB-8 OR FRCI-12	2 TILES UPGRADED TO AETB-8 MATERIAL FROM LI-900 (ATTRITION CHANGEOUT)	KSC
19351	TILE GAP HEATING OEX PANEL DELETION	10 LI-900 PRODUCTION TILES REPLACE OEX PANEL TILES	PALMDALE
19546	INBOARD ELEVON TILE ENHANCEMENT	COMBINE HUB TILE AND TILE ADJACENT (AFT) INTO ONE LARGER TILE (ATTRITION CHANGEOUT)	KSC

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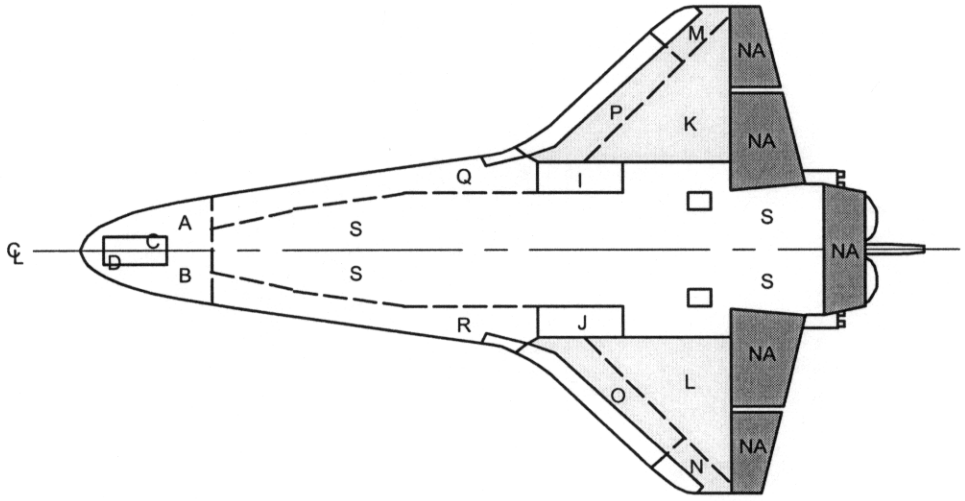
Table 3. Keq Values



NUMBER OF LOCATIONS OVER NOTED KEQ VALUES					
VEHICLE LOCATION	≤110	>110	>120	>128	>136
A	6	2	0	0	0
B	3	4	1	0	0
C	0	5	4	0	0
D	0	4	0	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	1	2	0	0	0
N	0	0	0	0	0
O	0	0	0	0	0
P	0	0	0	0	0
Q	2	0	0	0	0
R	2	2	0	0	0
S	0	0	0	0	0
KEQ TOTALS	14	19	5	0	0
PREVIOUS FLIGHT	13	11	1	0	0
OV-102 AVERAGE	93.5	23.6	56.8	27.3	23.1
FLEET AVERAGE	7.4	18.5	9.7	2.3	0.4

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3.0 SUMMARY

(B. McCartin)

Post-flight 27 inspections and evaluation of OV-102 found the thermal protection system to be in nominal condition, with the exception of two anomalies. The V070-395018-043 tile on the aft fuselage stub carrier panel was found to have more than 50 percent of the tile missing. The anomaly did not result in any overtemperature conditions related to the loss of tile material. This anomaly is further explained in section 5.3.3. Flight 27 was the first flight of OV-102 following the orbiters J3 major modification period.

The second notable anomaly was the V070-399441-044 gap filler (chin panel/nose cap expansion seal interface) which was breached in two locations resulting in the removal of the chin panel post-flight 27 to facilitate replacement of the gap filler. The damaged gap filler was installed new prior to flight 27. Two possible contributing factors in the premature failure of the gap filler were type A sealant from the nose cap assembly and marginal step/gap conditions at the chin panel-to-nose cap expansion seal interface. Refer to section 5.1.2 and section 5.1.4 for additional details.

Other than the damage to the chin panel gap filler and the missing portion of the aft stub tile, the TPS performance was nominal. Overall, the condition of the TPS was good with no items noted that would cause an impact to processing schedules for the next mission of OV-102.

4.0 FLIGHT DATA

(B. McCartin)

OV-102 was launched at 6:22:02 a.m. EST on March 1, 2002 from launch pad LC-39A. The orbiter touched down at 4:31:52 a.m. EST on March 12, 2002 at the KSC Shuttle Landing Facility on runway 33. For the STS-109 mission, OV-102 was assigned left OMS pod LP05 (flight 16) and right OMS pod RP05 (flight 15).

Both the number of overall debris impacts (98) and impacts over 1 inch (18) were below average when compared to previous flights for both OV-102 and the vehicle fleet (refer to tables 4 and 5, and figures 1 through 3).

There was one protruding pillow gap filler and two protruding Ames gap fillers detected post flight (refer to table 6 and section 5.1.1 for additional details). The STS-109 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 is shown in table 9, and current charred filler bar locations are shown in figure 11.

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Table 4. Debris Damage Assessment Summary

	IMPACTS > 1"	TOTAL
LOWER SURFACE	14	63
UPPER SURFACE	0	1
WINDOW AREA	4	29
RIGHT SIDE	0	4
LEFT SIDE	0	1
RIGHT OMS POD	0	0
LEFT OMS POD	0	0
TOTALS	**18**	**98**

Table 5. Debris Damage and Flight Comparison - OV-102 Only

MISSION	IMPACTS > 1"	TOTAL IMPACTS
STS-9/FLT 6	14	58
STS-61C/FLT 7	39	193
STS-28R/FLT 8	20	76
STS-32R/FLT 9	15	120
STS-35/FLT 10	17	147
STS-40/FLT 11	25	197
STS-50/FLT 12	45	184
STS-52/FLT 13	16	290
STS-55/FLT 14	13	143
STS-58//FLT 15	26	155
STS-62/FLT 16	16	97
STS-65/FLT 17	21	151
STS-73/FLT 18	26	147
STS-75/FLT 19	17	96
STS-78/FLT 20	12	85
STS-80/FLT 21	8	93
STS-83/FLT 22	13	81
STS-94/FLT 23	12	90
STS-87/FLT 24	132	308
STS-90/FLT 25	20	131
STS-93/FLT 26	49	208
STS-109/FLT 27	18	98
OV-102 AVERAGE	**26.1**	**143.1**
FLEET AVERAGE	**30.5**	**144.9**

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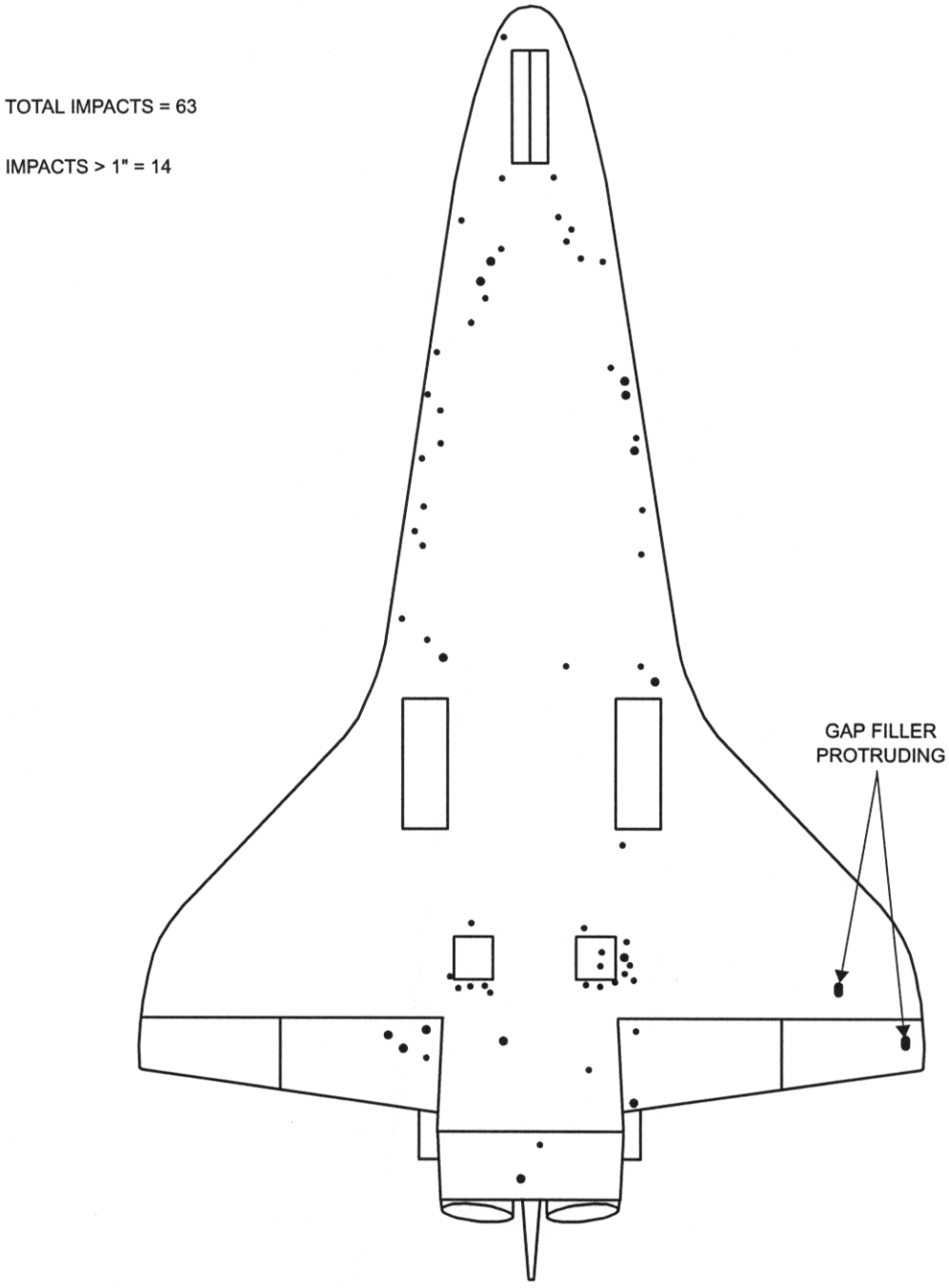

Figure 1. Lower Surface Debris Damage

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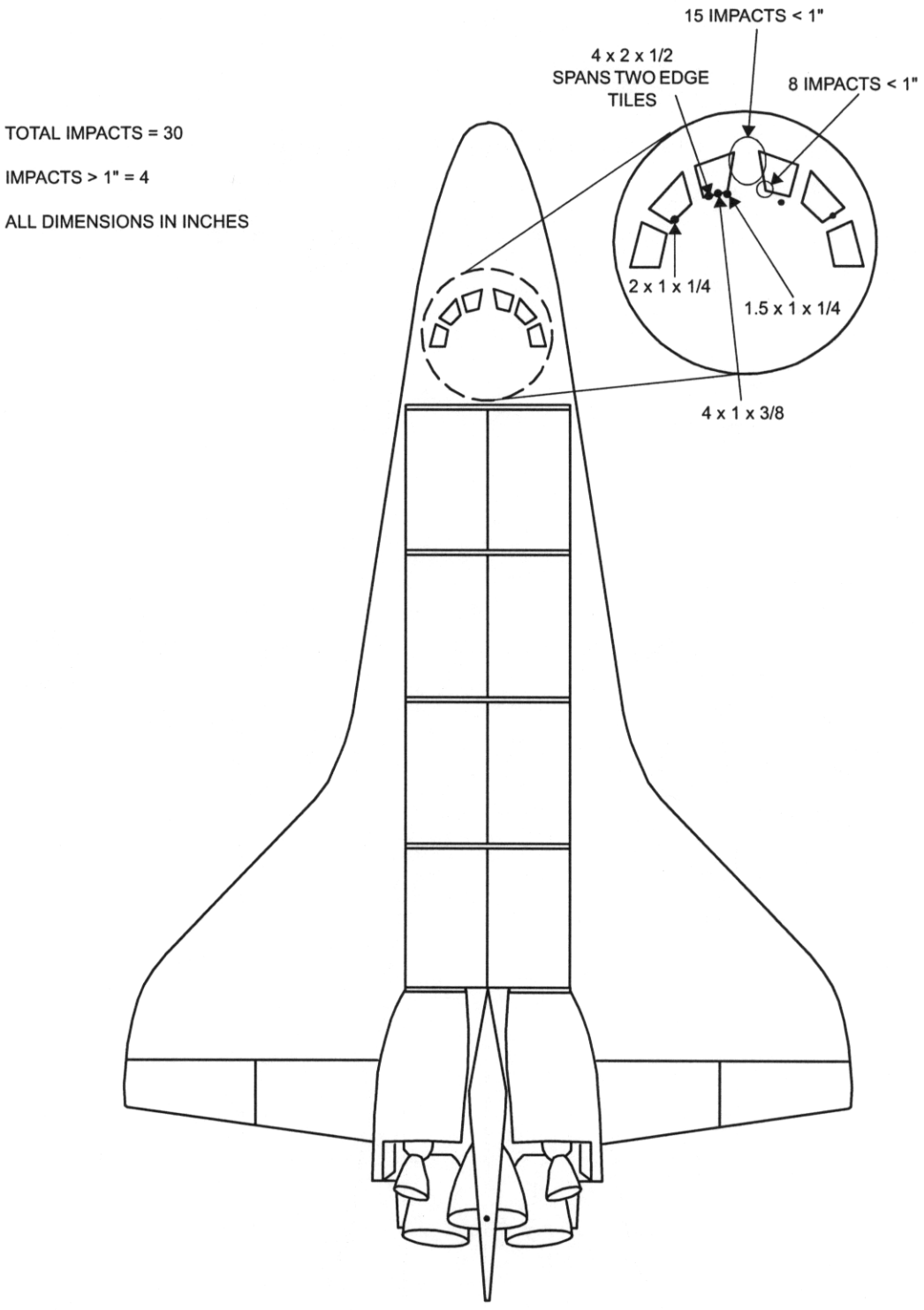

Figure 2. Upper Surface Debris Damage

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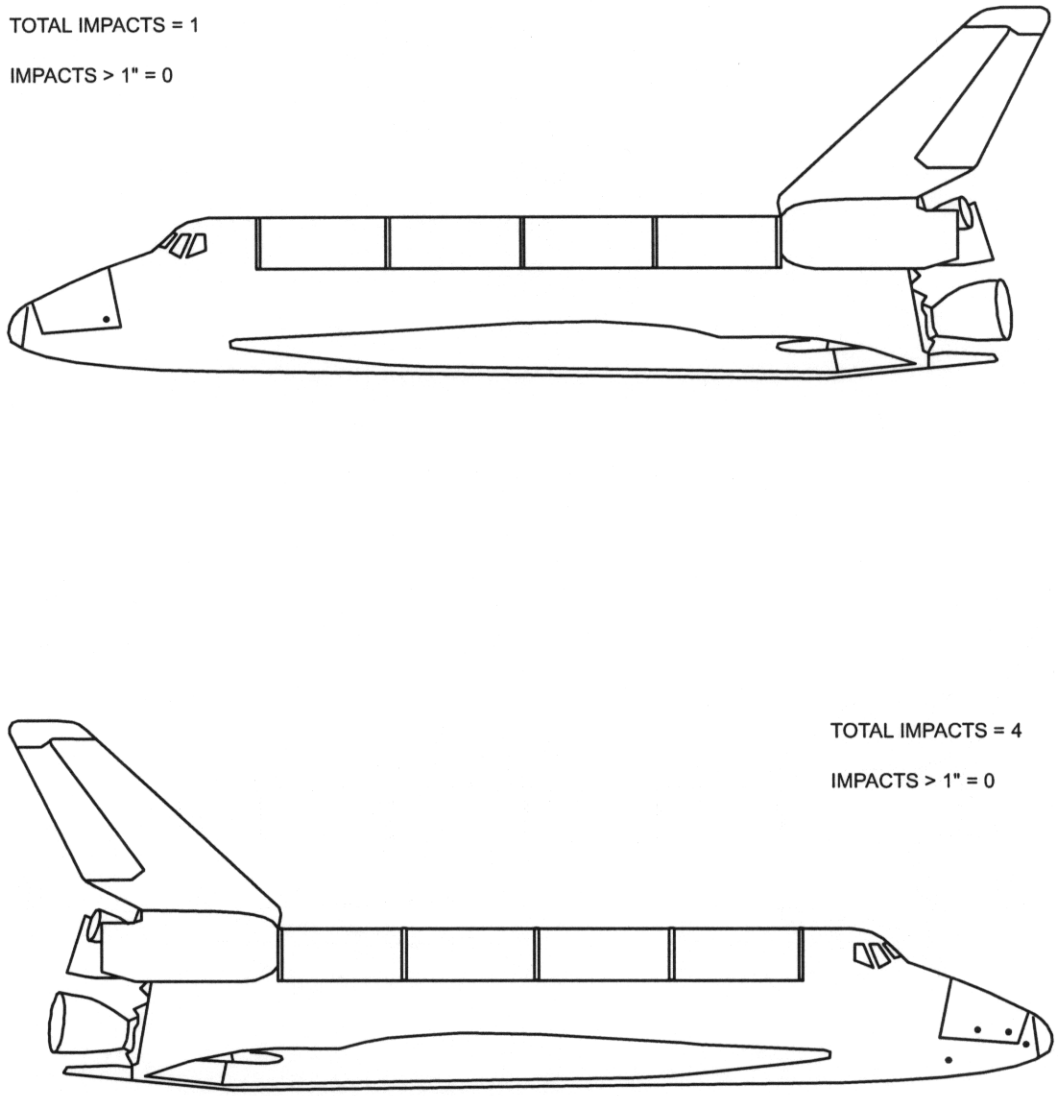

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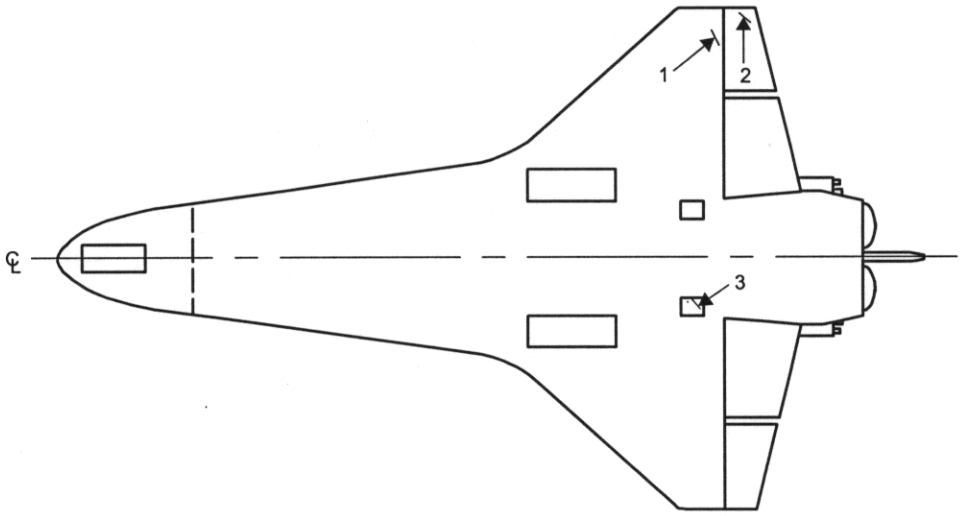
Figure 3. Fuselage Debris Damage

Table 6. Protruding Gap Filler Locations



LOCATION NUMBER	X	Y	ADJACENT TILE NUMBERS	AMOUNT PROTRUDED
1	1375	-392	V070-191025-456/V070-191026-283	1" CONSTANT
2 (AMES)	1417	-460	V070-193014-075/V070-193018-115	0.75" CONSTANT
3 (AMES)	1352	66	V070-395055-097/V070-395025-037	0.4" CONSTANT

Table 7. Summary of Reentry Data

ORBITAL INCLINATION: ***28.5°***
ANGLE OF ATTACK: ***40°***
CROSSRANGE, NM: ***266.8***
WEIGHT AT ENTRY INTERFACE, LBS X 1000: ***222.5***
CENTER OF GRAVITY AT ENTRY INTERFACE, INCH: X_o = ***1083.8***
ELEVON POSITION*: ***-3°***
BODY FLAP POSITION*: ***-0.5°***
*POSITION AT TIME OF PEAK HEATING DURING REENTRY. UP IS INDICATED BY (-), DOWN IS INDICATED BY (+).

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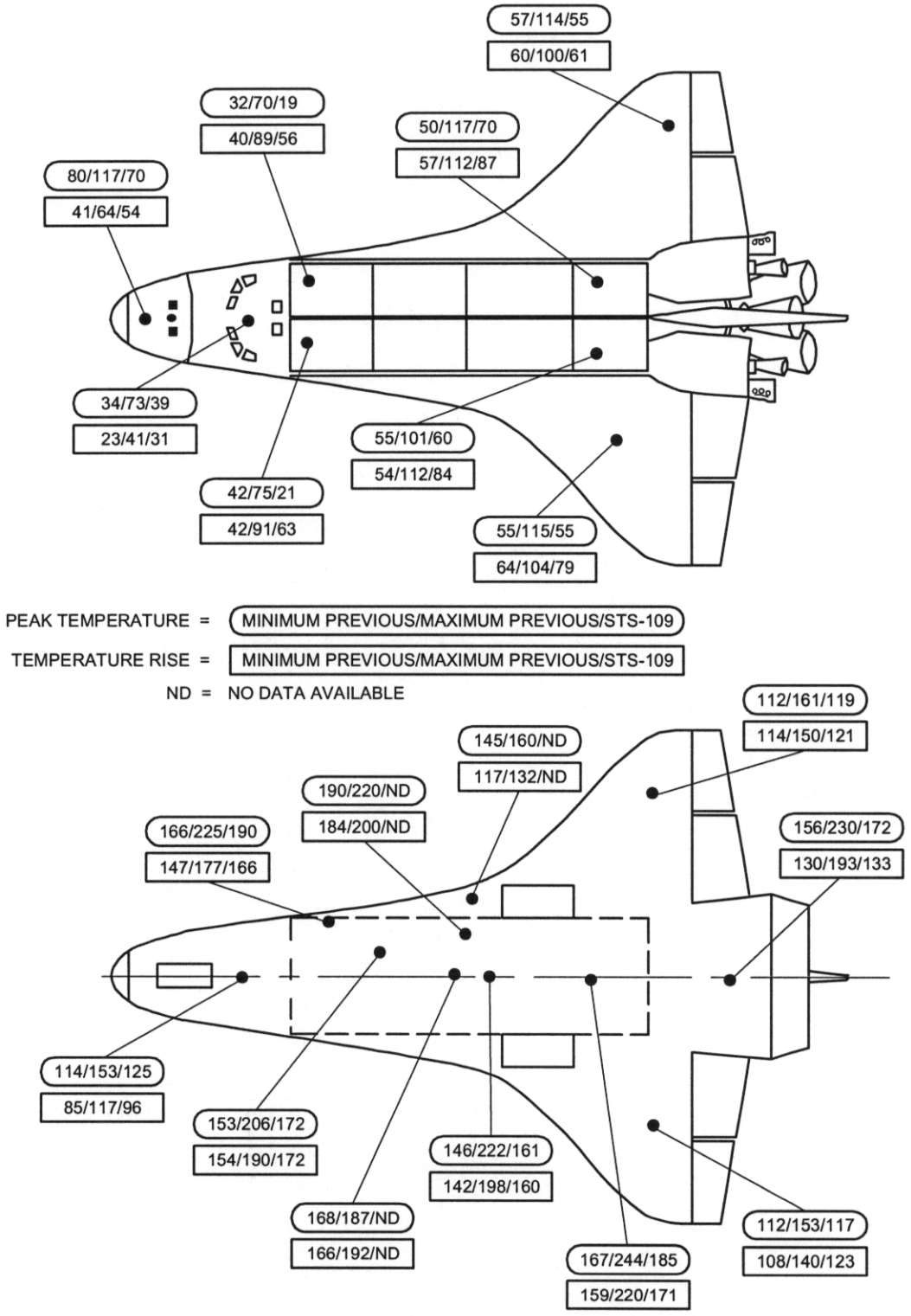

Figure 4. Peak and Structural Temperature Rises (°F)

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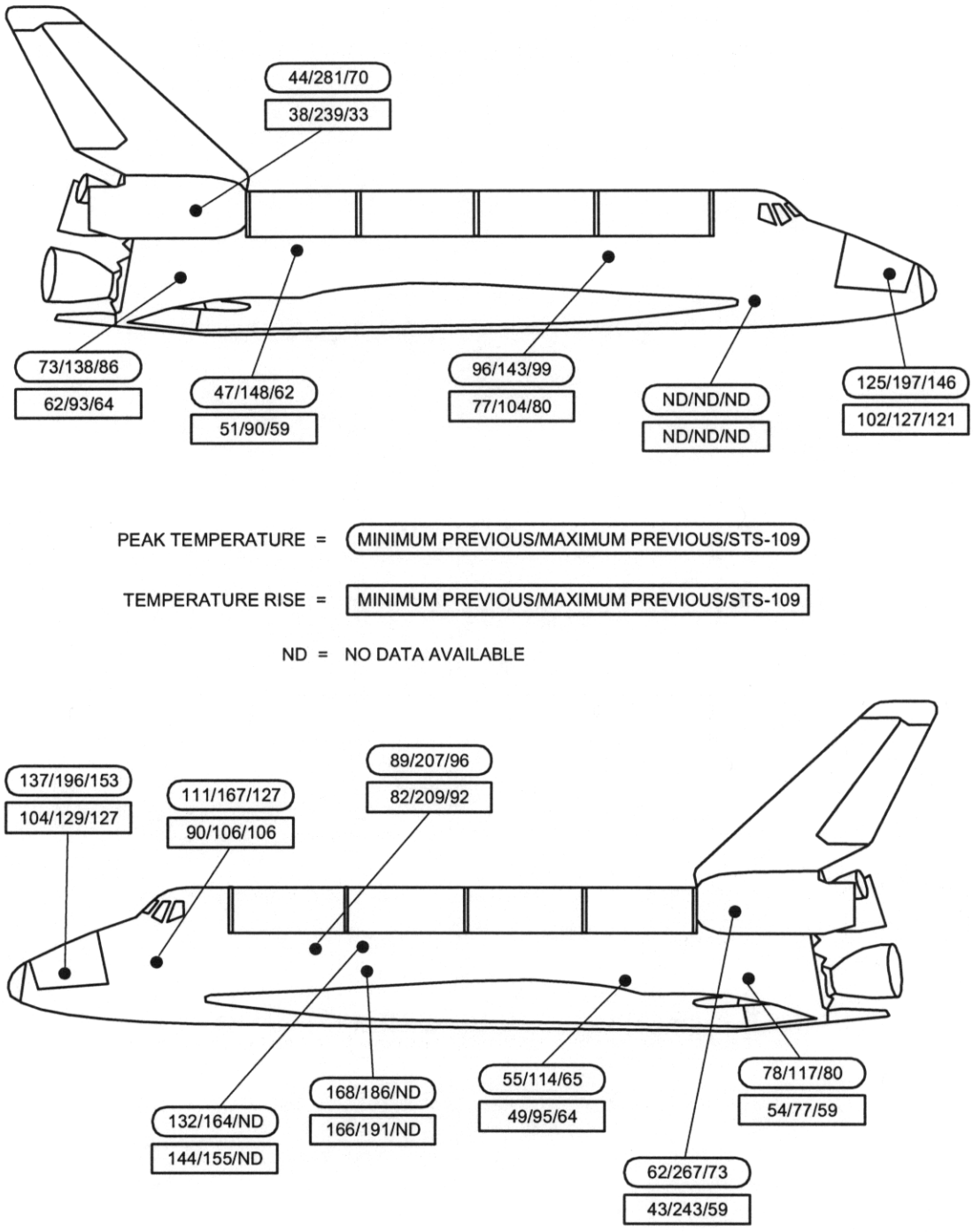

Figure 4. Peak and Structural Temperature Rises (°F) (cont'd)

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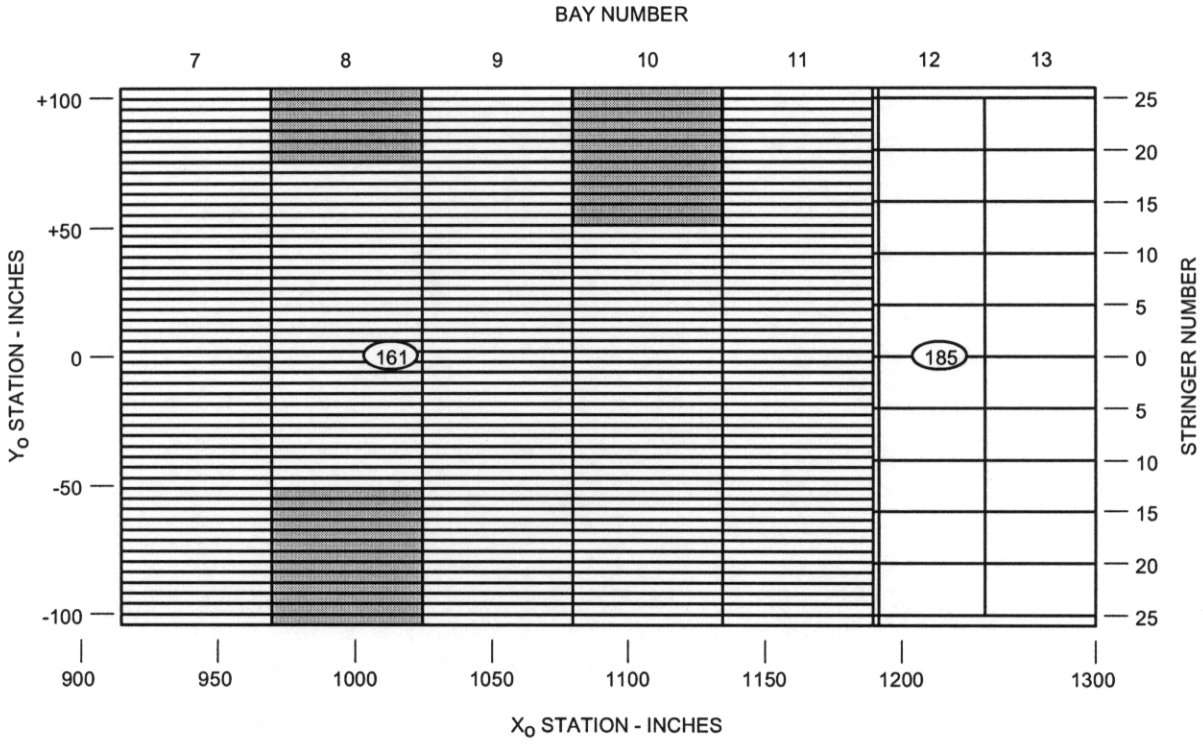

NX = TEMPERATURE LESS THAN 130°F

N3 = TEMPERATURE LESS THAN 150°F

BLANK INDICATES TEMPILABEL® NOT READ

INACCESSIBLE REGION

THERMOCOUPLE DATA

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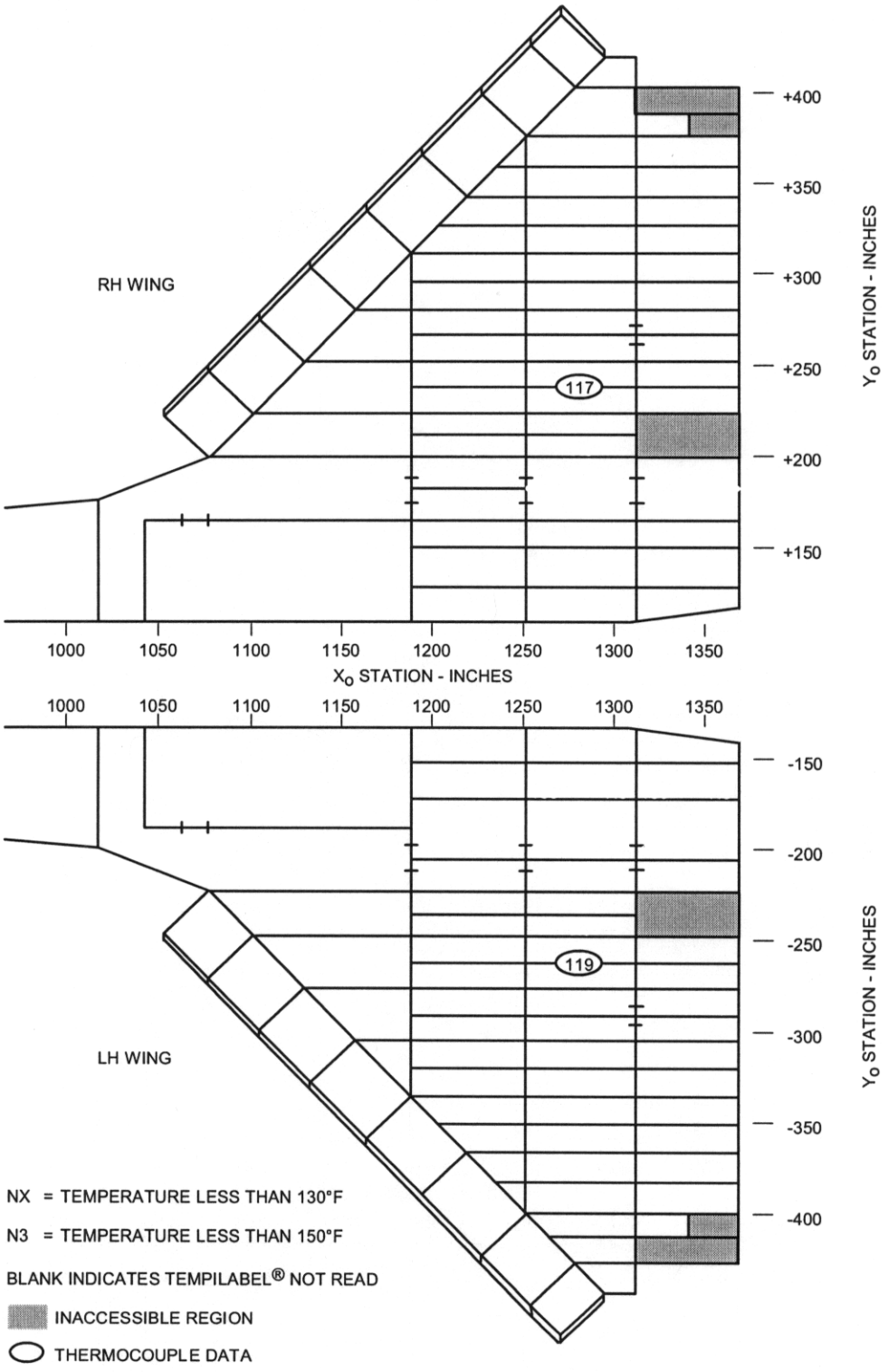

Figure 6. Lower Wing Structure Tempilabel® and Thermocouple Data

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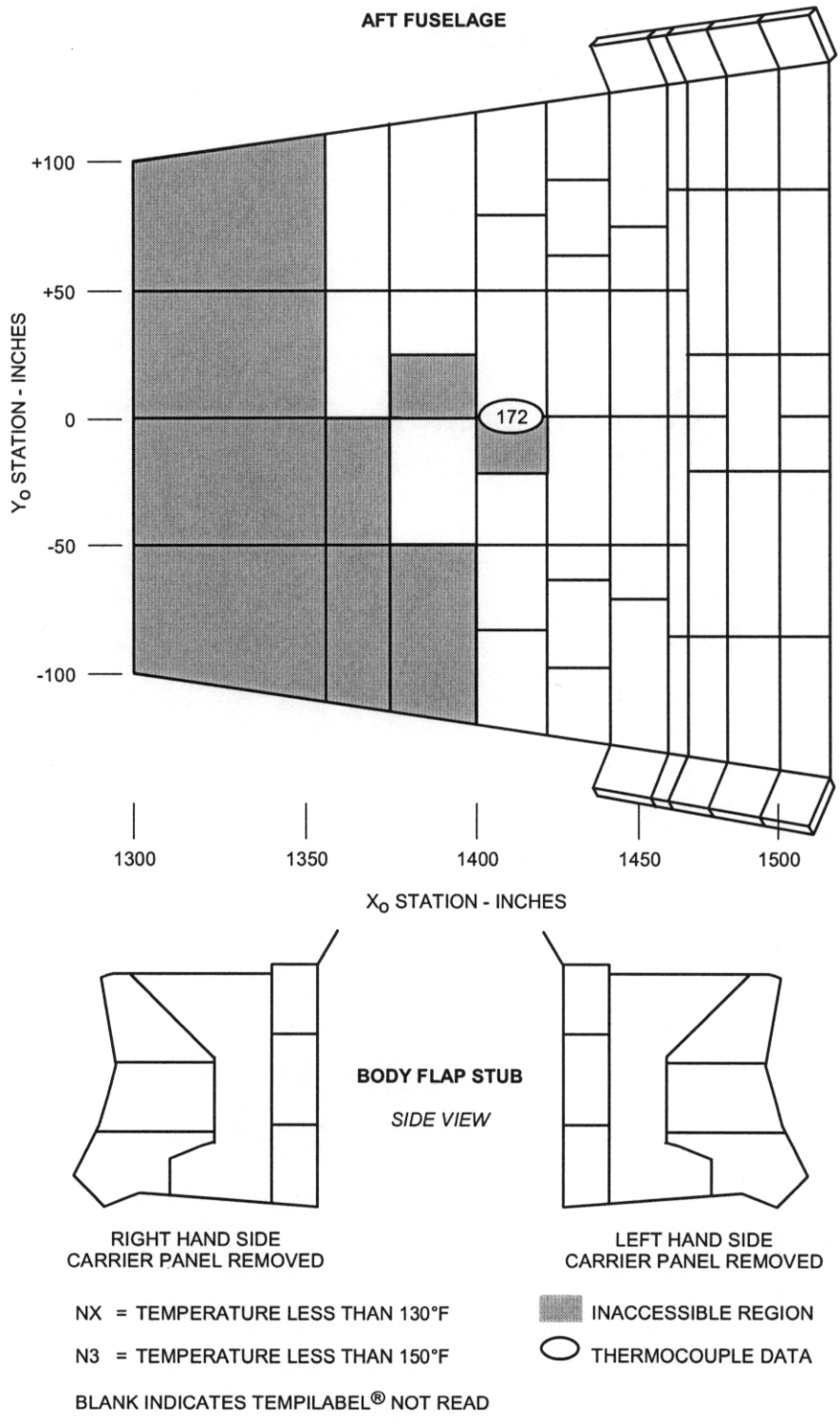

Figure 7. Aft Fuselage Lower Skin and Body Flap Stub Structure Tempilabel® and Thermocouple Data

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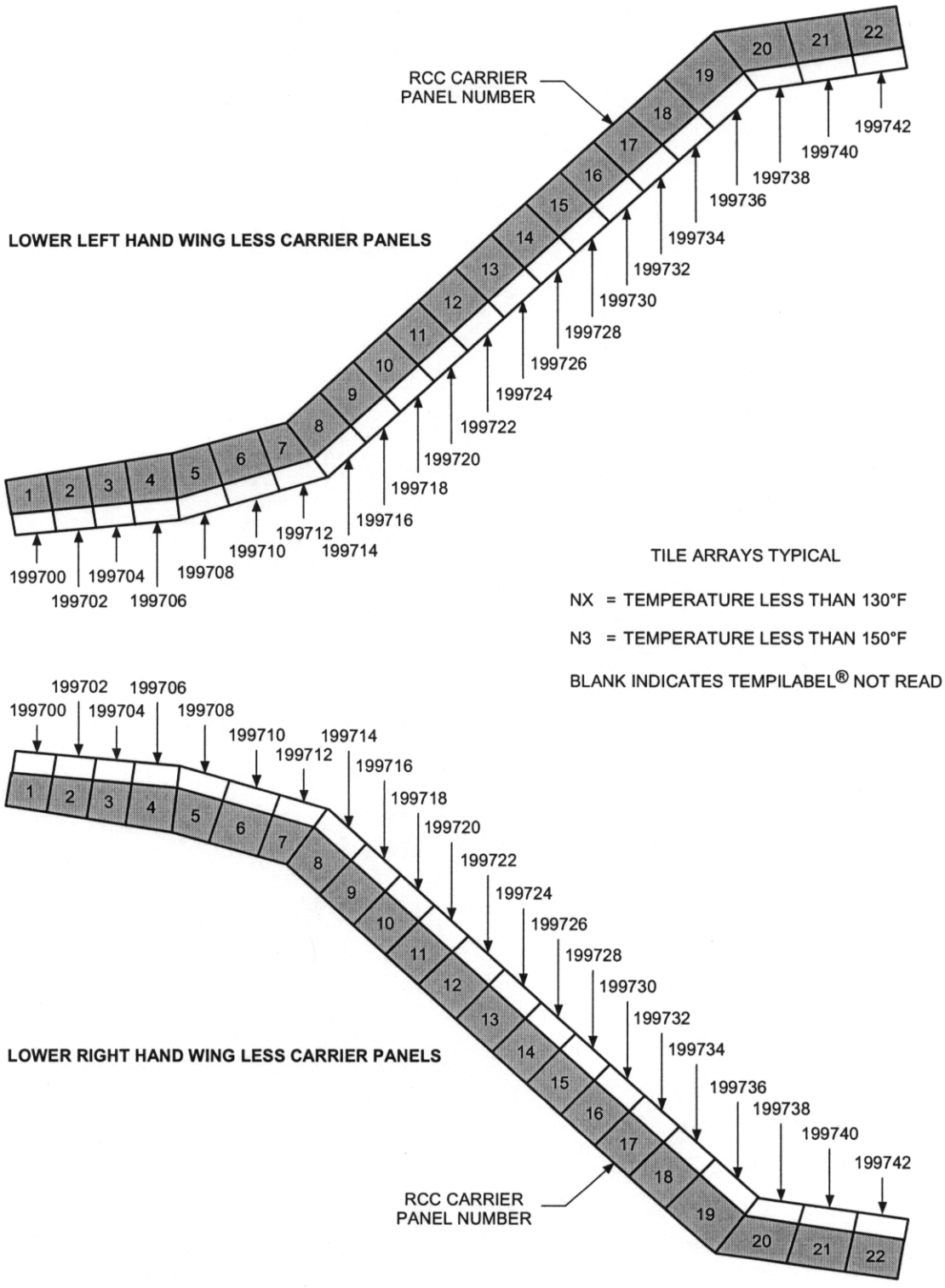

Figure 8. Lower Wing LESS Carrier Panels Tempilabel® Data

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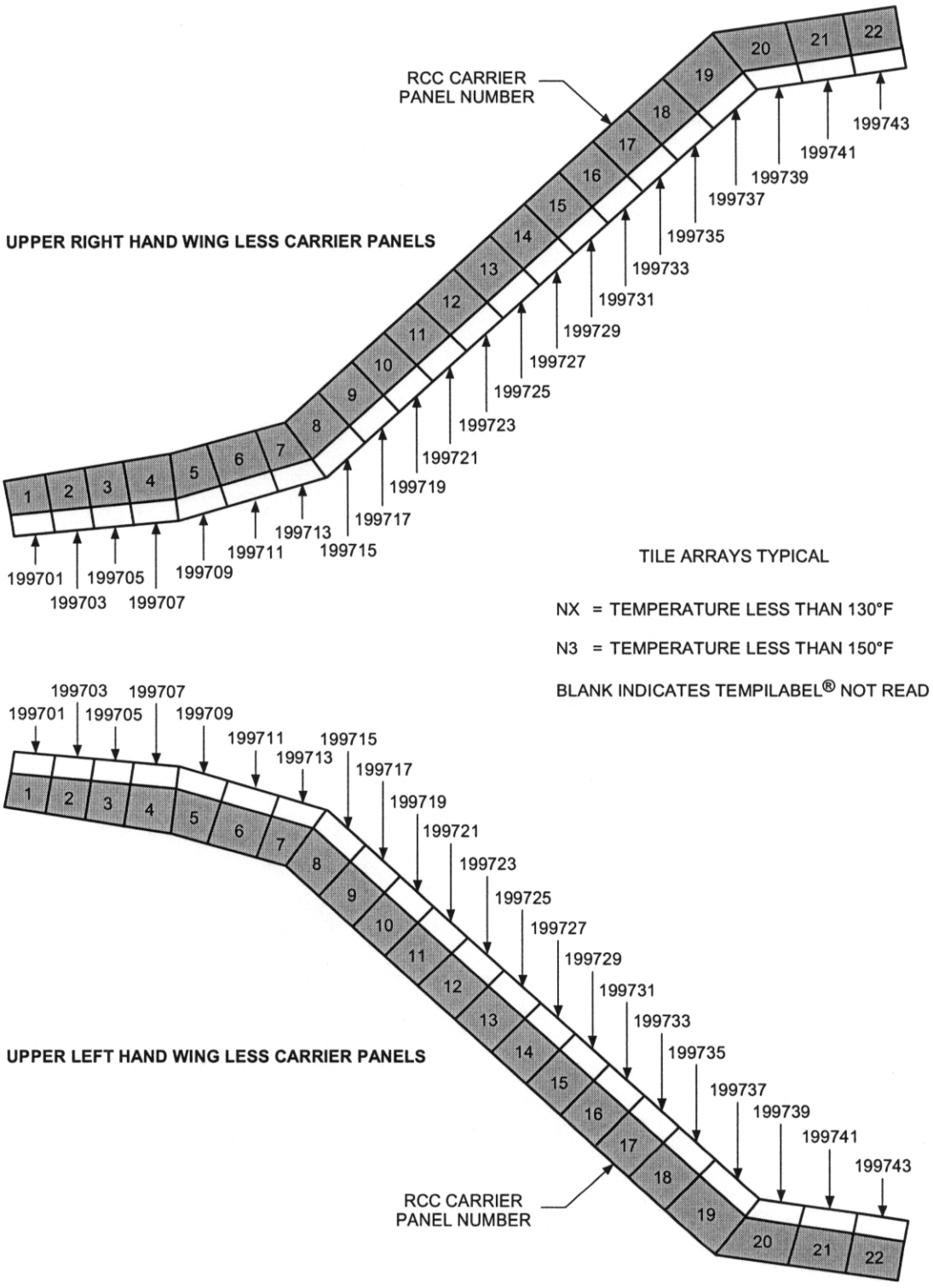

Figure 9. Upper Wing LESS Carrier Panels Tempilabel® Data

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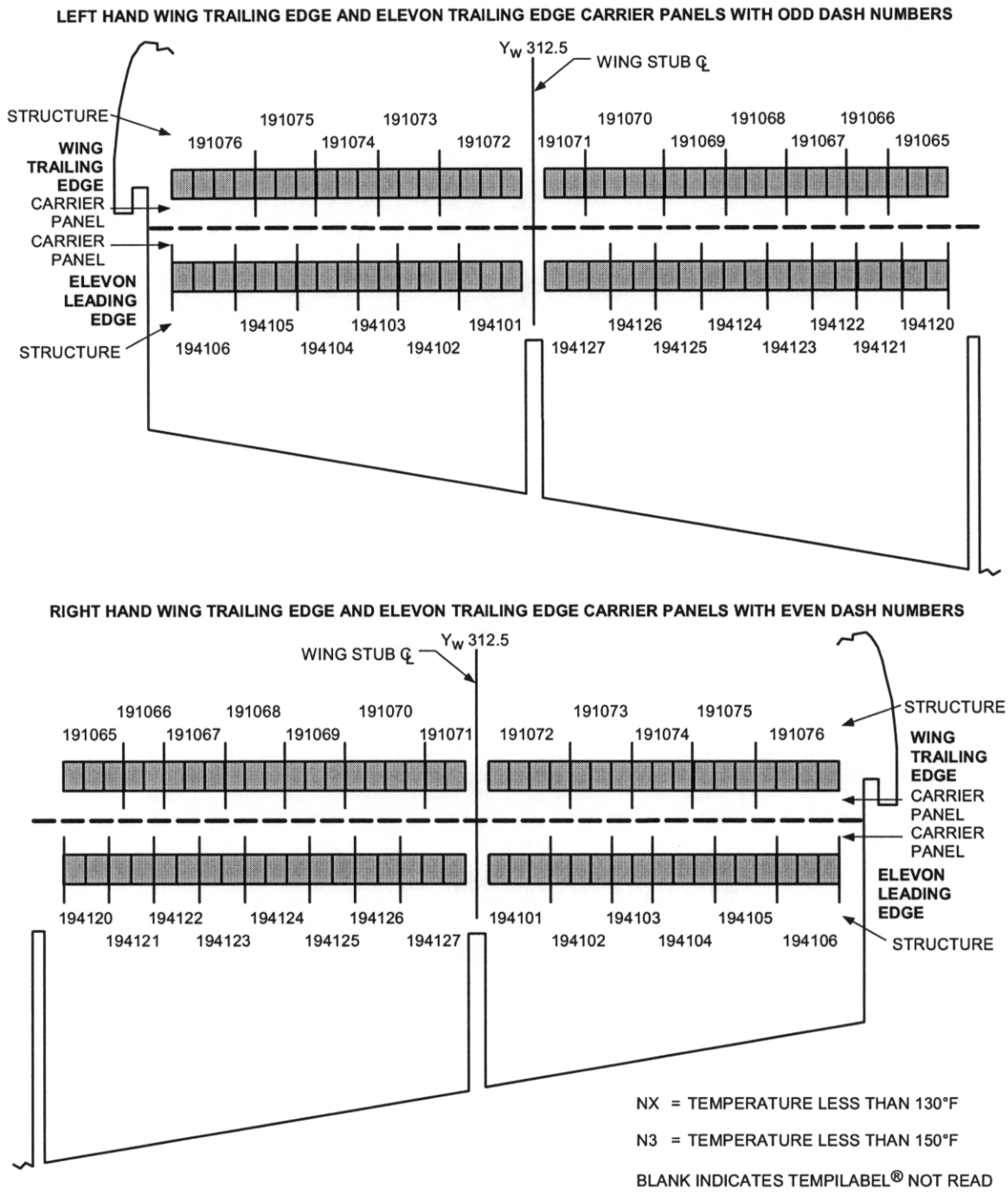

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Figure 10. Wing-Elevon Lower Cove Tempilabel® Data

Table 8. Boundary Layer Transition Flight Comparison - OV-102 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-28R	OV-102	8	1215	900
STS-32R	OV-102	9	1210	1250
STS-35	OV-102	10	1225	1210
STS-40	OV-102	11	1200	1220
STS-50	OV-102	12	1300	1200
STS-52	OV-102	13	1230	1240
STS-55	OV-102	14	1068	1068
STS-58	OV-102	15	1260	1142
STS-62	OV-102	16	1214	1207
STS-65	OV-102	17	NO DATA	NO DATA
STS-73	OV-102	18	1021	893
STS-75	OV-102	19	1260	1260
STS-78	OV-102	20	NO DATA	1261
STS-80	OV-102	21	1233	1233
STS-83	OV-102	22	NO DATA	NO DATA
STS-94	OV-102	23	1040	1040
STS-87	OV-102	24	1281	1234
STS-90	OV-102	25	1186	1047
STS-93	OV-102	26	1328	1276
STS-109	OV-102	27	NO DATA	1199
OV-102 AVERAGE			**1204.4**	**1160.0**
FLEET AVERAGE			**1190.1**	**1173.3**

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Table 9. OV-102 Charred Filler Bar History

MISSION/FLT	CAT 1	CAT 2	CAT 3	OTHER	TOTAL
STS-61C/FLT 7	131	109	21	117	378
STS-28R/FLT 8	1028	436	18	0	1482
STS-32R/FLT 9	330	146	28	0	504
STS-35/FLT 10	57	30	10	0	97
STS-40/FLT 11	38	78	16	0	132
STS-50/FLT 12	73	32	13	0	118
STS-52/FLT 13	38	42	6	0	86
STS-55/FLT 14	82	78	10	0	170
STS-58/FLT 15	117	183	6	0	306
STS-62/FLT 16	129	24	2	0	155
STS-65/FLT 17	8	24	2	0	34
STS-73/FLT 18	35	23	5	0	63
STS-75/FLT 19	54	43	3	0	100
STS-78/FLT 20	18	15	1	0	34
STS-80/FLT 21	71	15	0	0	86
STS-83/FLT 22	26	40	0	43	109
STS-94/FLT 23	39	8	3	20	70
STS-87/FLT 24	30	37	1	0	68
STS-90/FLT 25	12	48	1	18	79
STS-93/FLT 26	13	52	1	1	67
STS-109/FLT 27	22	13	0	14	49
OV-102 AVERAGE	**112.0**	**70.3**	**7.0**	**10.1**	**199.4**
OV-102 MEDIAN	**46.5**	**41.0**	**4.0**	**0.0**	**98.5**
FLEET AVERAGE	**71.3**	**45.4**	**3.8**	**5.0**	**125.5**
FLEET MEDIAN	**28.0**	**26.0**	**2.0**	**0.0**	**74.5**

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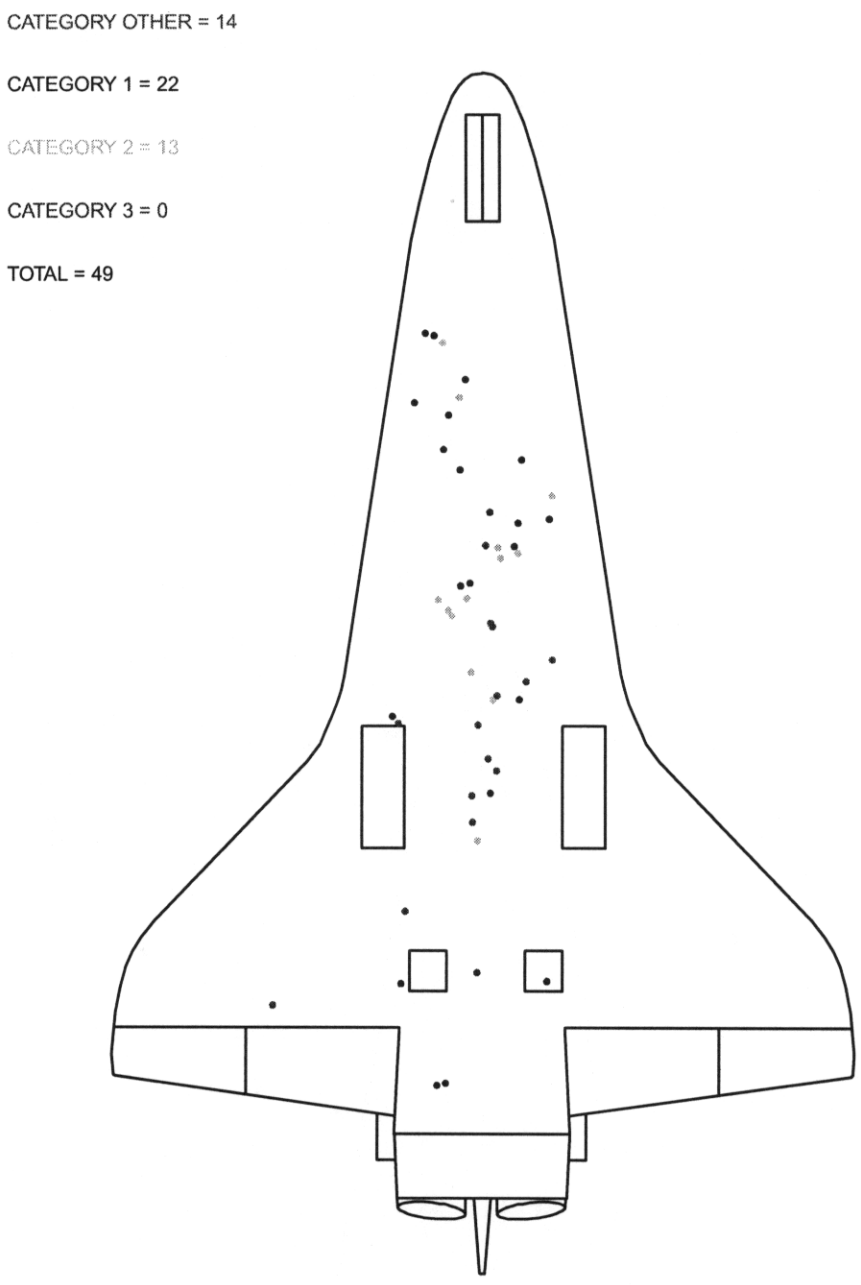

Figure 11. Charred Filler Bar Locations

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5.0 EVALUATION

5.1 Lower Fuselage and Wings

5.1.1 General

(B. McCartin)

The post-flight inspection of the lower fuselage and lower surface wing areas found the TPS components to be in nominal condition. The number of debris impacts on the lower surface was below the vehicle and fleet average. Damages were concentrated primarily along the wing chine areas and in areas around the ET doors, which is typical for lower surface damages. The number of large damages (>1 inch in diameter) was also below the vehicle and fleet averages with depths generally 0.13 inch or less. The majority of impacts were within criteria suitable for repair utilizing standard procedures (refer to photo 5 and photo 6).

Post-flight walkdown and surveillance of lower surface areas revealed two protruding Ames gap fillers and one design pillow gap filler.

One protruding Ames was located on the left outboard elevon between tiles V070-193014-075 and V070-193018-115 with a protrusion of approximately 0.75 inch constant (refer to photo 7). The other protruding Ames was located on the right ET door between tiles V070-395055-097 and V070-395025-037 with a protrusion of approximately 0.4 inch constant (refer to photo 8). There was no notable degradation of adjacent RSI components due to the protruding Ames gap fillers.

The protruding design pillow gap filler (V070-191135-085) was located on the left wing between the V070-191025-456 and V070-191026-283 tiles with a protrusion of 1 inch constant (refer to photo 9). The disturbed airflow caused by the protruding gap filler resulted in excessive localized heating. This excessive localized heating caused the gap filler to shrink and also slumped the V070-191026-283 and V070-191026-061 tiles resulting in removal of both parts. The gap filler displacement and shrinkage allowed flow into the lower portion of the tile-to-tile gap resulting in charred SIP, filler bar, and instrumentation wiring. The V070-191025-456 tile was removed due to SIP charring and the V070-191025-301 tile was removed to determine the extent of wiring damage.

The V07P8085A measurement associated with the charred wiring is a pressure port instrument that is not a life-long measurement to be maintained active. Given the condition of the wiring and the amount of rework involved to maintain this measurement, the decision was made to permanently deactivate the measurement by terminating wires at the cavity perimeter and updating the instrumentation tracking drawing (V070-780122) via the EOTF category.

Several captive gap fillers installed between tiles on the right wing glove area were breached. Due to the overall condition of the gap fillers and the limited repair options, the V070-394503-283, -285, and V070-394504-382 tiles were removed and replaced along with the associated gap fillers.

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Photo 5. Lower Left-Hand Chine Debris Impact

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Photo 6. Right-Hand and Lower Surface Debris Impacts

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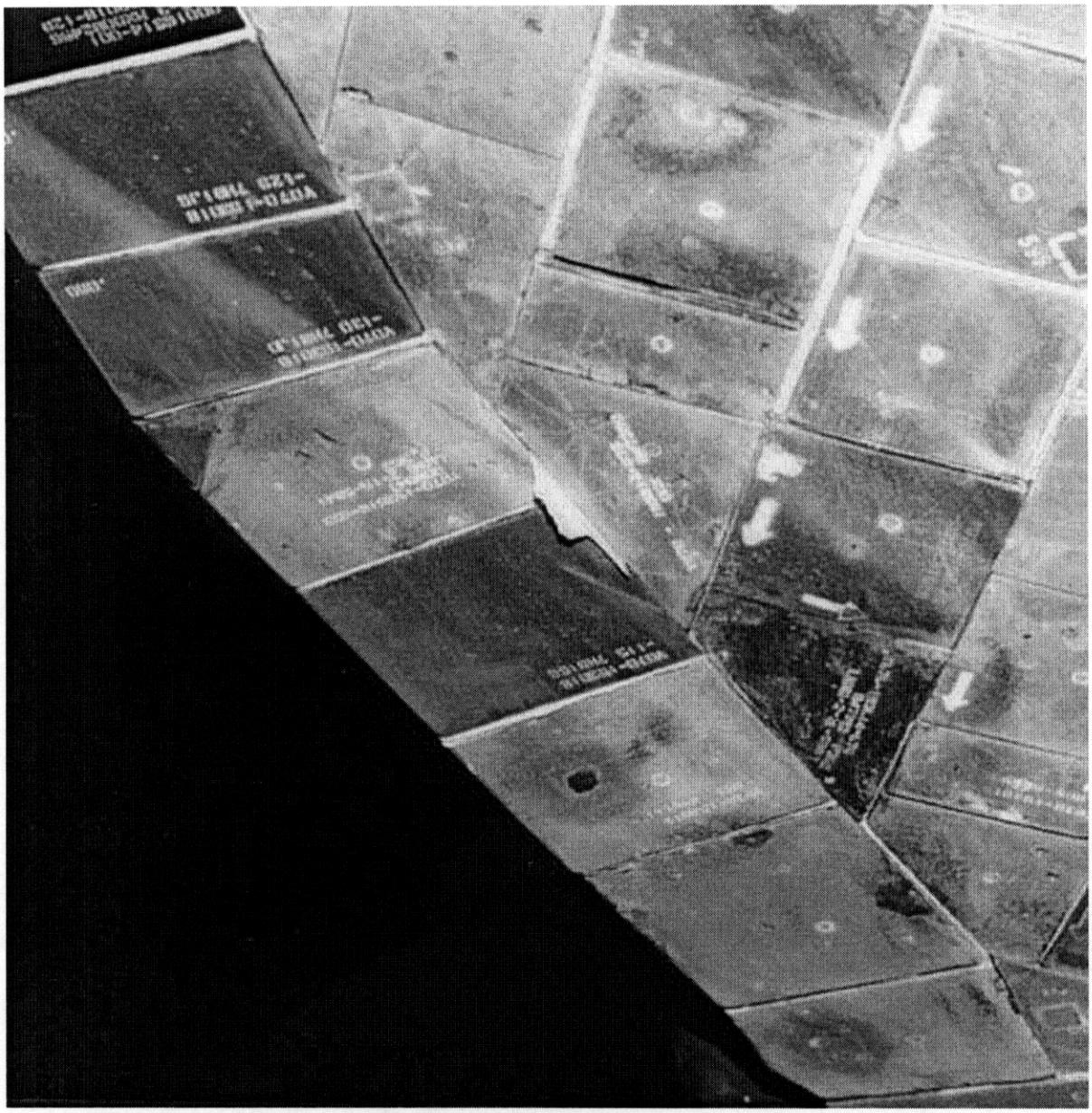

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Photo 7. Protruding Ames Gap Filler on Left Outboard Elevon

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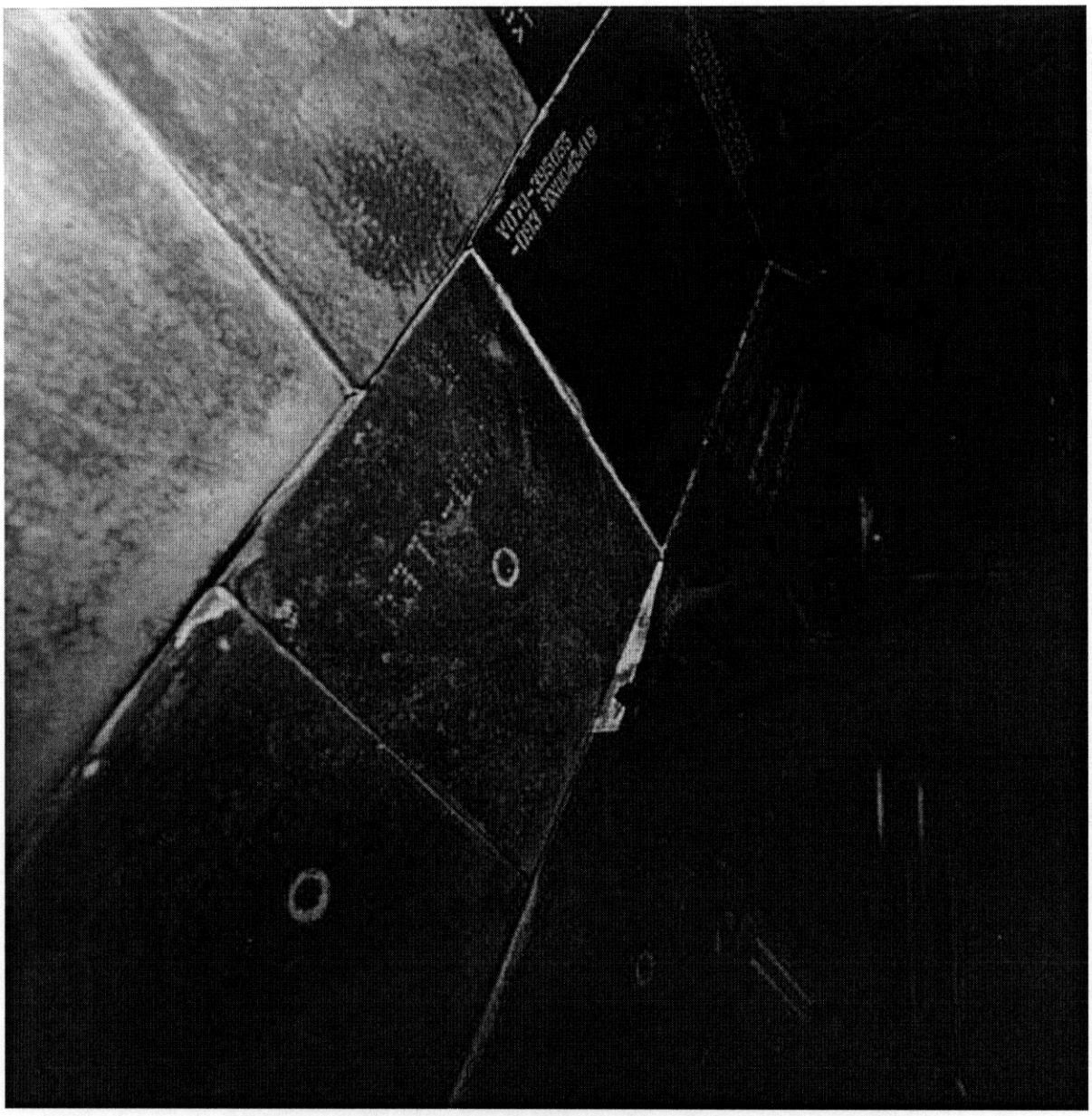

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Photo 8. Protruding Ames Gap Filler on Right ET Door

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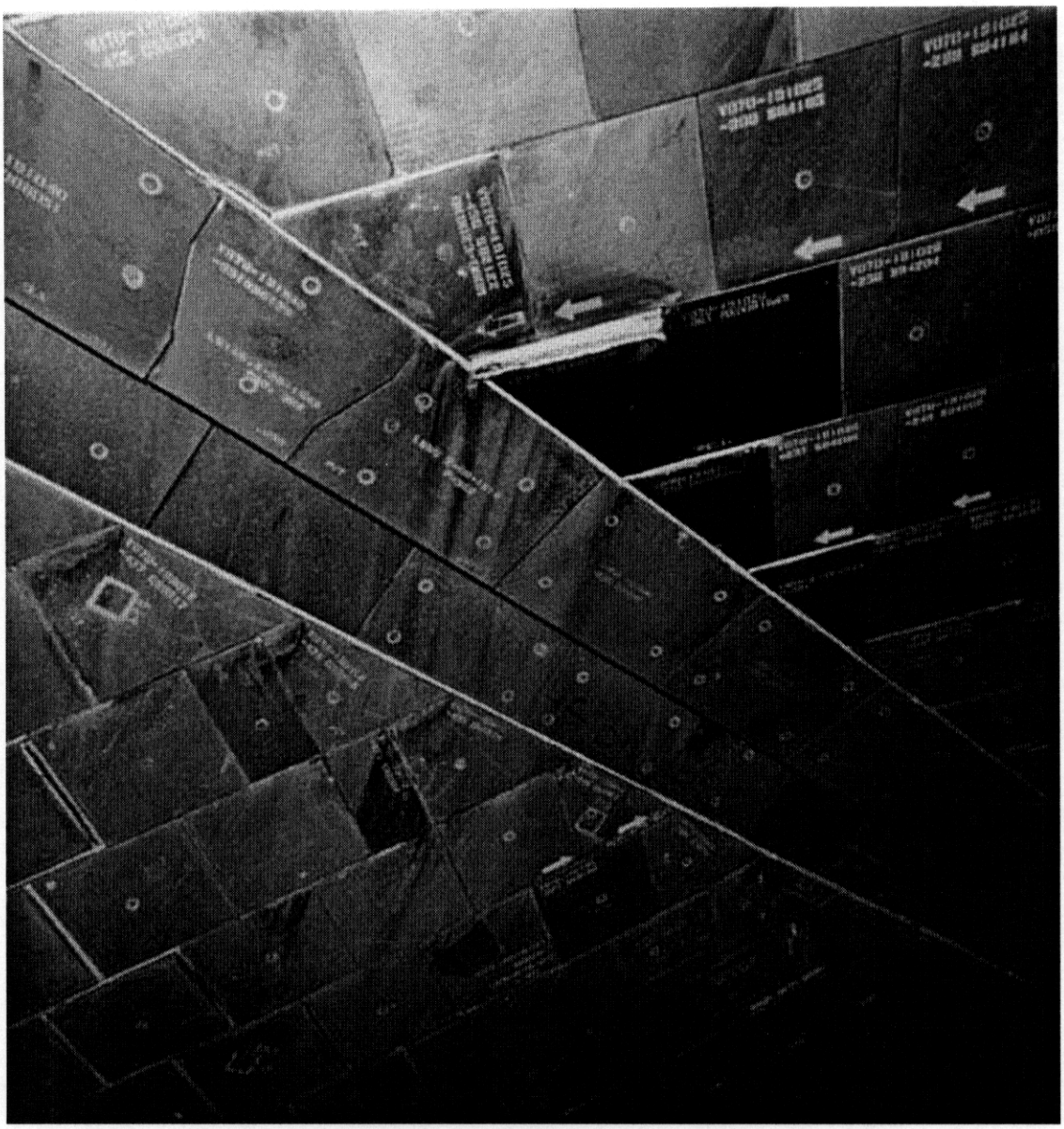

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Photo 9. V070-191135-085 Pillow Gap Filler Protruding On Lower Left Wing

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5.1.2 Nose Landing Gear Door Area

(B. McCartin)

The overall condition of the chin panel installation appeared nominal with the exception of the V070-399441-044 gap filler (chin panel/nose cap expansion seal interface). The gap filler outer fabric was breached in two locations. This gap filler was newly installed during J3 OMM prior to flight 27. Possible contributing factors in the premature failure of the gap filler were type A sealant from the nose cap assembly and marginal step/gap conditions at the chin panel to nose cap expansion seal interface. The type A sealant on the nose cap assembly was refurbished during J3 OMM. The type A sealant may have caused the outer fabric of the gap filler to adhere to the nose cap expansion seal resulting in separation of the outer fabric during gap expansion. Several locations along the chin panel to nose cap interface were noted as having out-of-tolerance step/gap conditions prior to flight 27. These conditions may have caused localized heating in the noted gap resulting in degradation of the gap filler outer fabric (refer to photo 10 and photo 11). Refer to section 5.1.4 for additional details.

Tile installations on the nose landing gear doors appeared nominal with no major damages to periphery tiles. The V070-391025-046 tile on the left-hand door was removed and replaced due to degraded previous repairs as well as new flight damage.

The NLGD thermal barriers were in good condition with the exception of seven previously flown thermal barriers, which were replaced due to flight damage. In addition, 15 thermal barriers were removed in support of the chin panel removal. New thermal barriers were installed at these locations. The three chin panel OML thermal barriers (V070-398379-009 (2) and V070-398379-010) were replaced with a single OML thermal barrier (V070-398379-017) in accordance with V070-398379 EO B03. This modification was implemented to reduce the number of OML thermal barrier junctions along the chin panel, which contributed to damage along the interfacing tile lips. Several patches installed to improve the compression of the NLGD thermal barrier seal-to-door periphery tiles were frayed/degraded (refer to photo 12). The removal and replacement of several primary thermal barriers consequently eliminated the degrading patches. Refer to table 10 for NLGD thermal barrier replacement history and locations.

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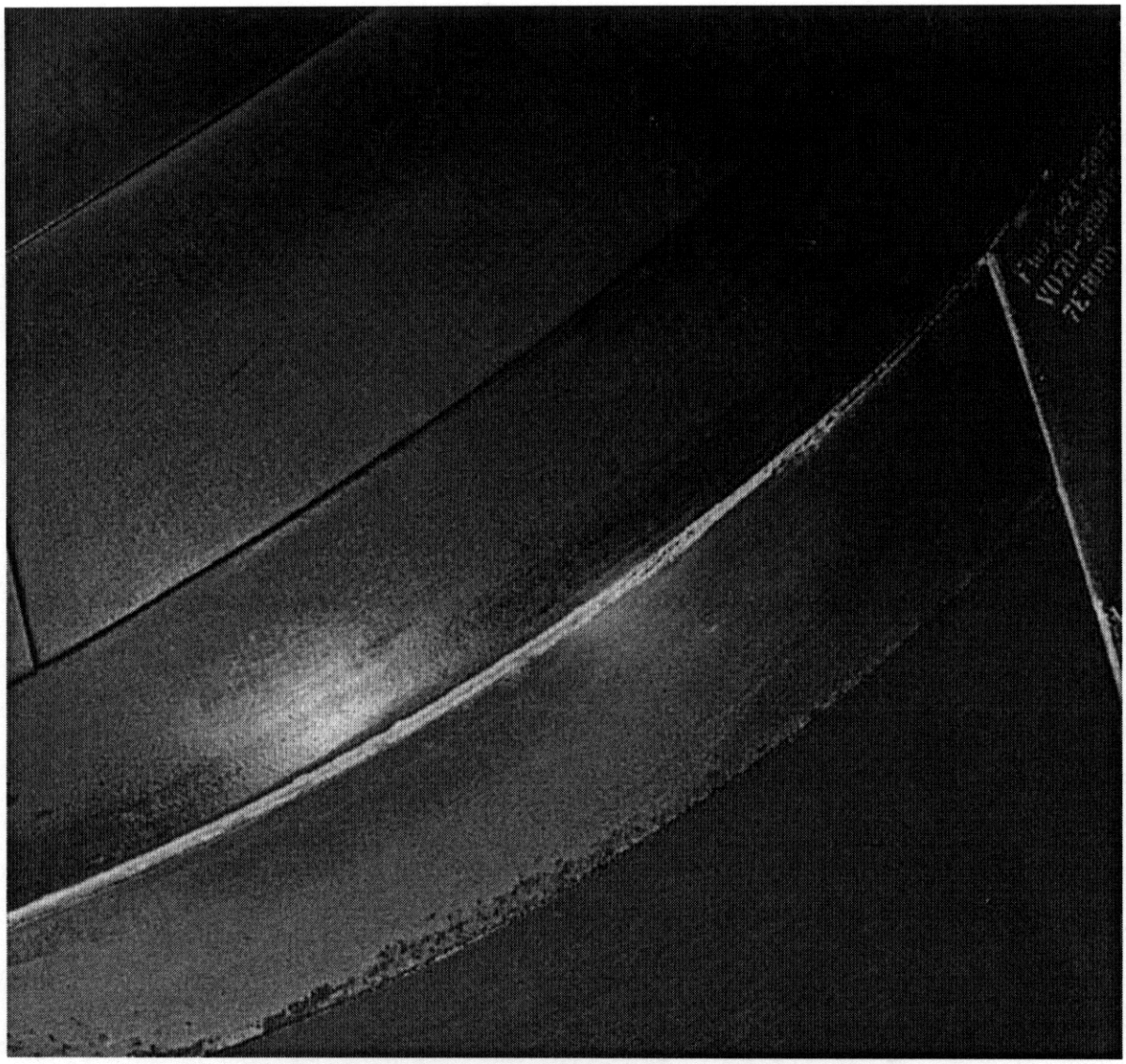

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Photo 10. V070-399441-044 Gap Filler Breached Location On Left-Hand Side

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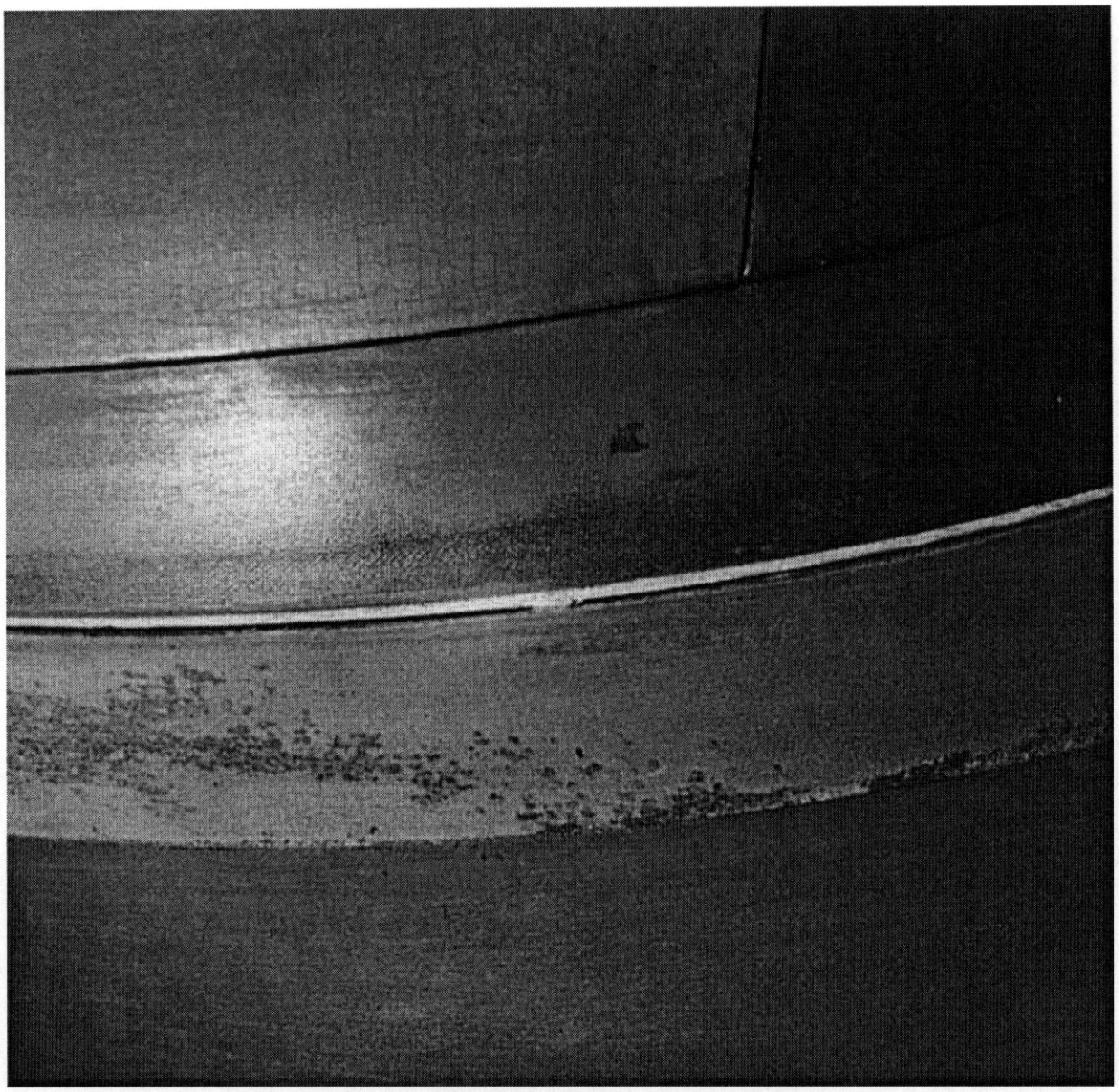

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Photo 11. V070-399441-044 Gap Filler Breached Location Left of Centerline

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Photo 12. OML And Primary Thermal Barrier Patches At Aft Right-Hand Hingeline Of NLGD Area

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Table 10. OV-102 NLGD Thermal Barrier Replacement History

BARRIER	POST-FLIGHT NUMBER									
	24	25	26	27	28	29	30	31	32	33
C1 - OML	D	NR	P	P						
C1 - PRIMARY	B	NR	P	P						
C1 - SECONDARY	B	B	P	P						
C2 - OML	NR	NR	D	NR						
C2 - PRIMARY	NR	NR	NR	NR						
C2 - SECONDARY	NR	NR	NR	NR						
C3 - PRIMARY	NR	NR	NR	NR						
C4 - OML	NR	NR	D	NR						
C4 - PRIMARY	NR	NR	NR	NR						
C5 - OML	D	NR	D	NR						
R1 - OML	D	NR	P	P						
R1 - PRIMARY	B	NR	P	P						
R1 - SECONDARY	B	NR	P	P						
R2 - OML	NR	NR	P	P						
R2 - PRIMARY	NR	NR	P	P						
R2 - SECONDARY	NR	NR	P	P						
R3 - OML	NR	NR	D	NR						
R3 - PRIMARY	NR	NR	NR	NR						
R3 - SECONDARY	NR	NR	NR	NR						
R4 - OML	D	D	NR	D						
R4 - PRIMARY	NR	NR	NR	NR						
R4 - SECONDARY	NR	NR	NR	NR						
R5 - OML	D	NR	NR	D						
R5 - PRIMARY	NR	NR	NR	D						
R6 - OML	D	NR	NR	NR						
R6 - PRIMARY	NR	D	NR	NR						
L1-OML	D	NR	P	P						

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-102 NLGD Thermal Barrier Replacement History (cont'd)

BARRIER	POST-FLIGHT NUMBER									
	24	25	26	27	28	29	30	31	32	33
L1 - PRIMARY	B	NR	P	P						
L1 - SECONDARY	B	B	P	P						
L2 - OML	NR	NR	P	P						
L2 - PRIMARY	NR	NR	P	P						
L2 - SECONDARY	NR	NR	P	P						
L3 - OML	NR	NR	NR	D						
L3 - PRIMARY	NR	NR	NR	NR						
L3 - SECONDARY	NR	NR	NR	NR						
L4 - OML	NR	NR	NR	D						
L4 - PRIMARY	NR	NR	NR	NR						
L4 - SECONDARY	NR	NR	NR	NR						
L5 - OML	NR	NR	NR	D						
L5 - PRIMARY	NR	NR	NR	D						
L6 - OML	B	NR	NR	NR						
L6 - PRIMARY	NR	D	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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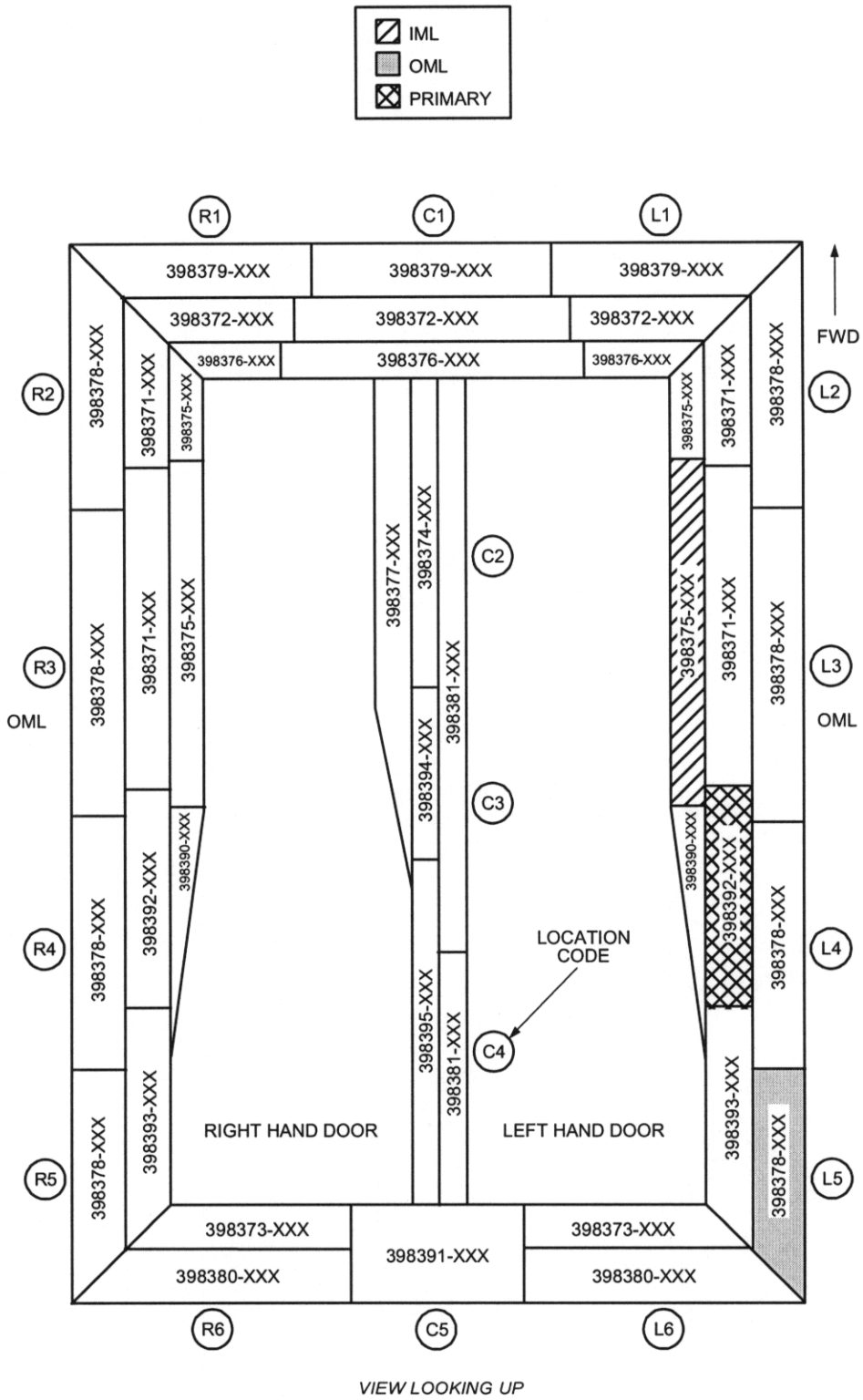

Figure 12. Nose Landing Gear Door Thermal Barrier Location References

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5.1.3 Main Landing Gear Door Area

(B. McCartin)

Post-flight evaluation of the MLGD areas concluded that the TPS performed nominally and no major damage of RSI components was evident. The V070-191121-006 tile sustained a shallow edge damage at the interface to the adjacent thermal barrier. The damaged area did not result in any subsurface flow or overtemperature between the tile and the thermal barrier. This tile is located at the forward/outboard corner (structure side) of the right-hand MLGD. Damage at this location is consistent with damages seen on the other vehicles (refer to photo 13).

Several breached thermal barriers were found around the periphery of the right-hand MLGD cavity. Three thermal barriers on the left-hand MLGD and eight thermal barriers on the right-hand MLGD door were removed and replaced due to flight damage (refer to photo 13 and photo 14). Refer to table 11 for MLGD thermal barrier replacement history and locations.

Table 11. OV-102 MLGD Thermal Barrier Replacement History

BARRIER	POST-FLIGHT NUMBER									
	24	25	26	27	28	29	30	31	32	33
L1	NR	NR	D	NR						
L2	D	D	NR	NR						
L3	D	NR	AN	D						
L4	D	NR	D	NR						
L5	D	NR	AN	D						
L6	NR	NR	NR	NR						
L7	NR	NR	D	NR						
L8	NR	NR	D	NR						
L9	NR	NR	D	NR						
L10	NR	NR	D	NR						
L11	NR	NR	D	NR						
L12	D	NR	D	NR						
L13	NR	NR	NR	D						
L14	NR	NR	D	NR						
L15	D	NR	D	NR						

B - DEBOND
D - DAMAGE
G - DEGRADED
P - CHIN PANEL SUPPORT
A - ACCESS TO ADJACENT COMPONENT
AN - ACCESS TO ADJACENT COMPONENT (NOT REPLACED)
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-102 MLGD Thermal Barrier Replacement History (cont'd)

BARRIER	POST-FLIGHT NUMBER									
	24	25	26	27	28	29	30	31	32	33
L16	D	NR	NR	NR						
L17	NR	NR	NR	NR						
L18	NR	NR	D	NR						
L19	NR	NR	NR	NR						
L20	NR	NR	NR	NR						
L21	NR	NR	AN	NR						
R1	D	NR	NR	D						
R2	NR	D	NR	NR						
R3	D	NR	D	D						
R4	NR	NR	D	NR						
R5	NR	NR	D	NR						
R6	NR	NR	D	NR						
R7	NR	NR	NR	NR						
R8	NR	NR	NR	NR						
R9	NR	NR	NR	NR						
R10	NR	D	NR	NR						
R11	D	D	AN	D						
R12	NR	D	AN	D						
R13	NR	NR	D	NR						
R14	D	NR	NR	D						
R15	NR	D	NR	D						
R16	NR	NR	D	NR						
R17	NR	NR	D	NR						
R18	NR	NR	D	NR						
R19	NR	NR	D	NR						
R20	D	NR	NR	D						
R21	D	D	NR	D						

B - DEBOND
D - DAMAGE
G - DEGRADED
P - CHIN PANEL SUPPORT
A - ACCESS TO ADJACENT COMPONENT
AN - ACCESS TO ADJACENT COMPONENT (NOT REPLACED)
NR - NO REPLACEMENTS TOOK PLACE

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

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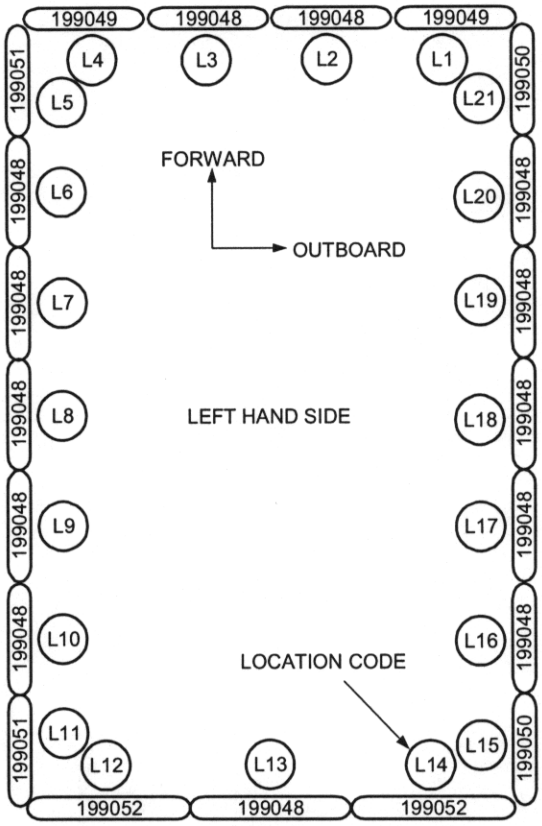

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Figure 13. Main Landing Gear Door Thermal Barrier Location References, Left-Hand Side

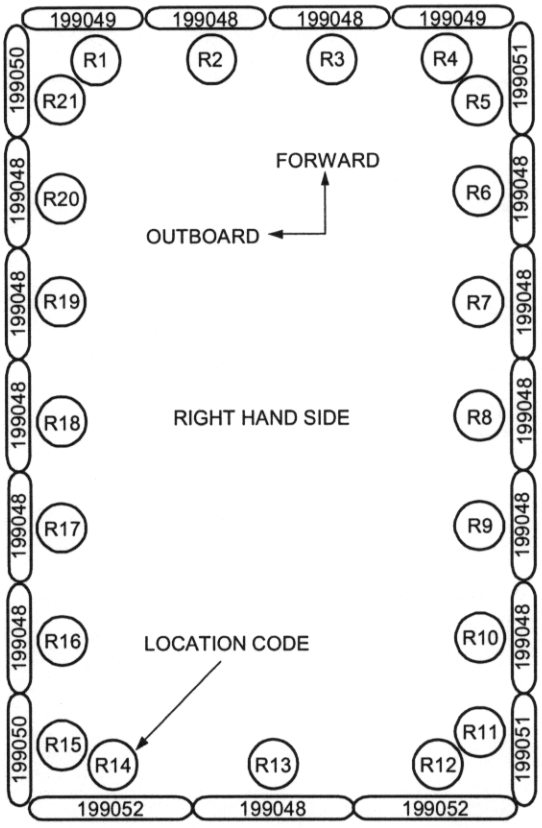

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Figure 14. Main Landing Gear Door Thermal Barrier Location References, Right-Hand Side

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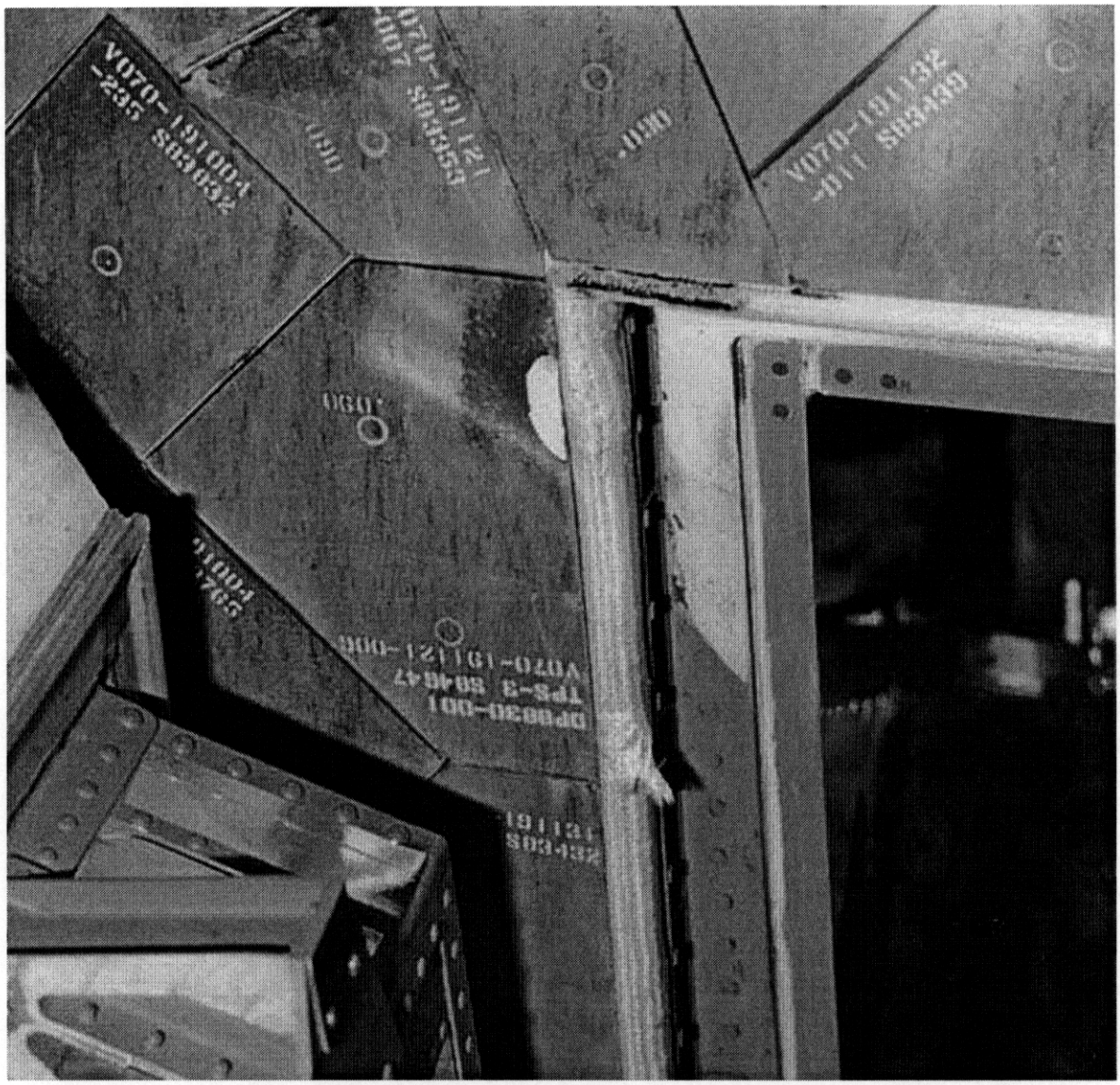

Photo 13. V070-191121-006 Tile Damage and Torn Thermal Barrier At Forward/Outboard Corner of Right-Hand MLGD

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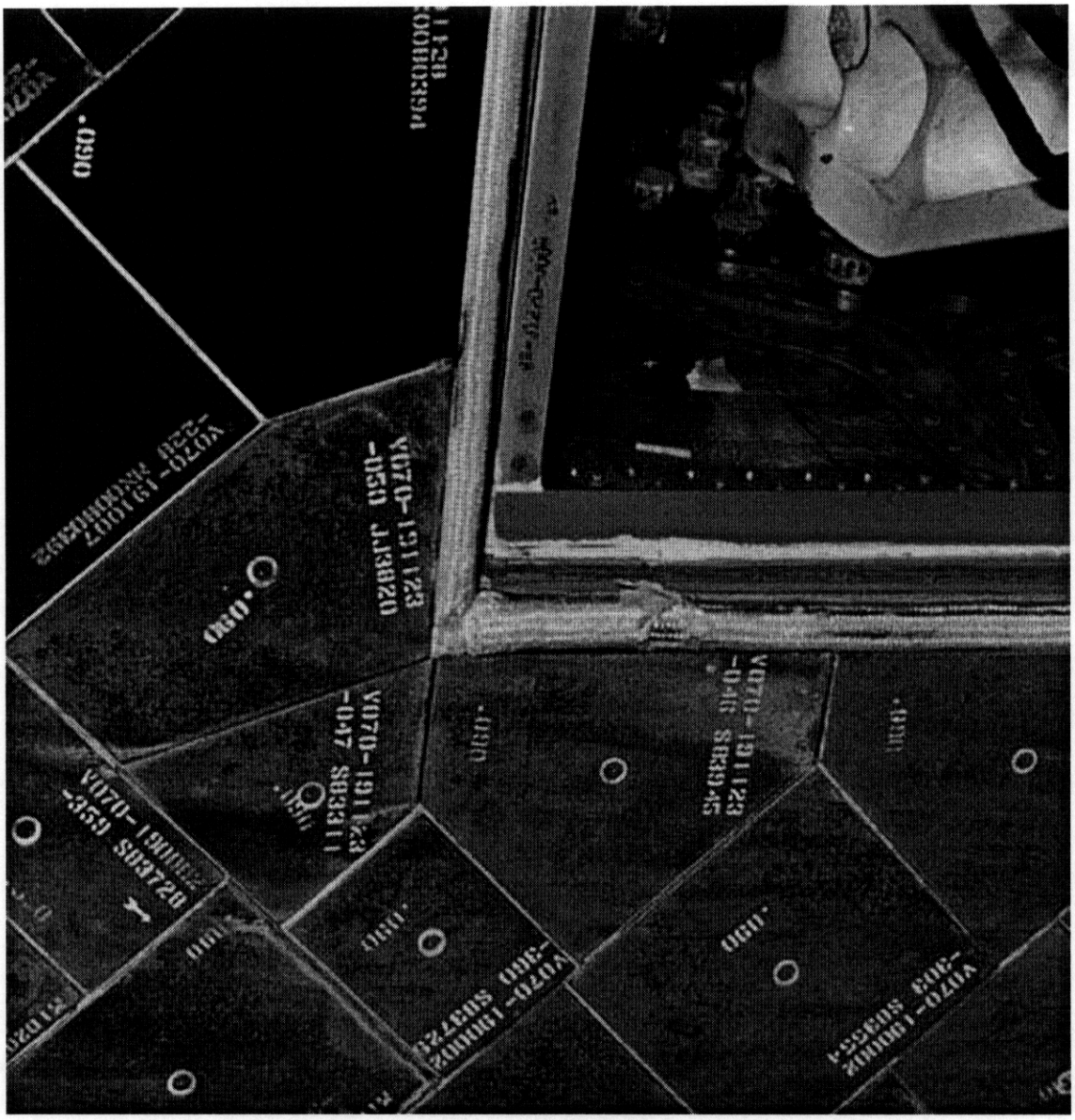

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Photo 14. Damaged Thermal Barrier At Aft/Inboard Corner of Right-Hand MLGD

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5.1.4 Leading Edge Structural Subsystem

(M. Gordon/G. Grant)

In general, the LESS was in nominal post-flight condition, however, there was a necessity to remove the chin panel assembly on account of severe damage to the V070-399441-041 gap filler. Also, there was a bizarre contamination discovery in the left wing RCC cavity. The gap filler data gathered during post-flight engineering inspection is shown in figure 15.

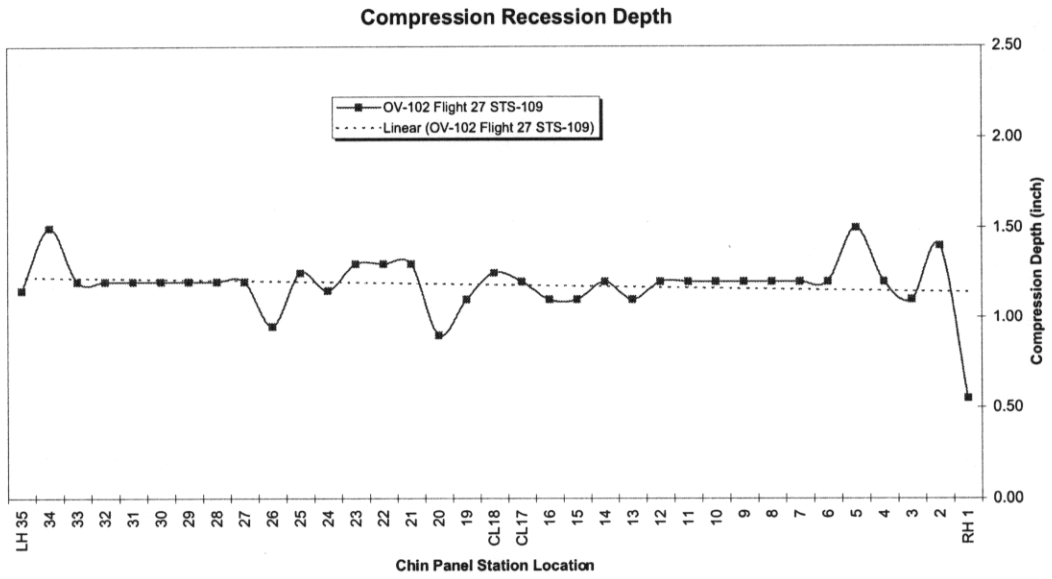

Figure 15. OV-104 Gap Filler Compression Recession Measurements

The V070-399441 gap filler was breached in two locations. One location was approximately 2.5 inches in length and was located on left side 6 to 8 inches from the outboard edge of the chin panel and the other location was approximately 0.5 inch in length and was located just left of the centerline (refer to photo 15). The inner fabric was exposed on the larger damage toward the outboard left portion of the gap filler. Aside from the damages, the outer fabric of this gap filler appeared to be separated by adhering to both the nose cap expansion seal and the chin panel gap seal. In addition to the damages to the V070-399441 gap filler, there were significant damages to the V070-399412-053, V070-399412-082, V070-399442-009, and V070-399442-010 gap fillers that warranted replacement.

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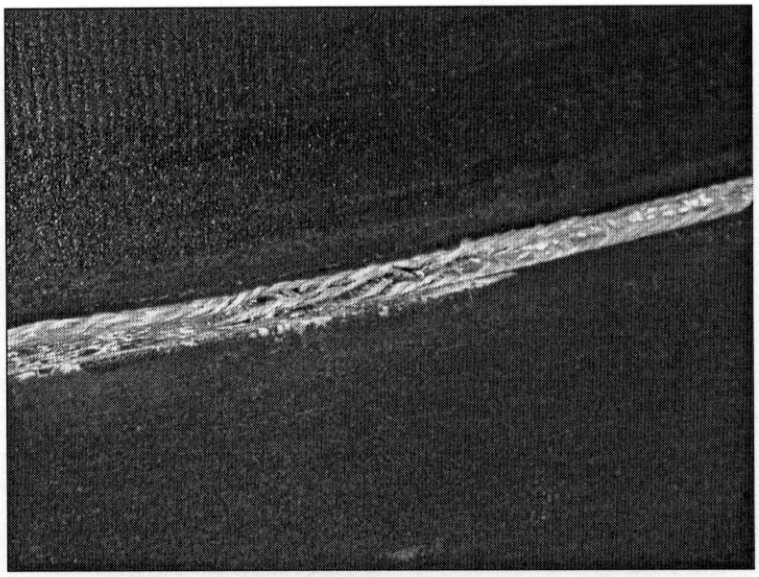

Photo 15. V070-399441 Gap Filler Adherence to Adjacent RCC

The result of these softgood damages warranted the removal of the chin panel; however, there was also a concern with the aerothermal roughness of the installation. The preflight concerns with the installation step and gap conditions were addressed by the evaluation of the internal components. Since there was no internal thermal damage to the softgoods and that the reinstallation step and gap measurements did not exceed those accepted before the STS-109 mission, there was no requirement for chin panel reshimming to improve the marginal step condition between the nose and chin panel.

During the chin panel rework, the reported adherence of the fabric to the adjacent RCC was addressed by wet sanding the RCC to remove the glass fibers embedded on the glass sealant. Prior to this repair, a 0.23 inch by 0.05 inch by 0.028 inch silicon carbide chip in the right-hand outboard corner of the MC621-0007-8557 chin panel angle seal was discovered and was repaired per ML0601-9026 procedure TPS-365 method A after the wet sanding.

The stress analysis of the OV-102 RCC nosecap/chin panel design step exceedance for the next mission, STS-107, NEOM trajectory was performed under direction of the LESS PRT. The step and gap measurements across the interface between the nose cap and chin panel assemblies following OMM revealed unacceptable surface roughness. This high roughness would result in increased aeroheating of the orbiter lower surface. The next flight of OV-102, STS-107, has a higher heating than STS-109, the last flight of OV-102. All margins of safety for this STS-107 flight, using flight specific temperature data, were determined to be positive for the chin panel structure. The results for this Nose Cap/Chin Panel Step Exceedance Study indicate a 0.06 (0.10 for STS-109) first-flight margin of safety and a mission life of 70 missions based on mass loss cutoff values of the OV-102 RCC Chin Panel Expansion Mission Mix. This analysis shows that the OV-102 chin panel has no restrictions to flight due to the nosecap-to-chin panel step.

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There was an unusual discovery on the left wing leading edge. USA QC inspectors discovered the condition during V6028 inspections of the wing leading edge and upper wing. There is a discolored area on the upper wing that emanates from the number 15 upper access panel gap (refer to photo 16). This gap is intended to vent the RCC cavity and from the appearance of the upper wing, these vented gases included some condensable material that collected on the upper wing HRSI/LRSI tiles. This condition was sampled and analyzed for elemental identification. The contaminant was a curious lead-rich inorganic residue.

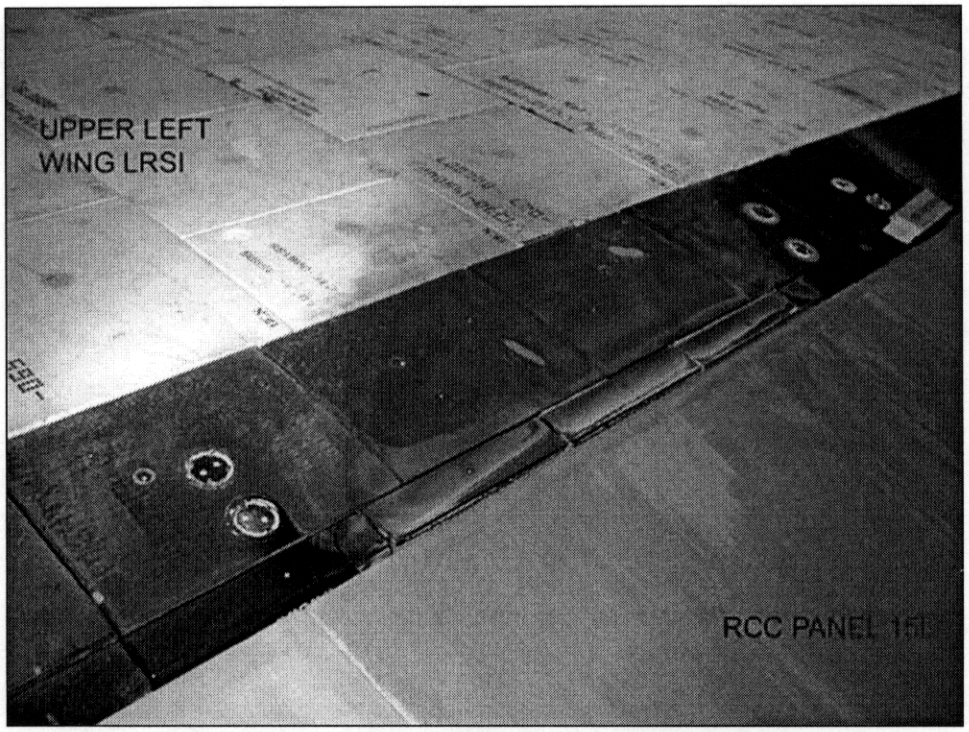

Photo 16. Upper Wing Discoloration

It should be noted that there was a low compression condition on the spar-side of the V070-199728 carrier panel cavity between the V070-199728-043 and V070-192145-033 HRSI tiles. The gap accepted 0.045-inch thick shims with a slight drag, which is far beyond the required 0.010-inch shim check that is performed per V6049.003. There is evidence that there was once an Ames gap filler bonded to that spar-side tile; however, inspection of the V6049.003 paper indicates that there was no Ames gap filler installed for STS-109, nor was there any identification of low compression in the area.

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There was no sign of localized overtemperature (e.g., slumped tile edges/corners, embrittled fabric, etc.) in the area. Given the results of the inspection, it does not appear as though there was any appreciable flow ingestion to call the discrepancy a "flowpath". The upper and lower access panels were removed for further inspection. Upon internal inspection, a white mass of material was discovered in the left-hand WLE panel number 15 cavity as shown in photo 17. The chemical identification of this debris indicated that it was primarily made of an amorphous titanium oxide mass. Although it was widely accepted that this contaminant was benign to the LESS components, the source/cause of this FOD was investigated.

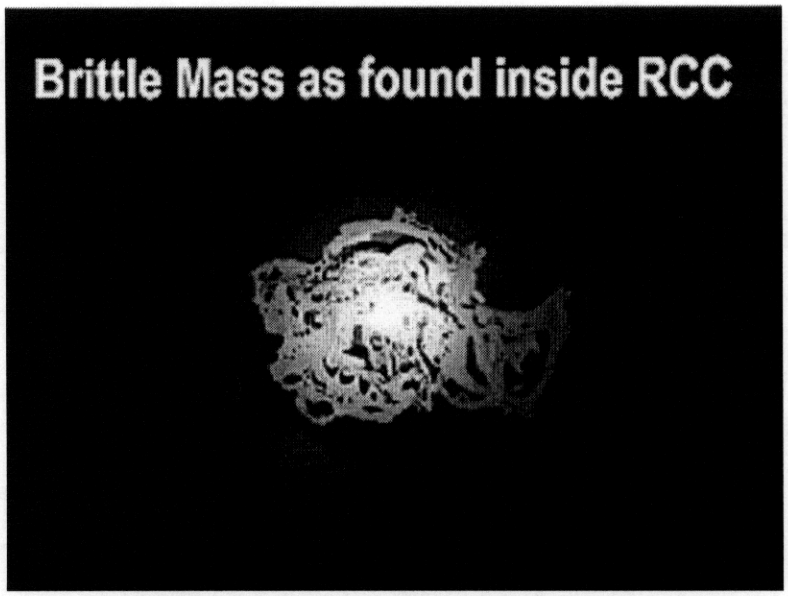

Photo 17. WLE RCC Internal Contaminate

The findings of the LESS PRT investigation identified that the most likely source was a mass of white masking tape that was soiled with a lead-containing paint. Investigation indicated that less than half of a roll of 3M #850 tape would have been able to produce the quantity of material found in the RCC cavity. This used tape ball was believed to have fallen into the RCC cavity during OMM activity in Palmdale. The foreign material was removed from the cavity by vacuuming. The upper wing discoloration was removed using Scotchbrite pad and DI water and no further action was required for internal WLE surfaces. The entire rework was accepted with unrestricted material review board approval.

There was one other problem report event that is worthy of discussion - an excessive flaking discrepancy on the heel portion of a tee seal was documented against the left-hand rib splice 11. This defect has been determined to be flaking of the type A material from a previous repair (tap test was negative for internal defects) and was deemed acceptable per ML0601-0002, section 4.12.6. The cause of the condition was excess type A sealant that was applied to the part following a previous repair because of a void in the carbon substrate beneath the silicon carbide that was crushed from slight finger pressure. This defect was previously written up against

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TES-2-J3-0486 and was documented on CAR KP0274. The defect was repaired by the vendor per 209-21-003 and was accepted for unrestricted use prior to STS-109. The bottom line insofar as DR TES-2-28-0508 is concerned is that the repair is continuing to perform within expectations and no further inspections (outside of the standard post-flight inspections) are required.

Aside from these three events, the overall condition and appearance of the remainder of the LESS was excellent. The type A sealant appeared to be in nominal post-flight condition. No unexpected individual pinhole or pinhole clusters were noted. This inspection indicated that the newly developed RCC refurbishment procedure is continuing to perform within its expectations. The MC621-0007-7009 forward arrowhead plate (35AH001) and MC621-0007-7010 aft arrowhead plate (30AH002) will both fly their second mission on STS-107, after a flawless first flight aboard STS-109.

The engineering walkdown was performed and the lower LESS access carrier panel TPS installations were found to be in nominal post-flight condition. Two carrier panels were removed to replace embrittled horsecollar gap fillers. Quite a few lower LESS carrier panel installations had unacceptable (low) horsecollar gap filler compression and were reworked using the appropriate standard repair. A summary of carrier panel removal activity is included in table 12.

Table 12. LESS Carrier Panel Activity Post STS-109, OV-102 Flight 27

LESS CARRIER PANEL NO.	DISCREPANCY	ACTION TAKEN
LH #1	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199700-041 ON FRONT EDGE OF CARRIER PANEL).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #3	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199704-033 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #9	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199716-054 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #11	LOW HORSECOLLAR GAP FILLER COMPRESSION AT TWO DIFFERENT LOCATIONS (ADJACENT TO V070-199720-043 AND -047 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316 AT BOTH LOCATIONS.
LH #12	LOW HORSECOLLAR GAP FILLER COMPRESSION WHICH SPANS MULTIPLE TILES (ADJACENT TO V070-199722-041 AND -043 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #13	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199724-047 ON WING SPAR SIDE); UNACCEPTABLE HORSECOLLAR GAP FILLER RECESSION (ADJACENT TO V070-199724-041 TILE ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316; INSTALL TADPOLE GAP FILLER (TO REDUCE RECESSION) PER TPS-316.

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Table 12. LESS Carrier Panel Activity Post STS-109, OV-102 Flight 27 (cont'd)

LESS CARRIER PANEL NO.	DISCREPANCY	ACTION TAKEN
LH #15	POSSIBLE FLOWPATH DETECTED AROUND UPPER ACCESS CARRIER PANEL V070-199729-057.	UPPER AND LOWER ACCESS PANELS WERE REMOVED TO EVALUATE. REFER TO THIS SECTION AND SECTION 5.2.1 FOR DETAILED EXPLANATION.
LH #16	LOW HORSECOLLAR GAP FILLER COMPRESSION WHICH SPANS MULTIPLE TILES (ADJACENT TO V070-199730-041, -043, -045, AND -047 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #18	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199734-047 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
LH #19	HORSECOLLAR GAP FILLER IS BRITTLE ADJACENT TO V070-199736-047 TILE.	REMOVE CARRIER PANELS PER ML0601-9028 PROCESS T-330; REFURBISH INSTALLATIONS WITH NEW HORSECOLLAR GAP FILLER AND OTHER PARTS AS APPLICABLE PER ML0601-9028 PROCESS T-331, T-332, AND/OR T-333; REINSTALL CARRIER PANELS.
LH #20	HORSECOLLAR GAP FILLER IS BRITTLE ADJACENT TO V070-199738-033 TILE.	REMOVE CARRIER PANELS PER ML0601-9028 PROCESS T-330; REFURBISH INSTALLATIONS WITH NEW HORSECOLLAR GAP FILLER AND OTHER PARTS AS APPLICABLE PER ML0601-9028 PROCESS T-331, T-332, AND/OR T-333; REINSTALL CARRIER PANELS.
LH #22	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199742-049 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
RH #2	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199702-034 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
RH #5	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199708-038 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
RH #7	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199712-038 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.
RH #8	LOW HORSECOLLAR GAP FILLER COMPRESSION (ADJACENT TO V070-199714-048 ON WING SPAR SIDE).	INSTALL AMES GAP FILLER (TO INCREASE COMPRESSION) PER TPS-316.

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5.1.5 External Tank Door Area

(B. McCartin)

All of the perimeter thermal barriers for both ET doors were removed and replaced during J3 OMM prior to flight 27. Post-flight 27 inspection of the external tank door thermal barriers concluded that three barriers on the right-hand door and two barriers on the left-hand door required replacement due to flight damage or degradation. The forward and aft outboard thermal barriers on the left-hand door were replaced due to outer fabric damage. The forward and aft (small) hinge cover thermal barriers were replaced on the left-hand door due to splits in the outer fabric caused by apparent pinching from the door hinges. Evaluation of the ET doors and door cavity found various minor damages to tile surfaces. All other RSI components were found to be in nominal condition. Refer to table 13 for ET door thermal barrier replacement history and locations, and photo 18 for left-hand ET door tile damages.

Table 13. OV-102 External Tank Door Replacement History

BARRIER	POST-FLIGHT NUMBER									
	24	25	26	27	28	29	30	31	32	33
L1	G	A	G	NR						
L2	G	A	G	NR						
L3	G	A	G	NR						
L4	G	A	G	D						
L5	G	A	G	D						
L6	G	A	G	NR						
L7	G	A	G	NR						
R1	G	A	G	NR						
R2	G	A	G	G						
R3	G	A	G	NR						
R4	G	A	G	NR						
R5	G	A	G	G						
R6	G	A	G	G						
R7	G	A	G	NR						

B - DEBOND
D - DAMAGE
G - DEGRADED
L - 3 FLIGHT CYCLE LIMIT
A - ACCESS TO ADJACENT COMPONENTS
NR - NO REPLACEMENTS TOOK PLACE

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

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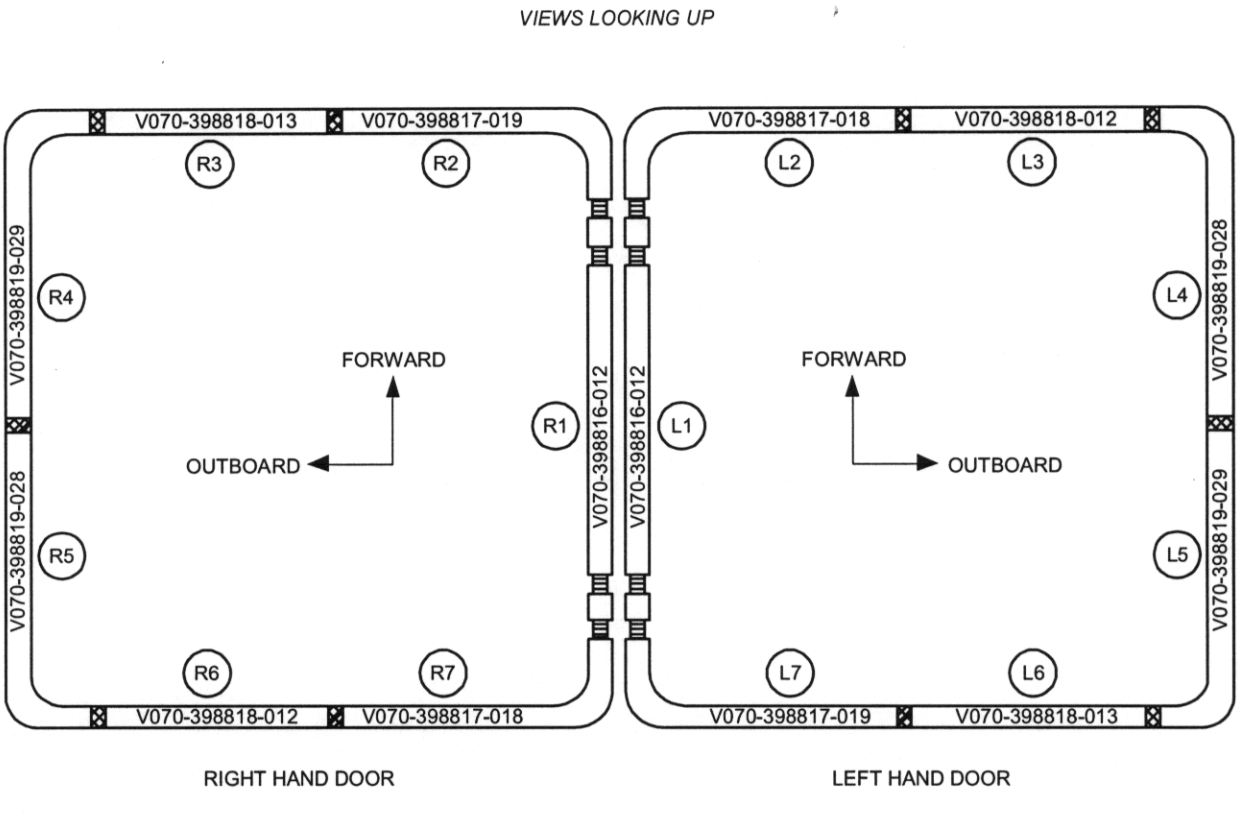

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Figure 16. External Tank Thermal Barrier Location References

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Photo 18. Tile Damages at Left-Hand ET Door Perimeter Structure

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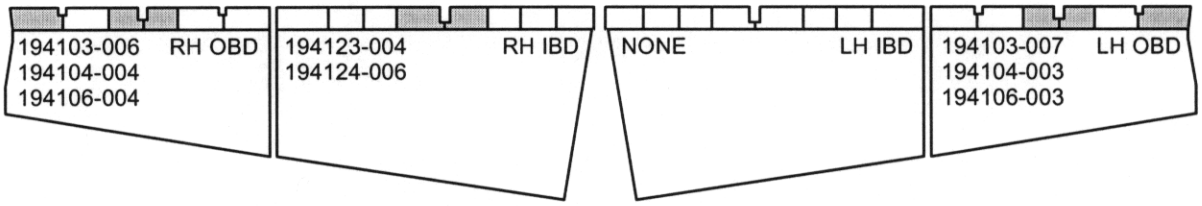
5.1.6 Elevon Area

(G. Grant)

The overall condition of the elevon cove was good. Several discrepancies were written on various types of degradation to tiles, gap fillers, and cove blankets. Specific information on some of these is listed in table 14. Prior to the launching of the STS-109 mission, an interesting problem was discovered on OV-104 during processing for its upcoming STS-110 mission. The V070-191068-016 panel was removed in support of rework to reduce the leak rate. Upon takedown of the panel, scorched SIP and some discolored Koropon was found. An evaluation of what caused the degradation determined that the potential existed on all of these installations for each vehicle to have gaps between the V070-191044 blankets and the V070-191039 and V070-191040 tiles. OV-102 was approved to fly STS-109 without inspection or rework as it was determined that all of the installations were fully disassembled during the OMDP prior to STS-109. Some of the post-flight rework will correct these deficiencies in areas where carrier panels were taken down post STS-109 mission with material review board approval.

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



P ELEVON	ANEL NUMBER V070-	ASSOCIATED WAD	PART NUMBER V070-	REASON REMOVED	RESOLUTION
RIGHT-HAND INBOARD	194123-004 194124-006	NA	NA	ELEVON COVE	REPLACE DEGRADED/ DAMAGED PARTS
RIGHT-HAND OUTBOARD	194103-006	RWNG-A0198	191044-032	COVER ASSY HAD PREVIOUS SCREED REPAIR	REMOVE CARRIER PANEL AND REPLACE COVER ASSY
	194104-004	RWNG-6805	194141-086	GAP FILLER DEGRADED	REMOVE CARRIER PANEL AND REPLACE GAP FILLER
	194106-004	V6059.004	NA	OMRSD INSPECTION	ROUTINE REFURBISHMENT; REINSTALLATION
LEFT-HAND INBOARD	NONE	NA	NA	NA	NA
LEFT-HAND OUTBOARD	194103-007	LWNG-6806	193024-067	FLOWPATH ON 194144-009 ASSY	REPLACE DEGRADE/ DAMAGED PARTS
	194104-003	LWNG-6804	191044-191	BLANKET STRAP DEBONDED	REBOND STRAP PER TPS-343
	194104-003	LWNG-6805	193049-024	GAP FILLER BONDLINE VOIDS	REPLACE GAP FILLER PER P-600/601
	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

(B. McCartin)

The upper surface fuselage and upper wing RSI components performed as expected and were in nominal condition. The severity of tile damage around the periphery of the windows was moderate with numerous damages occurring between window numbers 3 and 4 (refer to figure 2 for locations, and photo 19 for visual detail). Several large damages in the wraparound portion of the window carrier panel tiles resulted in removal and replacement of seven tiles. Tiles V070-390066-187, -189, -191, and -193 were removed and replaced around window number 2 (refer to photo 20). Tiles V070-390067-165, -166, and -171 were removed and replaced around window number 3 (refer to photo 21).

A large outgassing deposit was evident on the upper left wing. The deposit appeared to emanate from upper LESS carrier panel 15 and extend aft onto the upper surface tiles (refer to section 5.1.4 for a detailed description).

5.2.2 Forward Reaction Control System

(C. Madden)

The various RSI components on the FRCS exhibited typical flight degradation in certain locations. A majority of the thermal barriers suffered degradation to the black RTV coating and sustained fraying of outer cover fabric. All barriers were reworked using standard repair procedures. Several tile and FI blankets experienced minor damage. All were reworked using standard repair procedures. Several gap fillers on the FRCS were removed and replaced due to damage sustained during flight.

5.2.3 Windows

(B. Tipton)

Post-flight inspections revealed a total of 148 flight-related damages spread over seven orbiter windows as a result of the STS-109 mission. Impact damages on the right-hand middle window (W5, 1 impact) and the right-hand overhead window (W7, 1 impact) were found to be unacceptable and the windows are being removed and replaced prior to flight 27. New damages detected on the left-hand side (W1, 1 impact), left-hand middle (W2, 26 impacts), left-hand forward (W3, 17 impacts), right-hand forward (W4, 101 impacts), and right-hand side (W6 1 impact) thermal panes were all shown by Stress analysis to be acceptable for unrestricted use. A complete OV-102 thermal window history is shown in table 15.

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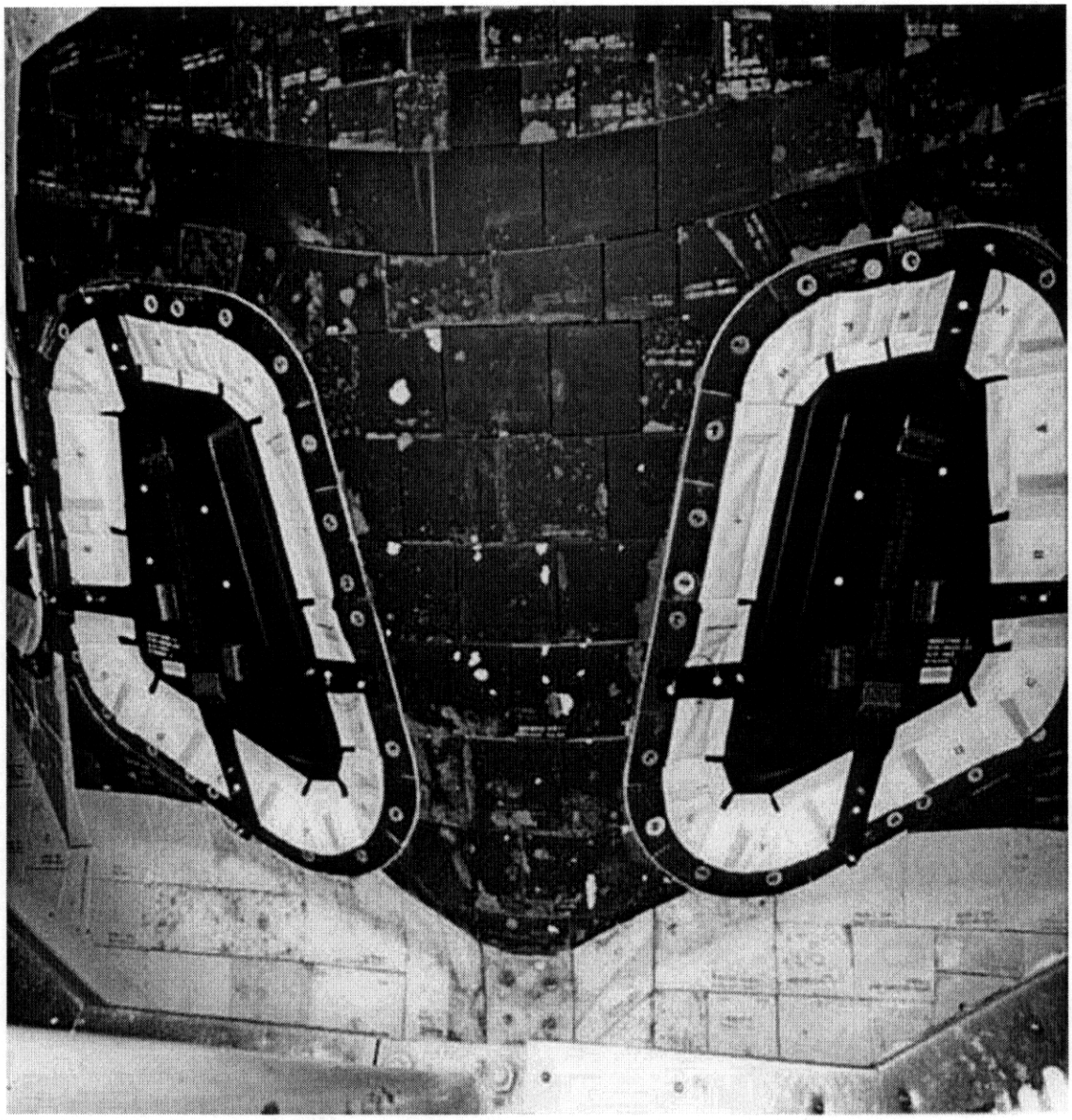

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Photo 19. Tile Damages Between Window Numbers 3 and 4

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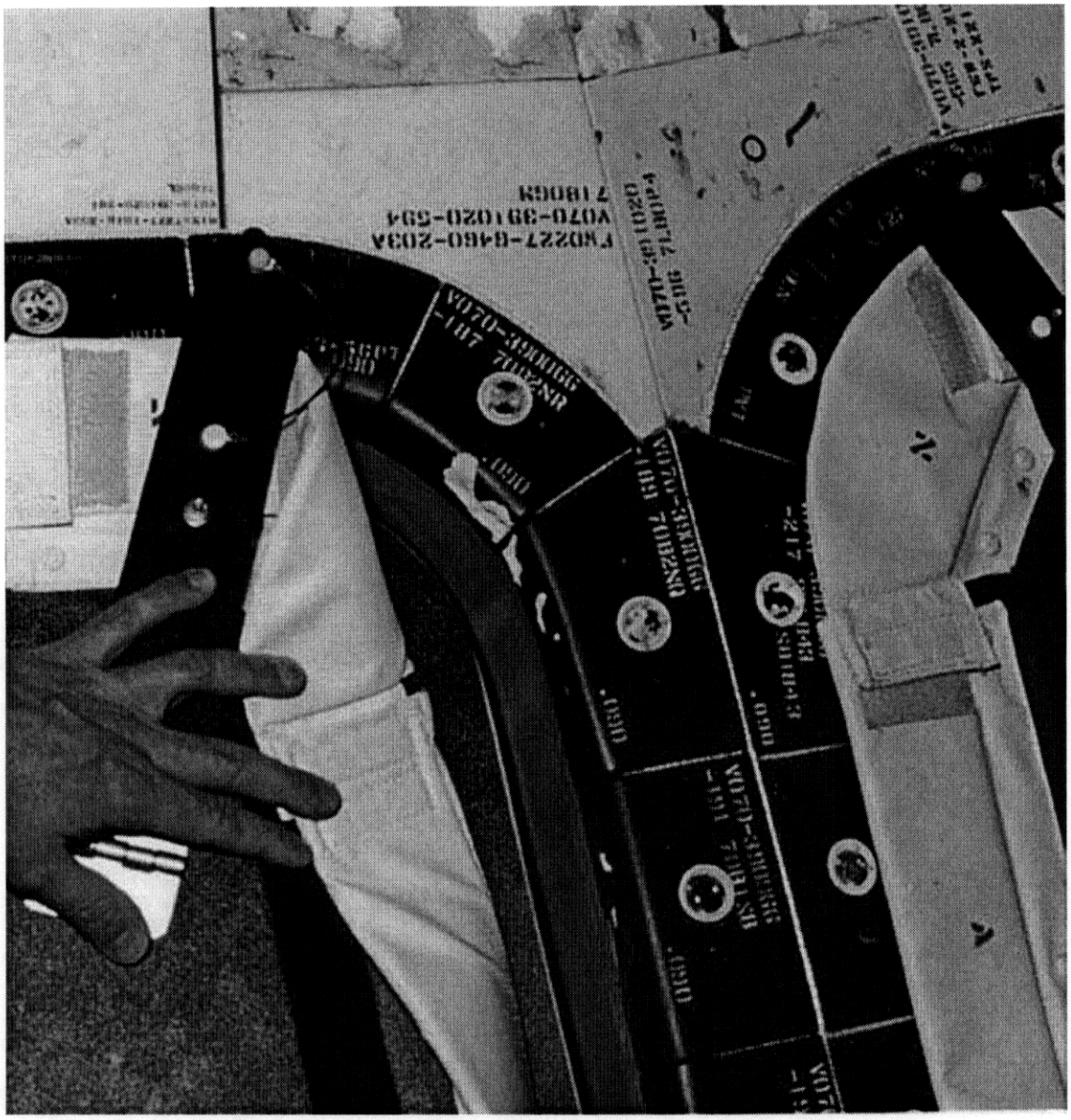

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Photo 20. Tile Damages On Window Number 2 Periphery Carrier Panels

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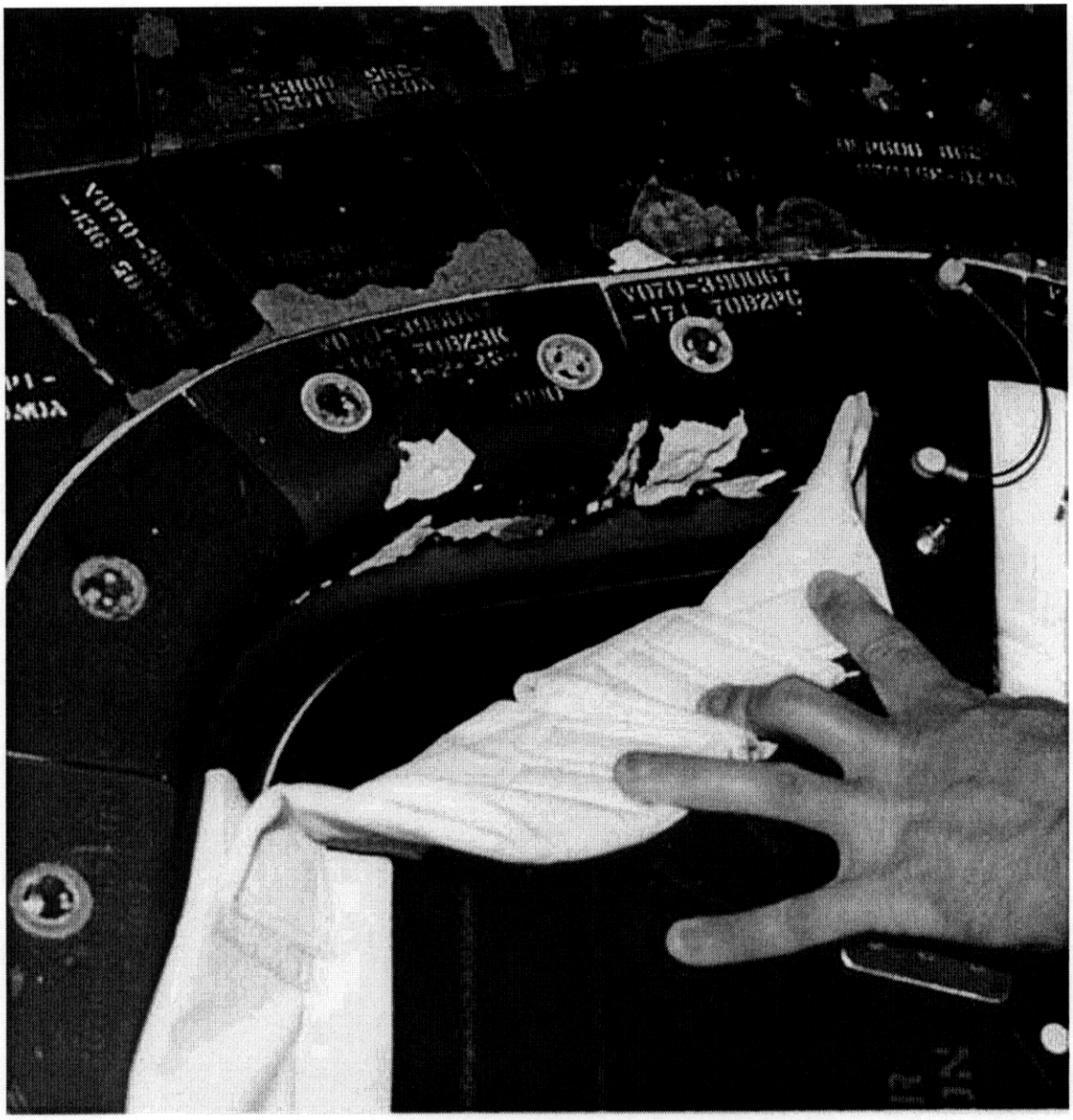

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Photo 21. Tile Damages On Window Number 3 Periphery Carrier Panels

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Table 15. OV-102 Window Flight Damage History

POST-STS	FLIGHT	DATE	WINDOW NUMBER	DAMAGE	DISPOSITION
1	102/1	04/81	NA	NONE	NA
2	102/2	11/81	NA	NONE	NA
3	102/3	03/82	NA	NONE	NA
4	102/4	06/82	NA	NONE	NA
5	102/5	11/82	3 4	PIT BRUISE	ACCEPTABLE SCRAP
9	102/6	11/83	1 6	PIT PIT	SCRAP ACCEPTABLE
61C	102/7	01/86	1	PIT	ACCEPTABLE
28R	102/8	08/89	NA	NONE	NA
32R	102/9	01/90	NA	NONE	NA
35	102/10	12/90	1	PIT/CRACKS	SCRAP
40	102/11	06/91	2 3 4 5 7	SCRATCH SCRATCH SURFACE DEFECT PIT SCRATCH	ACCEPTABLE ACCEPTABLE ACCEPTABLE SCRAP SCRAP
50	102/12	06/92	2 3 4 6 8	PIT 2 PITS CRATER/PIT PIT PIT	ACCEPTABLE ACCEPTABLE SCRAP SCRAP SCRAP
52	102/13	10/92	1 3	PIT BRUISE	SCRAP SCRAP
55	102/14	04/93	NA	NONE	NA
58	102/15	10/93	2	PIT	ACCEPTABLE
62	102/16	03/94	6	2 PITS	SCRAP
65	102/17	07/94	2 4 5 6	PIT 2 PITS 9 PITS 2 PITS	ACCEPTABLE ACCEPTABLE ACCEPTABLE SCRAP
73	102/18	10/95	1 2 3 5 6	3 PITS 3 PITS PIT PIT PIT	SCRAP SCRAP ACCEPTABLE ACCEPTABLE SCRAP
75	102/19	02/96	1 3 4 11	PIT 5 PITS, SCRATCH 11 PITS PIT	SCRAP ACCEPTABLE ACCEPTABLE ACCEPTABLE
78	102/20	06/96	4	2 PITS	ACCEPTABLE

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Table 15. OV-102 Window Flight Damage History (cont'd)

POST-STS	FLIGHT	DATE	WINDOW NUMBER	DAMAGE	DISPOSITION
80	102/21	11/96	1	PIT	ACCEPTABLE
			2	7 PITS	ACCEPTABLE
			3	6 PITS	ACCEPTABLE
			4	14 PITS	ACCEPTABLE
			5	16 PITS	ACCEPTABLE
			7	3 PITS	SCRAP
			8	4 PITS	SCRAP
83	102/22	04/97	2	22 PITS	ACCEPTABLE
			3	15 PITS	ACCEPTABLE
			4	12 PITS	ACCEPTABLE
			5	10 PITS	ACCEPTABLE
			9	PIT	ACCEPTABLE
94	102/23	07/97	2	7 PITS	ACCEPTABLE
			3	4 PITS	ACCEPTABLE
			4	12 PITS	ACCEPTABLE
			7	PIT	SCRAP
87	102/24	11/97	1	PIT	ACCEPTABLE
			2	58 PITS	ACCEPTABLE
			3	PIT	ACCEPTABLE
			4	53 PITS	ACCEPTABLE
			5	63 PITS	ACCEPTABLE
			6	SCUFF/BRUISE	REMOVE
90	102/25	5/98	1	PIT	SCRAP
			2	175 PITS	ACCEPTABLE
			3	109 PITS	ACCEPTABLE
			4	746 PITS	ACCEPTABLE
			5	2068 PITS	SCRAP
93	102/26	7/99	1	PIT	SCRAP
			3	14 PITS	ACCEPTABLE
			4	13 PITS	ACCEPTABLE
			5	13 PITS	ACCEPTABLE
109	102/27	3/02	1	1 PIT	ACCEPTABLE
			2	26 PITS	ACCEPTABLE
			3	17 PITS	ACCEPTABLE
			4	101 PITS	ACCEPTABLE
			5	1 PIT	SCRAP
			6	1 PIT	ACCEPTABLE
			7	1 PIT	SCRAP
			8		

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5.2.4 Upper Midfuselage/Payload Bay Doors

(B. Tipton)

The TPS on the midfuselage sidewall and payload bay door acreage was in excellent post-flight condition. Documented discrepancies included FI blanket tears, frays, and voids. All damages are within acceptable criteria for standard repair procedures.

The TPS on the payload bay door hinges was in typical post-flight condition. Inspection of the PLBD hinge area TPS, performed per OMI V6049.009, revealed ten areas of scraped and missing MB0125-063 Pyromark coating. There were two instances of filler bar/SIP erosions. All Pyromark coating anomalies and filler bar/SIP erosion were either within acceptable criteria or repaired per standard procedures. 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 TO 0.005 AFT: 0.000 CONST	N N	* NO DISCREPANCIES TO REPORT
LEFT HAND #2 Xo 669.800	FORWARD: 0.000 TO 0.010 AFT: 0.005 TO 0.010	N N	* NO DISCREPANCIES TO REPORT
LEFT HAND #3 Xo 737.300	FORWARD: 0.005 TO 0.025 AFT: 0.000 TO 0.010	N N	* SCRAPING IN PYROMARK 0.25" x 1.0" (LOC B) * SIP EROSION 2.80" x 0.250" (LOCATION 3)
LEFT HAND #4 Xo 783.550	FORWARD: 0.005 TO 0.020 AFT: 0.000 TO 0.005	N N	* SCRAPING IN PYROMARK 0.5" x 0.150" (LOC B)
LEFT HAND #5 Xo 850.600	FORWARD: 0.000 TO 0.005 AFT: 0.000 TO 0.005	N N	* SCRAPING IN PYROMARK 01.0" x 0.300" (LOC B)
LEFT HAND #6 Xo 917.650	FORWARD: 0.005 TO 0.018 AFT: 0.005 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: 0.005 TO 0.010 AFT: 0.010 TO 0.012	N N	* SCRAPING IN PYROMARK 1.0" x 0.5" (LOC B) * SCRAPING IN PYROMARK 1.5" x 0.5" (LOC C) * FILLER BAR EROSION 0.3" x 0.1" (LOCATION 1)
RIGHT HAND #2 Xo 669.800	FORWARD: 0.000 TO 0.010 AFT: 0.005 TO 0.010	N N	* SCRAPING IN PYROMARK 1.5" x 1.0" (LOC B)
RIGHT HAND #3 Xo 737.300	FORWARD: 0.000 TO 0.012 AFT: 0.005 TO 0.010	N N	* SCRAPING IN PYROMARK 1.5" x 0.3" (LOC B)
RIGHT HAND #4 Xo 783.550	FORWARD: 0.000 TO 0.010 AFT: 0.005 TO 0.010	N N	* SCRAPING IN PYROMARK 1.25" x 1.0" (LOC B)
RIGHT HAND #5 Xo 850.600	FORWARD: 0.000 TO 0.010 AFT: 0.010 TO 0.012	N N	* SCRAPING IN PYROMARK 1.5" x 0.3" (LOC B)
RIGHT HAND #6 Xo 917.650	FORWARD: 0.000 TO0.012 AFT: 0.005 TO 0.010	N N	* SCRAPING IN PYROMARK 0.9" x 0.2" (LOC B)
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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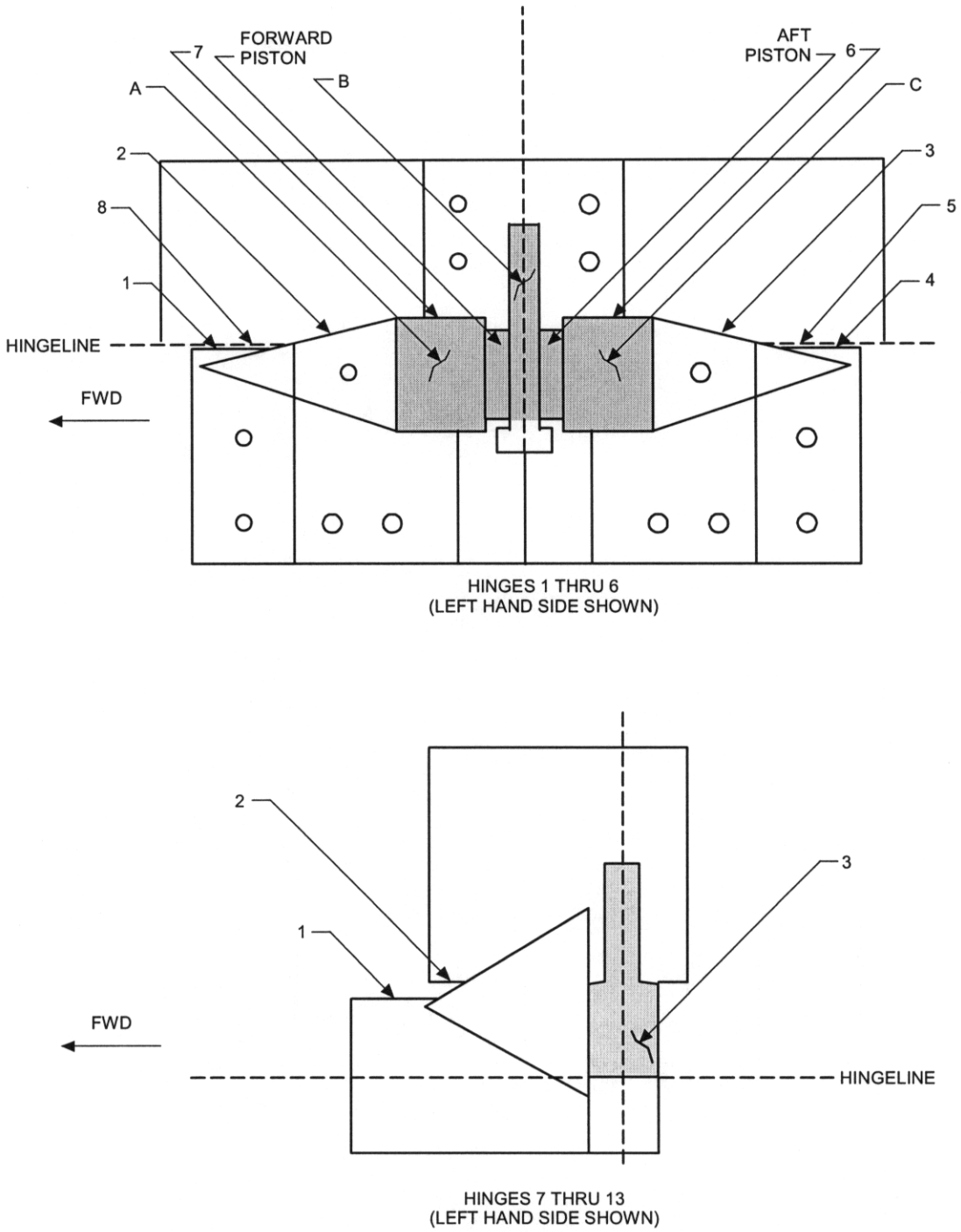

Figure 17. Payload Bay Door Hinge Cover

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5.3 Aft Fuselage

5.3.1 General

(B. McCartin)

Post-flight inspection of the aft fuselage TPS components revealed typical flight-related damages and degradation. Several tiles on the upper fuselage stub sustained flight damage resulting in tile replacements (refer to section 5.3.3 for additional details). Damages on the rudder/speed brake included: several tiles on the left-hand trailing edge that appeared to be from contact with metal thermal barrier/spring seals, torn aft segments of the splitline thermal barriers, and a piece of broken Macor along the right-hand splitline thermal barrier (refer to section 5.3.4 for additional details). Detailed assessments of the base heat shield, upper body flap, vertical stabilizer, and OMS pods are presented in subsequent sections.

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5.3.2 Base Heat Shield

(G. Grant)

The base heat shield area was in typical post-flight condition. Most of the "peppering" damages were corrected using standard repairs. The main engine dome heat shield components sustained their share of damages. The lower splice link on the number 2 engine dome had loose loops that were replaced with new ones. Also, the right-hand side blanket on engine number 2 was replaced because of missing stitching and loose tabs on both ends. The right-hand and left-hand side blankets were removed and replaced on engine number 1 due to extensive degradation. The left-hand DHS blanket on engine number 3 had missing and loose stitches at the upper edge. The missing stitches were accepted with concurrence from the material review board for unrestricted use without rework, while the loose stitches were replaced. No other activity warranted being mentioned.

5.3.3 Upper Body Flap

(B. Tipton)

The overall condition of the TPS components on the upper body flap was in typical post-flight condition. The most notable flight damage occurred on the V070-395018-043 and V070-395018-047 tiles. The V070-395018-043 tile had a little more than 50 percent of the tile missing from the aft/cantilevered portion of the tile. The remainder of the tile substrate was cracked/separated just above the densification layer with only a small area of the substrate integrity retaining the remainder of the tile to the cavity. The failure of this tile is believed to be related to a possible combination of several conditions. The location of this tile installation is a high vibro-acoustic area. The -043 tile is a LI-900 substrate material that was installed on class 1 SIP per design. The combination of LI-900 tile substrate installed on class 1 SIP has proven to be an undesirable combination resulting in many observed cases of in-plane cracks that occur at the

densification layer. The majority of tiles that had this combination per drawing requirements, have been updated through changes to the design by upgrading tile substrate to a stronger composition of material, (i.e., FRCI-12, AETB-8, or LI-2200). The tiles in this array that were installed on class 1 SIP fall into this category, and EO C07 to that drawing authorized the change of material substrate to the stronger AETB-8 TUFI composition on an attrition basis. As historical data reveals, some of these cantilevered tiles have experienced cracking from the OML completely through to the SIP. Some of the cracked conditions are suspected to be related to handling or operations being conducted in the immediate area. It is not known in many cases what initiates the crack, but with this tile it is suspected that the tile may have had a cracked condition that allowed the tile to move during flight inducing added loads that may have contributed to the failure of the substrate at the densification layer. The remainder of this tile was removed and the upgraded AETB-8 TUFI substrate was installed. The replacement part number of this new tile changed to the V070-395018-277 (refer to photo 22 and photo 23).

A somewhat similar case was possibly developing with the V070-395018-047 located five tiles outboard of the -043 tile. This tile had a crack in the OML completely through the substrate material to the SIP. The break appeared very similar to the configuration of the remaining portion of the -043 tile. The V070-395018-047 tile, also on class 1 SIP with an LI-900 substrate, was part of the attrition change to the upgraded AETB-8 TUFI composition. The cracked tile was removed and replaced with the upgraded material which is now part number V070-395018-281.

Some small typical damages occurred in various other areas of the body flap area that were within acceptable repair criteria.

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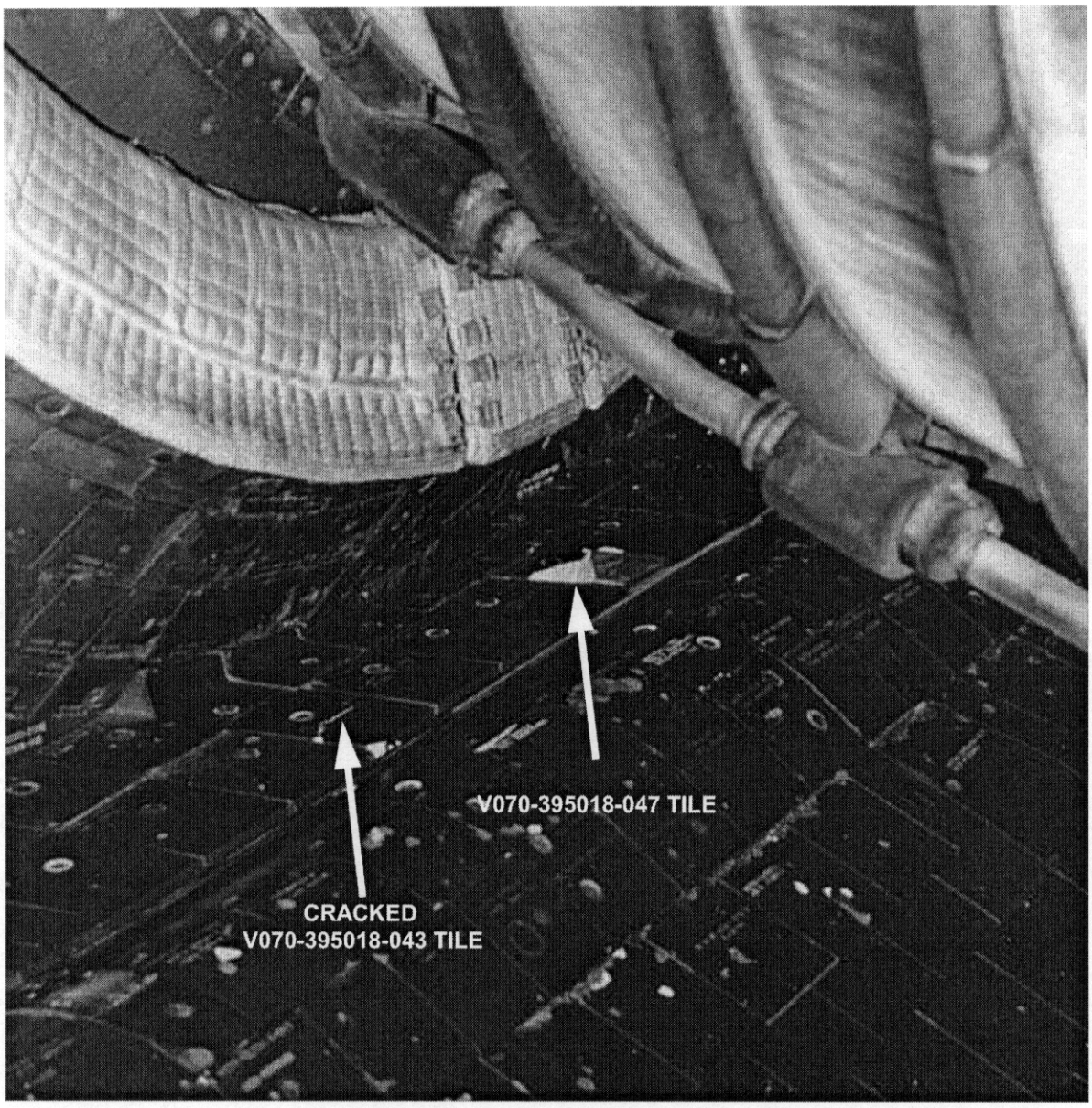

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Photo 22. Tile Damages On Body Flap/Fuselage Stub Carrier Panels

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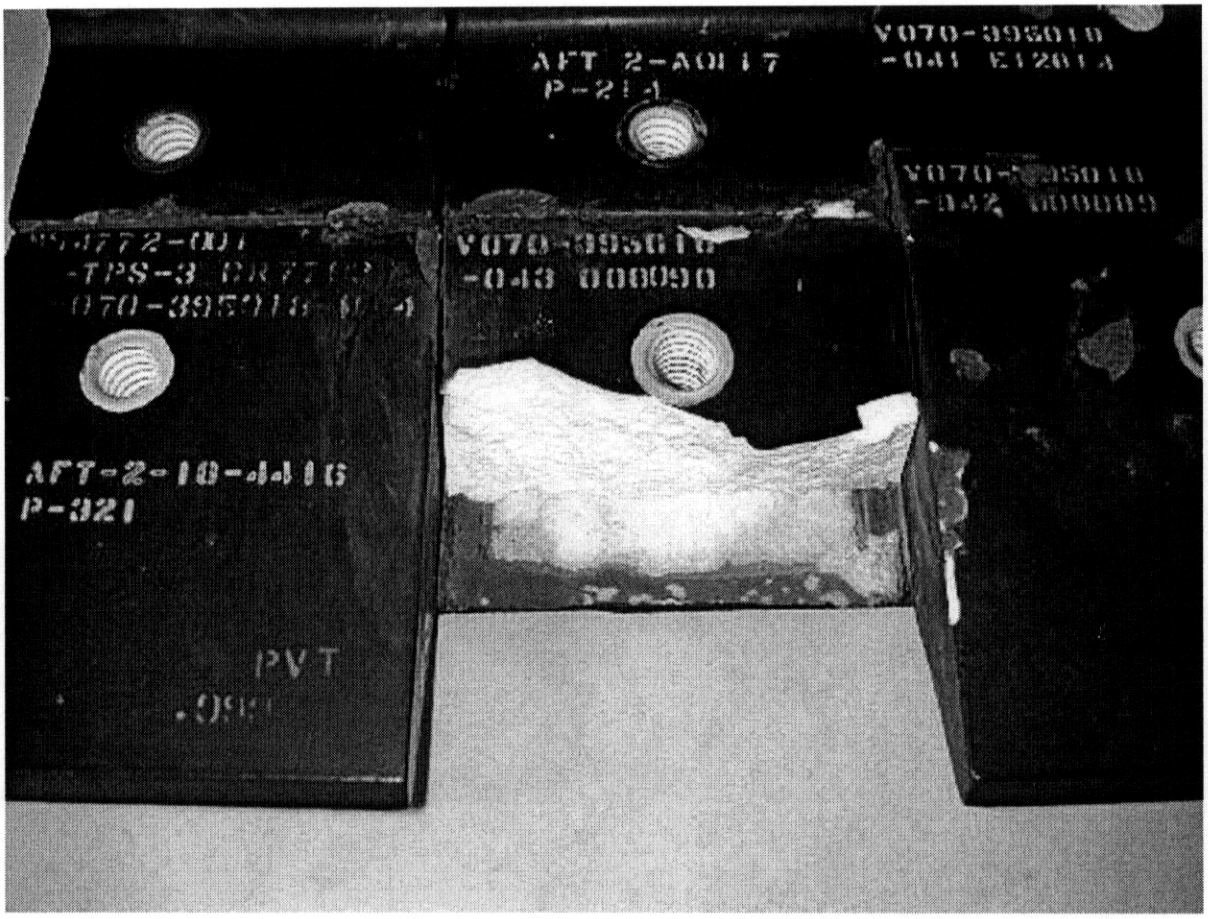

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Photo 23. Tile Damages On Body Flap/Fuselage Stub Carrier Panels

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5.3.4 Vertical Stabilizer and Rudder/Speed Brake

(J. Brand)

The TPS on the vertical stabilizer was in typical post-flight condition with one significant tile damage to the V070-292125-035 tile (refer to photo 24) reported by the TPS Runway Inspection Team. The tile damage resulted from contact with damaged metal thermal barrier spring seal. The tile and discrepant metal thermal barrier spring seal were removed and replaced. The aft portion of the V070-298130-002 right-hand splitline thermal barrier exhibited excessive damage warranting removal and replacement (refer to photo 25). The V070-298126-004 Macor located beneath the aft portion of the V070-298130-002 thermal barrier was broken/missing and was removed and replaced in conjunction with thermal barrier segment replacement. The V070-298130-001 left-hand splitline thermal barrier had minimal fraying damage and was stitched and coated. Other discrepancies found during TPS inspections were minor and were repaired using standard repair procedures.

5.3.5 OMS Pods

(L. Deel)

The TPS on both OMS pods performed satisfactorily. The damages were minor, with mostly chips and small gouges typical of this area and repairable with standard TPS specification procedures (refer to photo 26).

6.0 SPECIAL TOPICS

6.1 Restricted Paper Summary

(B. McCartin)

A summary of documents and associated conditions that were accepted on a restricted/limited-life usage for flight 27 are listed in table 17, as well as the post STS-109 proposed action/work for each condition.

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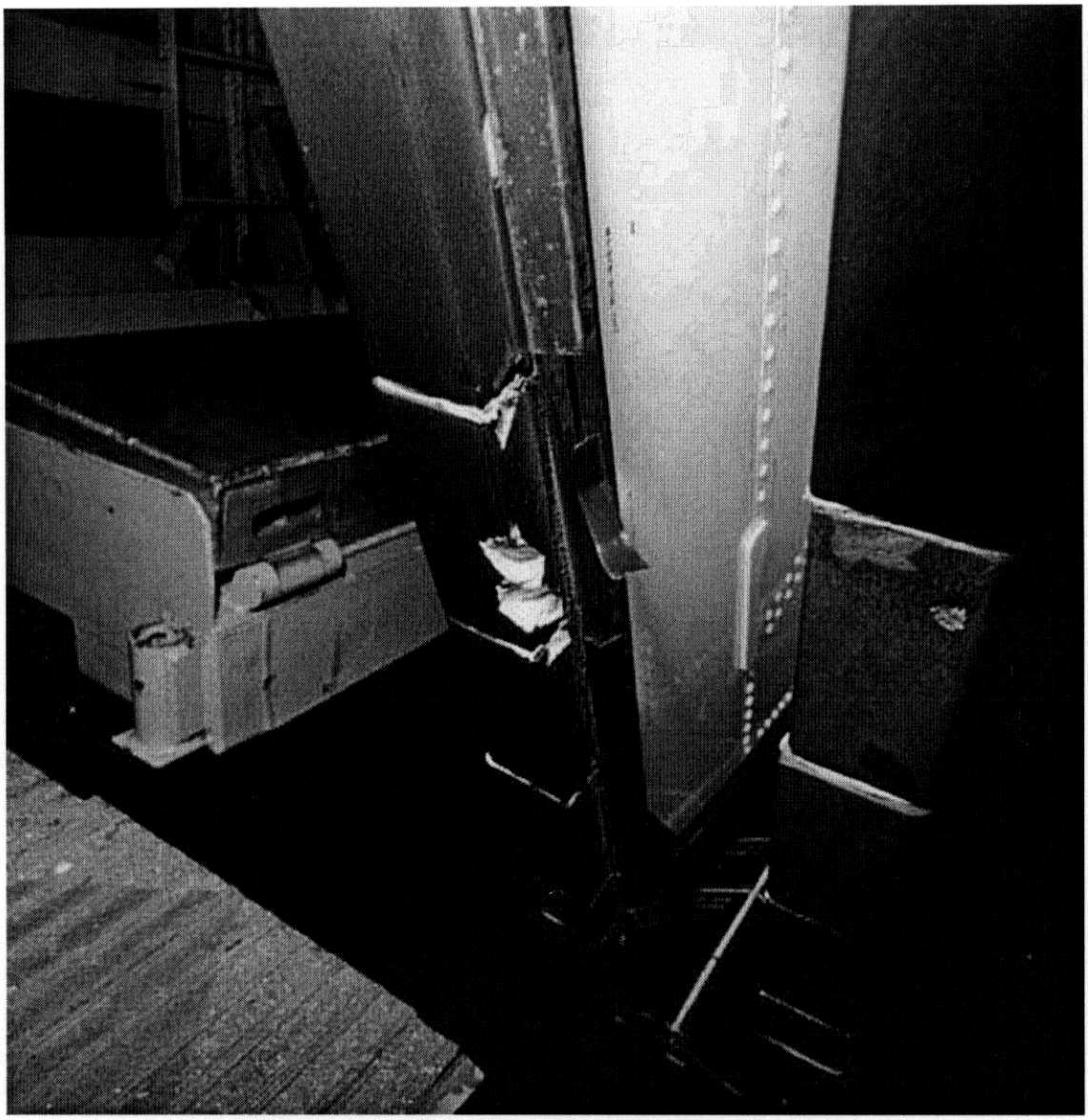

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Photo 24. V070-292125-035 Tile Damage and Damaged Metallic Thermal Tab

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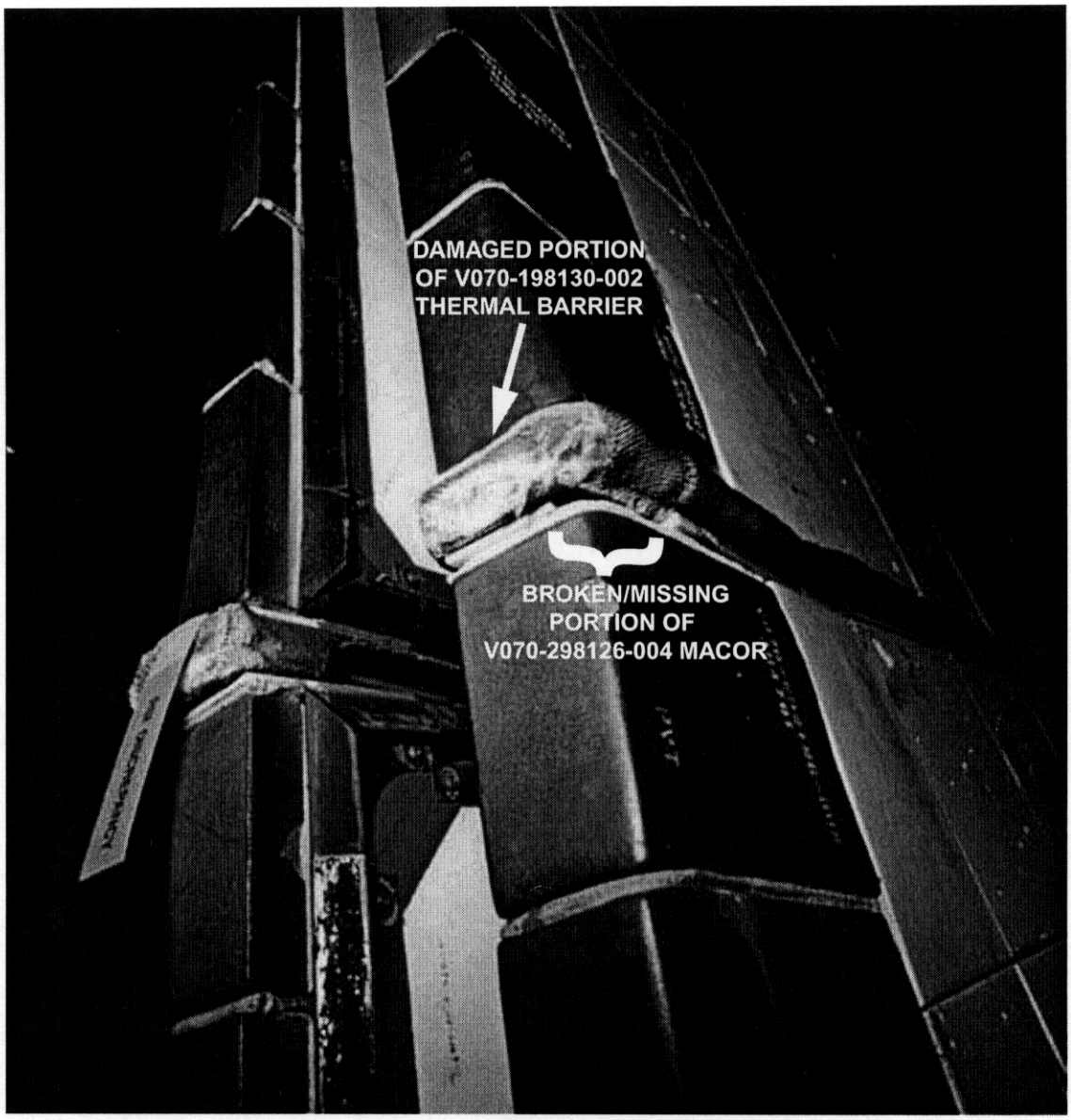

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Photo 25. Damaged Thermal Barrier and Macor at Aft Right-Hand Side of Vertical Speed Brake Splitline

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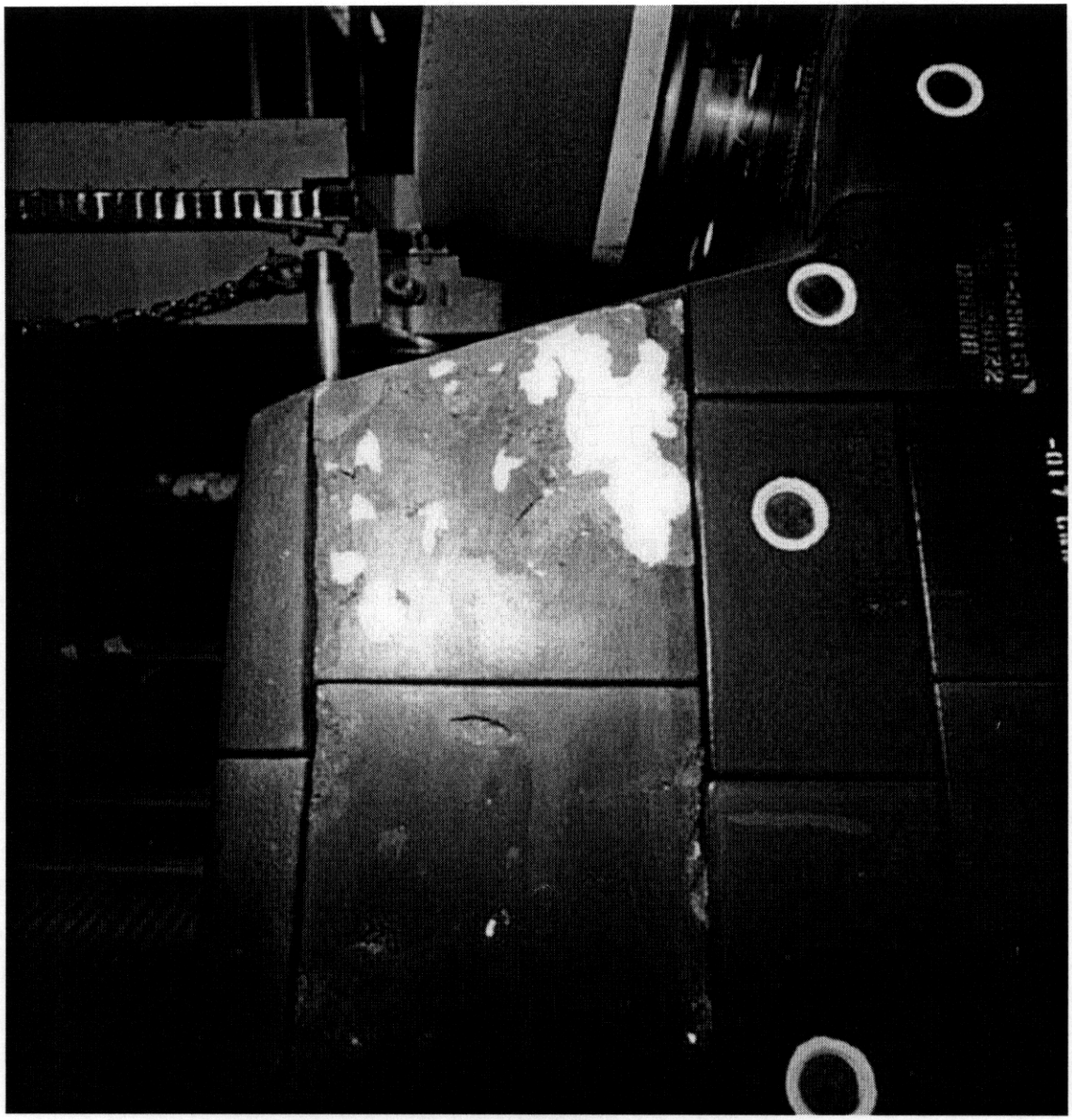

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Photo 26. V070-396151-189 Tile Damage on Left OMS Pod (LP05) Stinger

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Table 17. Restricted Paper Summary for STS-109

WAD	PROBLEM/DISCREPANCY	PROPOSED REWORK
AFT-2-A0199	LH ET DOOR STRUCTURE SIDE TILE IS MISLOCATED CAUSING A SIDEWALL STEP TO THE ADJACENT TILE	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
AFT-2-A0200	TILE CRACKED TO SIP	REMOVE AND REPLACE TILE
AFT-2-A0201	RH ET DOOR THERMAL BARRIER DOES NOT CONTACT LATCH PLATE AND INCONEL FINGERS; EXTRA LAYER OF SLEEVING ADDED	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
AFT-2-A0202	TILE CRACKED TO SIP	REMOVE AND REPLACE TILE
AFT-2-A0203	OUT-OF-TOLERANCE GAP AT RH FUSELAGE STUB CARRIER PANEL	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
AFT-2-A0204	ENGINE #1 DOME HEAT SHIELD BLANKET OCN DISCREPANCY	REMOVE AND REPLACE
FWD-2-A0285	OUT-OF-TOLERANCE GAP	REMOVE AND REPLACE TILE
FWD-2-A0286	ET ARROWHEAD BLANKET FABRICATED FOR OV-102 USE ONLY	PART WILL BE RESTRICTED FOR OV-102 USE ONLY; APPLY MR MARKING TO PART AND UPDATE DATABASE; PR WILL BE CLOSED
FWD-2-A0287	TILE HAS MULTIPLE DAMAGES	REMOVE AND REPLACE TILE
FWD-2-A0288	PARTIAL INSTRUMENTATION MOD COMPLETED PRIOR TO FLIGHT 27	COMPLETE MODIFICATION
FWD-2-A0289	PARTIAL INSTRUMENTATION MOD COMPLETED PRIOR TO FLIGHT 27	COMPLETE MODIFICATION
FWD-2-A0290	NLGD TILES HAVE OUT-OF-TOLERANCE STEPS, GAPS, AND RECESSION	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
FWD-2-A0291	NLGD TILE HAS OUT-OF-TOLERANCE CONTOURS	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
LWNG-2-A0191	LH INBOARD ELEVON DRAIN TILE HAS INCORRECT SIP CUTOUT	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
MID-2-A0065	RTV REPAIR ON FI BLANKET DAMAGE; LH FWD HOIST POINT	REMOVE AND REPLACE BLANKET
RINST-2-A0080	TILE HAS OUT-OF-TOLERANCE GAPS	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
RINST-2-A0083	MADS MEASUREMENT POST-FLIGHT DATA REVIEW REQUIRED	COMPLETE REVIEW
RINST-2-A0084	MADS MEASUREMENT POST-FLIGHT DATA REVIEW REQUIRED	COMPLETE REVIEW
RINST-2-A0086	MADS MEASUREMENT POST-FLIGHT DATA REVIEW REQUIRED	COMPLETE REVIEW
RSI-2-A0062	TILES CRACKED TO SIP (BUCKET)	REMOVE AND REPLACE TILES

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Table 17. Restricted Paper Summary for STS-109 (cont'd)

WAD	PROBLEM/DISCREPANCY	PROPOSED REWORK
RSI-2-A0063	TRACK OUT-OF-TOLERANCE KEQ LOCATIONS	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
RSI-2-A0064	OUT-OF-TOLERANCE GAPS BETWEEN ELEVON COVE FI BLANKETS AND WING TRAILING EDGE CARRIER PANEL TILES	REWORK SOME LOCATIONS; RE-RESTRICT REMAINING LOCATIONS FOR FUTURE FLIGHT REWORK
RWNG-2-A0198	ELEVON COVE DAMAGED COVER ASSEMBLY	REMOVE AND REPLACE COVER ASSEMBLY
RWNG-2-A0199	RH MLGD THERMAL BARRIER DAMAGED	REMOVE AND REPLACE THERMAL BARRIER
TLP05-A0012	EXPOSED SUBSTRATE IN TILE-TO-TILE GAPS	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
TLP05-A0015	TILES CRACKED TO SIP (BUCKET)	REMOVE AND REPLACE TILES
TLP05-A0016	TILE HAS OUT-OF-TOLERANCE STEP	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
TRP05-A0008	EXPOSED SUBSTRATE IN TILE-TO-TILE GAPS	RE-RESTRICT TO A FUTURE FLIGHT FOR REMOVAL AND REPLACEMENT
TRP05-A0009	TILES CRACKED TO SIP (BUCKET)	REMOVE AND REPLACE TILES
TRP05-A0010	TILE CRACKED TO SIP	REMOVE AND REPLACE TILE
TRP05-A0011	TILE CRACKED TO SIP	REMOVE AND REPLACE TILE
TRP05-A0012	TILE CRACKED TO SIP	REMOVE AND REPLACE TILE
VERT-2-A0067	PER PRINT PARTS NOT AVAILABLE FOR INSTALLATION	RE-RESTRICT TO A FUTURE FLIGHT
VERT-2-A0068	TILE LACKS PROPER FILLER BAR SEAL	REMOVE AND REPLACE TILE

6.2 *Deferred/Partial Mods*

(B. McCartin)

Prior to STS-109 (OV-102 flight 27), MCR 11618 authorized modification of TPS components to delete inactive instrumentation adjacent to window number 2. The modification required removal/replacement of three tiles and associated instrumentation. Due to processing time constraints, only one tile installation was modified to the engineering drawing requirements prior to flight 27. The remaining work was deferred to post-flight 27.

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6.3 Flight Demonstrations

(B. McCartin)

There are no TPS flight demonstrations currently being tracked on OV-102.

6.4 Significant Problems

(B. McCartin)

Other than the anomaly associated with the missing portion of the V070-395018-043 tile (refer to section 5.3.3), there were no significant TPS-related problems to report prior to or during the STS-109 mission.

6.5 AETB-8/TUFI Performance

(B. McCartin)

A combined total of over 200 tiles on the upper body flap, base heat shield, and OMS pods were upgraded to AETB-8 TUFI for STS-109. The AETB-8 TUFI tiles installed on the upper body flap had minimal damage. One tile on the right-hand side and two tiles on the left-hand side had one OML damage each ranging from 0.2 inch to 0.4 inch diameter (refer to photo 27 and photo 28). There was no evidence of exposed base silica at these locations. All other AETB-8 TUFI tiles installed on the aft base heat shield (refer to photo 29) and OMS pods appeared nominal with no indication of surface impact damages.

7.0 OPEN ISSUES FROM PREVIOUS REPORT

(B. McCartin)

Refer to section 6.4 (Significant Problems) in Post-Flight Assessment KLO-01-001, Mission STS-93, OV-102 Flight 26.

An ET door thermal barrier (right-hand outboard) required MR rework prior to STS-109. An additional layer of sleeving was added to fill voids between the barrier and door components (latch plate and Inconel fingers). Several tiles at this location were reworked earlier in the STS-109 flow to prevent the thermal barrier from rolling. Following the completion of tile replacements, adjustments were made to the right-hand ET door rigging. The combination of tile and door adjustments may have resulted in the poor thermal barrier compression. After one flight, the MR thermal barrier appeared to be in nominal condition and determined to be acceptable for continued use. No flight-related anomalies were observed in or around the MR barrier installation. When the thermal barrier is removed (ET door thermal barriers have a maximum three-flight limit), the tile installations will be assessed to determine how to correct the interface without requiring the continued use of MR barrier configurations.

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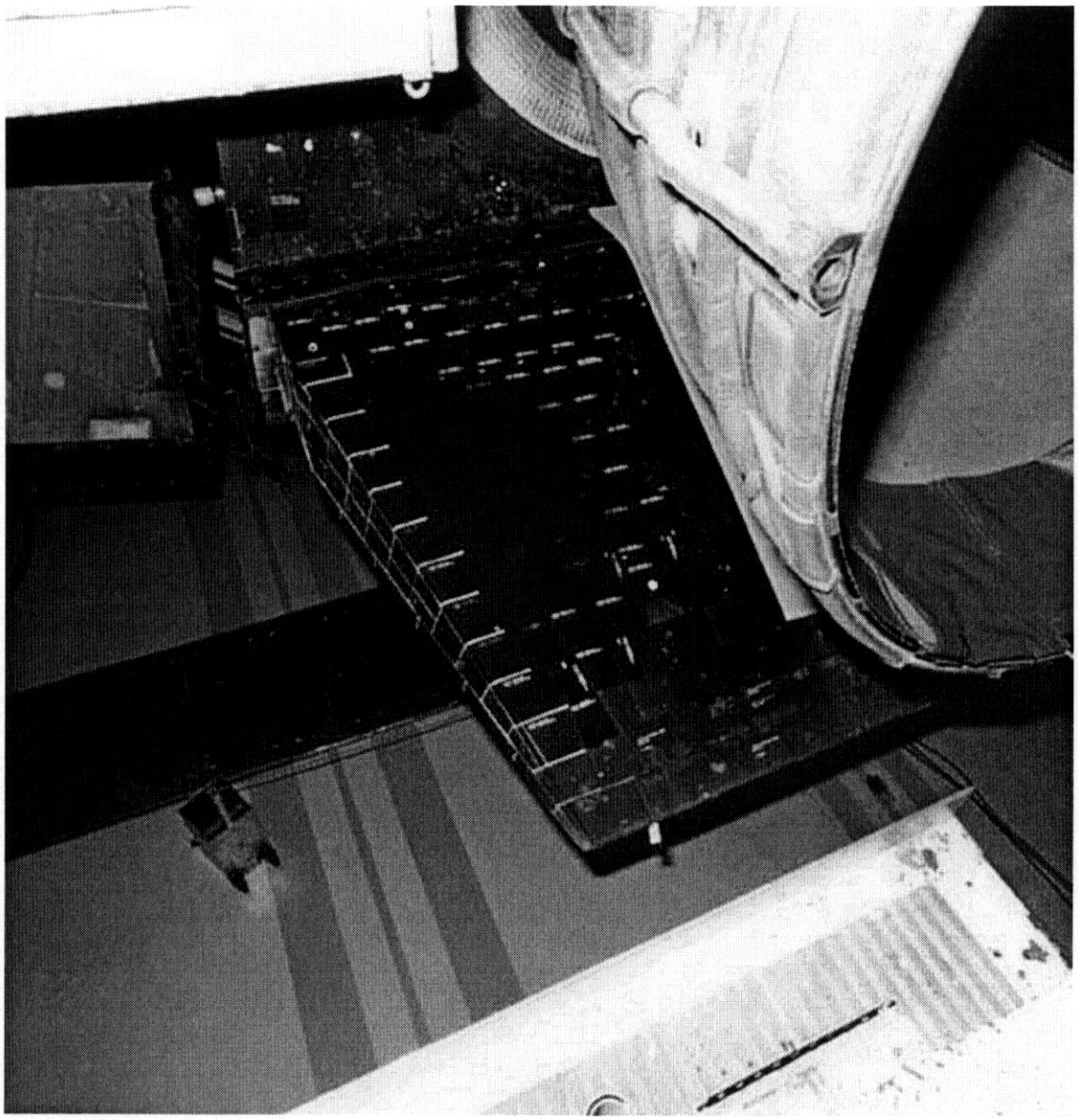

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Photo 27. AETB-8 TUFI Tiles Installed on Upper Body Flap (Left-Hand Side)

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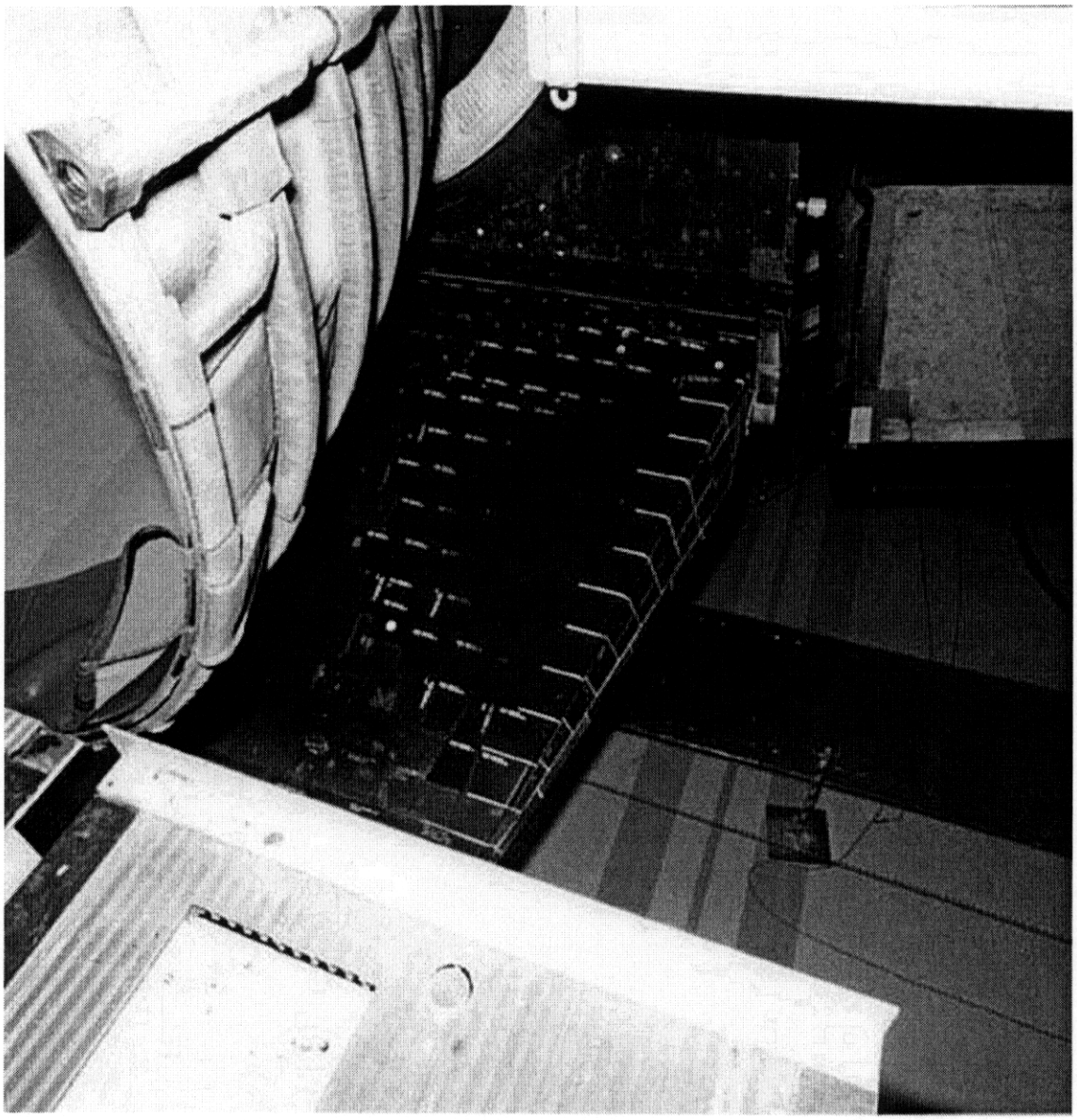

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Photo 28. AETB-8 TUFI Tiles Installed On Upper Body Flap (Right-Hand Side)

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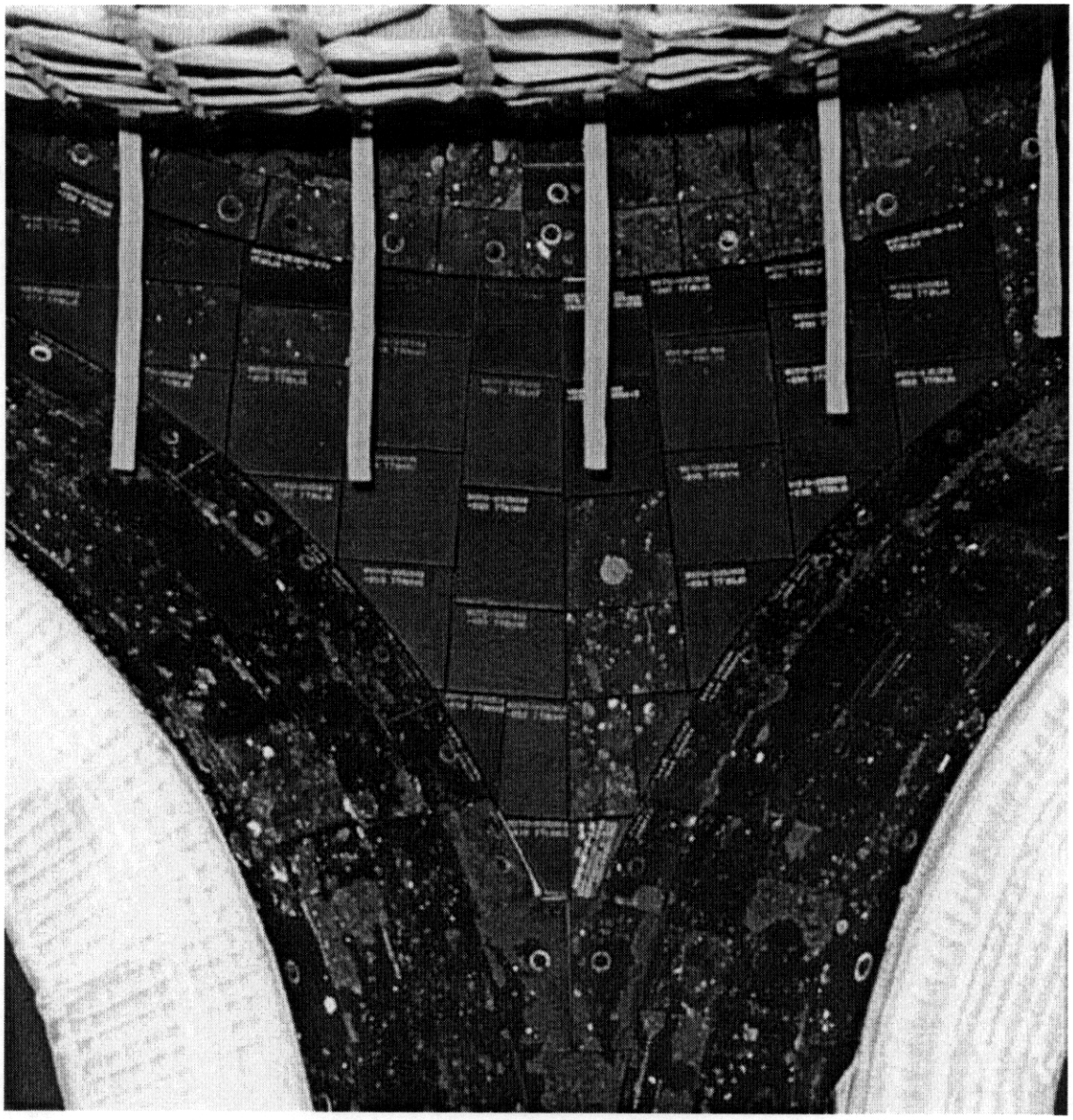

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Photo 29. AETB-8 TUFI Tiles Installed On Base Heat Shield

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8.0 APPENDICES

8.1 STS-109 TPS Quick Look Runway Inspection, March 12, 2002

(B. McCartin)

General

- OV-102 landed at 04:32 a.m. EST.
- Overall vehicle looked good with approximately 50 lower surface damages (approximately 13 damages over 1 inch).
- No protruding gap fillers were evident on forward lower surface. Several protruding gap fillers were found on left wing and right-hand ET door (see below).

Fwd

- Chin panel gap at time of access (05:55 a.m. EST) was 0.200 inch at the centerline.
- The V070-399441 gap filler appeared to be breached in two locations. One location was approximately 2.5 inches in length and was located on the left-hand side 6-8 inches from outboard edge. The other location was approximately 0.5 inch in length and was located just left of the centerline. Inner fabric was exposed on larger damage. Outer fabric appeared to be separated by adhering to the expansion seal.
- Window numbers 2, 3, and 4 had tile damages on upper side carrier panels.
- NLGD OML thermal barriers on left and right-hand sides were torn.

Mid

- Pillow gap filler protruding approximately 1 inch on left wing between tiles V070-191025-456 and V070-191026-283.
- Ames gap filler protruding approximately 0.75 inch on left-hand outboard elevon between tiles V070-193014-075 and V070-193018-115.
- Large OML damage on tile V070-394450-255 (3 inches by 2 inches).
- Right-hand MLGD thermal barrier V070-199050-018 (forward/outboard corner) was torn. Adjacent structure tile (V070-191121-006) had a shallow edge damage at this location.
- Right-hand MLGD thermal barrier V070-199051-018 (aft/inboard corner) was torn.
- Several degraded OML shaves on the lower surface.

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Aft

- ET door thermal barriers looked nominal.
- Right-hand ET door aft hinge has rainbow discoloration. No signs of TPS degradation.
- Ames gap filler protruding approximately 0.400 inch on right-hand ET door between tiles V070-395055-097 and V070-395025-037.
- V070-395018-043 tile (piano hinge tile) damage on upper body flap. Approximately one-half of the tile is broken of off the aft edge.
- Left-hand rudder/speed brake tile and Inconel thermal tabs were damaged on trailing edge approximately four tiles from lower edge.
- Right-hand splitline thermal barrier is damaged on aft end.

Runway inspection performed by:

SFOC SE: Ann Micklos

NASA SE: Joy Huff

Boeing OE: Bill McCartin

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