

**N93-22107**

**Thermal Protection System of the Space Shuttle's  
Orbiter**

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KSC**

## FINDINGS AND RECOMMENDATIONS

### ORBITER TPS DAMAGE REVIEW TEAM

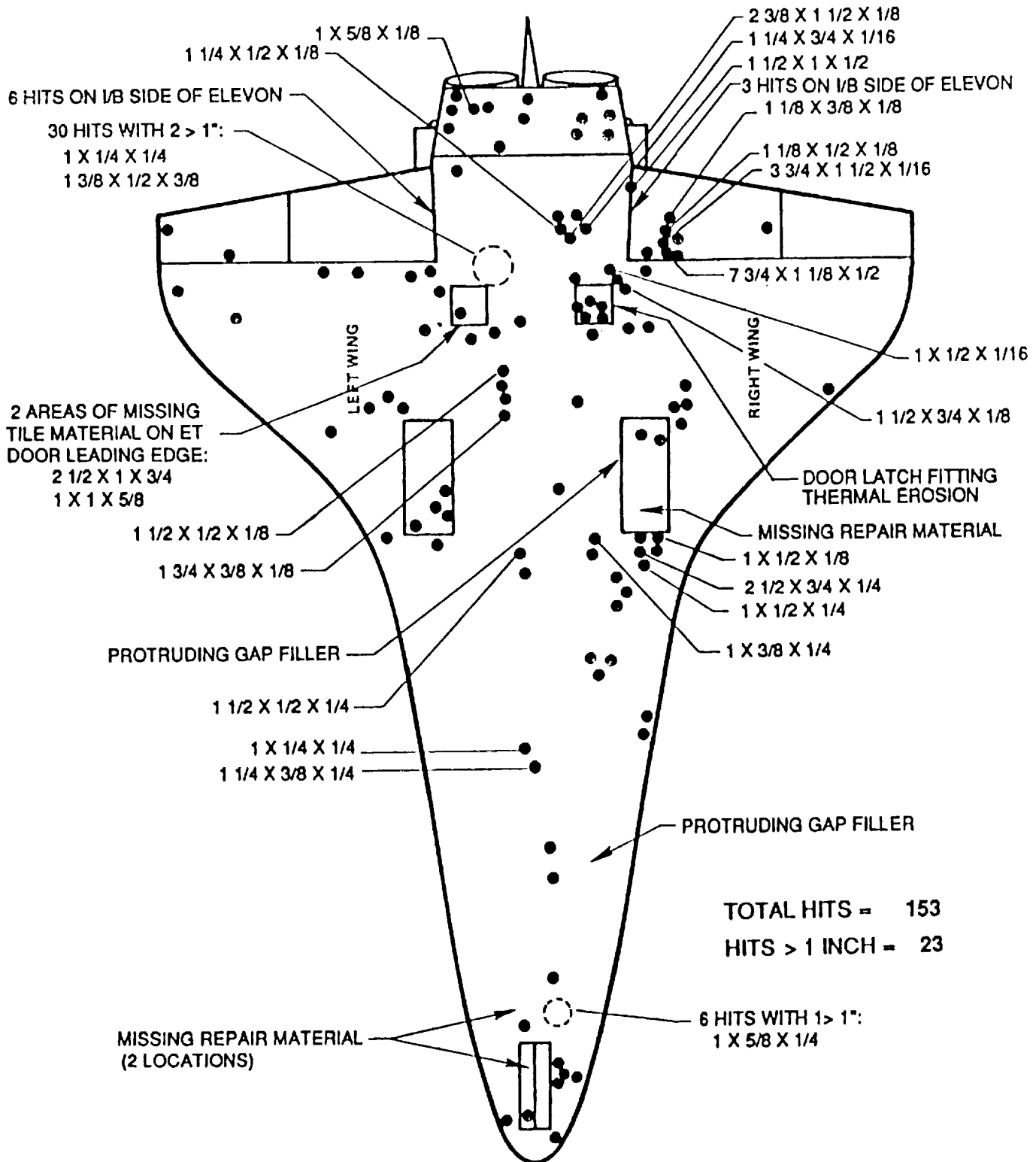
#### O FINDING 9

IT IS THE TEAM'S VIEW THAT THERE IS A GENERAL LACK OF AWARENESS OF ORBITER TILE SUSCEPTIBILITY TO DAMAGE BY DEBRIS - THE SAME APPLIES TO THE CARE AND CRITICAL NATURE OF THE SHUTTLE ELEMENTS AND OPERATIONS PROCESS SO NECESSARY TO MINIMIZING DAMAGING DEBRIS - IT IS ESSENTIAL THAT ALL INVOLVED EMPLOYEES, BOTH GOVERNMENT AND CONTRACTOR, UNDERSTAND THAT MINUSCULE LOOSE OBJECTS OR MATERIALS COMING OFF THE ELEMENTS WILL MOST LIKELY CAUSE SOME TILE DAMAGE AT THE SPEED ENCOUNTERED DURING ASCENT

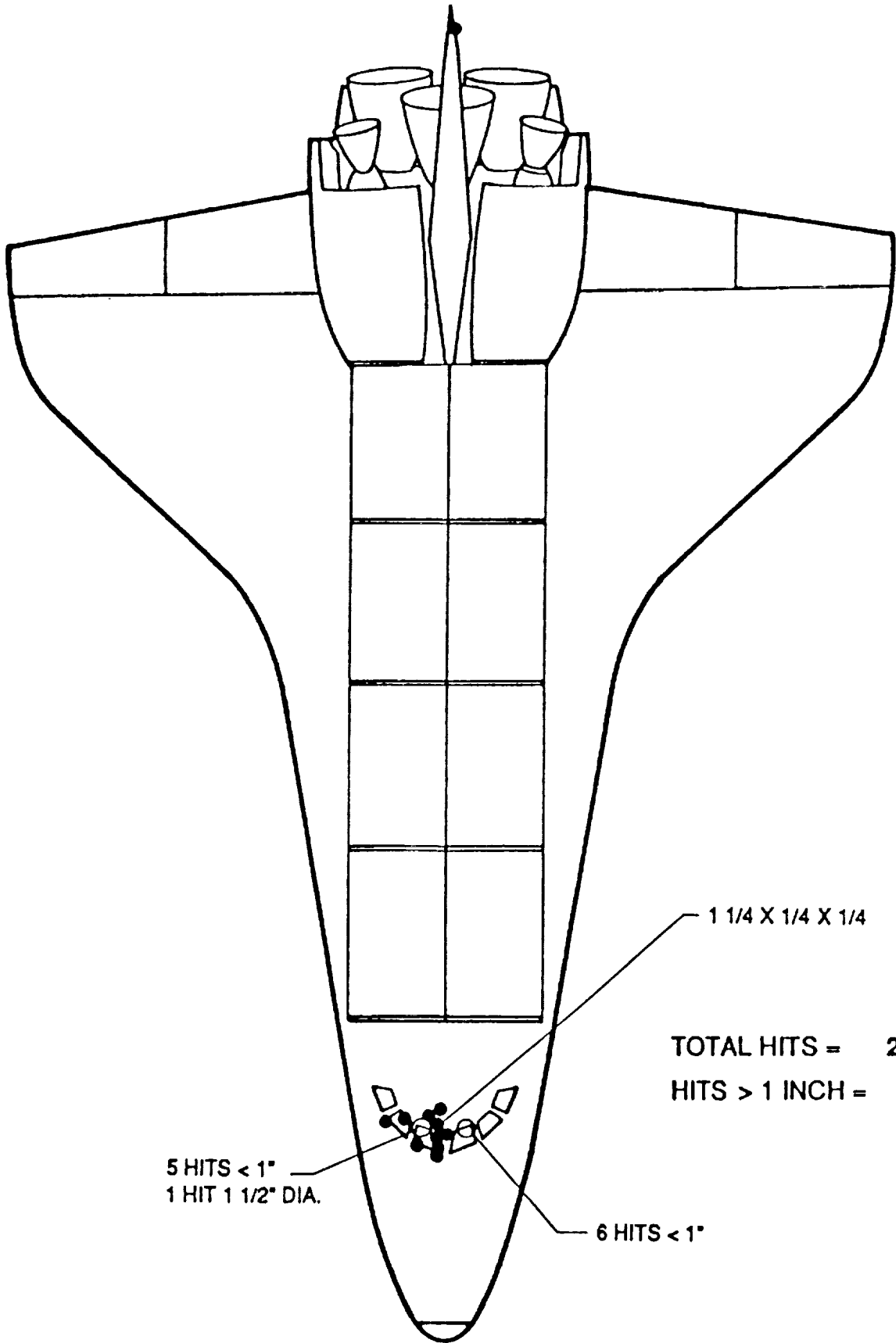
#### O RECOMMENDATION 9

IT IS RECOMMENDED THAT DESCRIPTIVE MATERIAL, PHOTOS, VIDEO TAPE, DEBRIS SAMPLES AND OTHER APPROPRIATE MATTER BE ASSEMBLED AND PROVIDED TO THE PROPER ORGANIZATIONS FOR DISSEMINATION TO THEIR EMPLOYEES - IT SHOULD EMPHASIZE THAT THE TILES PERFORM OUTSTANDING IN THEIR DEBRIS-FREE DESIGN ENVIRONMENT; BUT, ARE EXTREMELY SENSITIVE TO SMALL PARTICLE DAMAGE

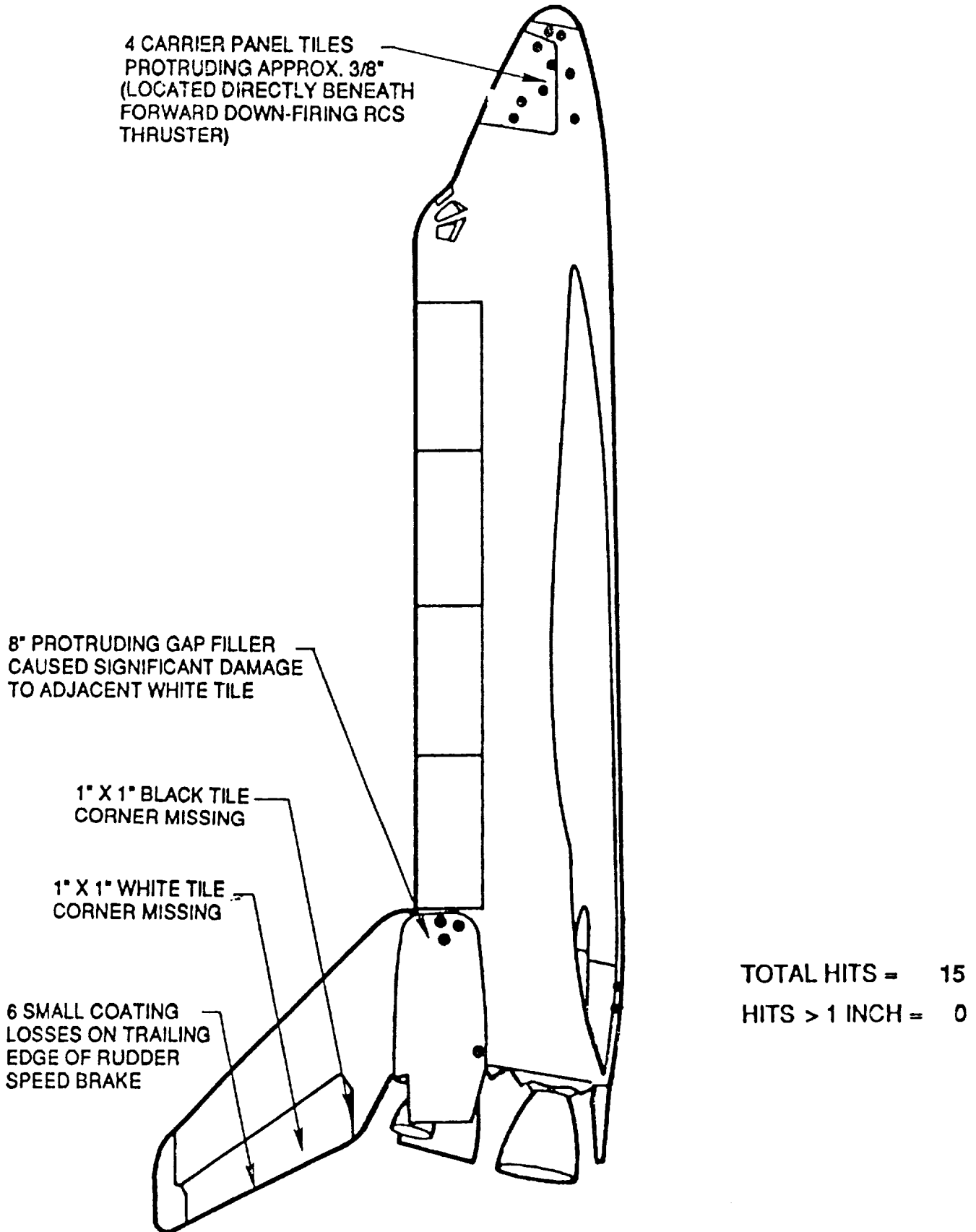
# DEBRIS DAMAGE LOCATIONS



# DEBRIS DAMAGE LOCATIONS

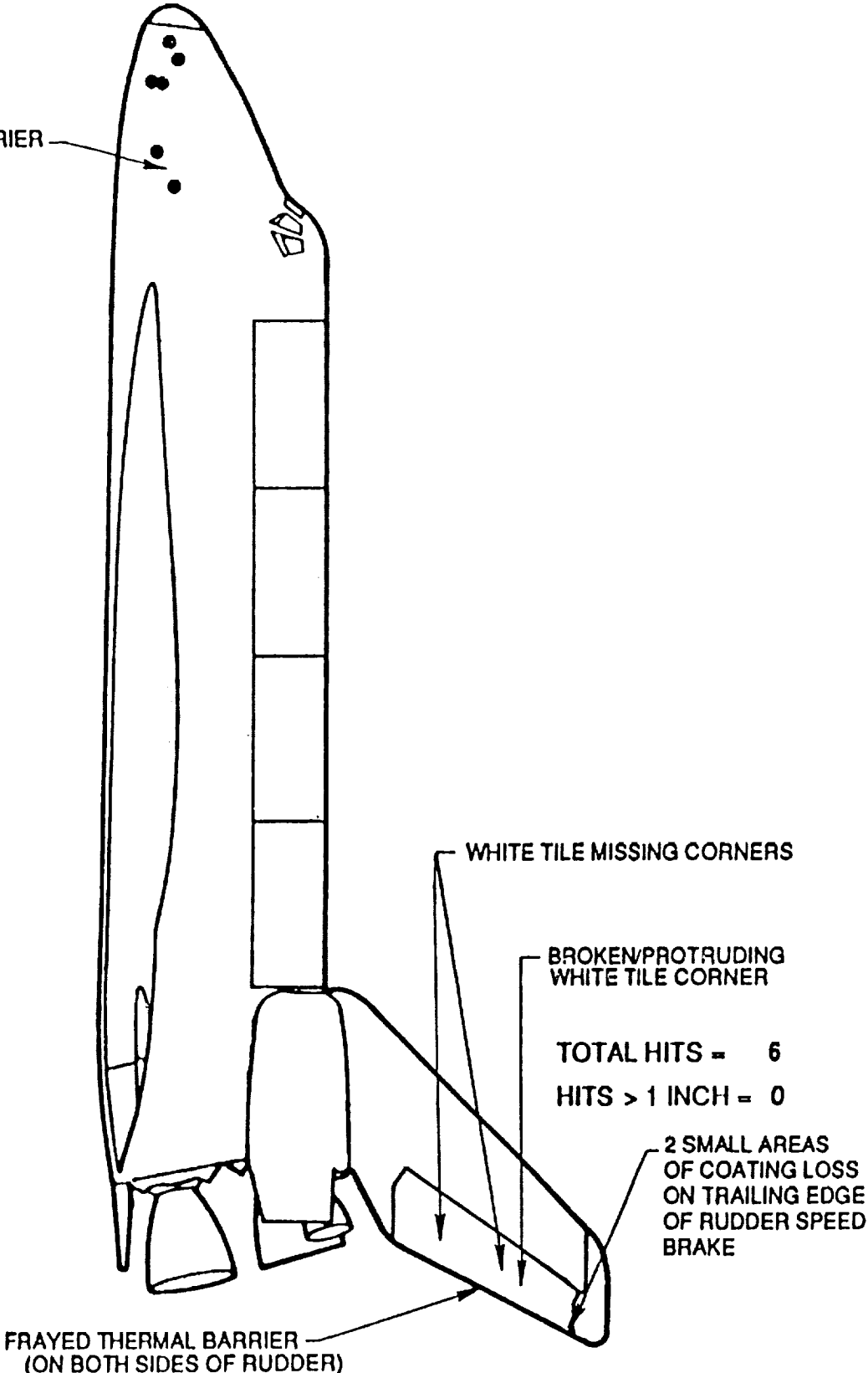


# DEBRIS DAMAGE LOCATIONS



# STS-40 DEBRIS DAMAGE LOCATIONS

FRAYED THERMAL BARRIER  
(4 PLACES)



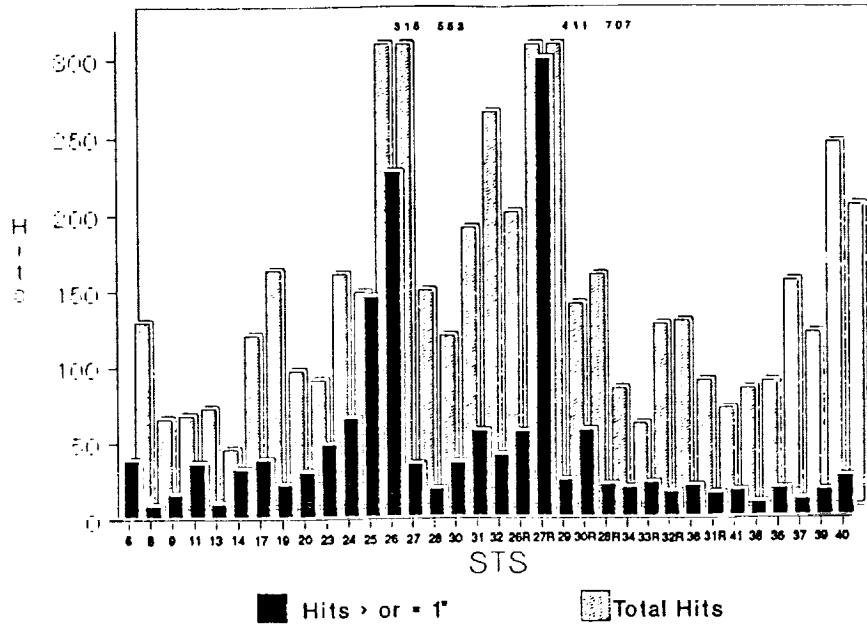
**STS-40 DEBRIS DAMAGE ASSESSMENT SUMMARY**

	<u>Hits &gt; or = 1"</u>	<u>Total Hits</u>
Lower Surface	23	153
Upper Surface	2	23
Right Side	0	11
Left Side	0	6
Right OMS Pod	0	4
Left OMS Pod	0	0
<b>TOTALS</b>	<b>25</b>	<b>197</b>

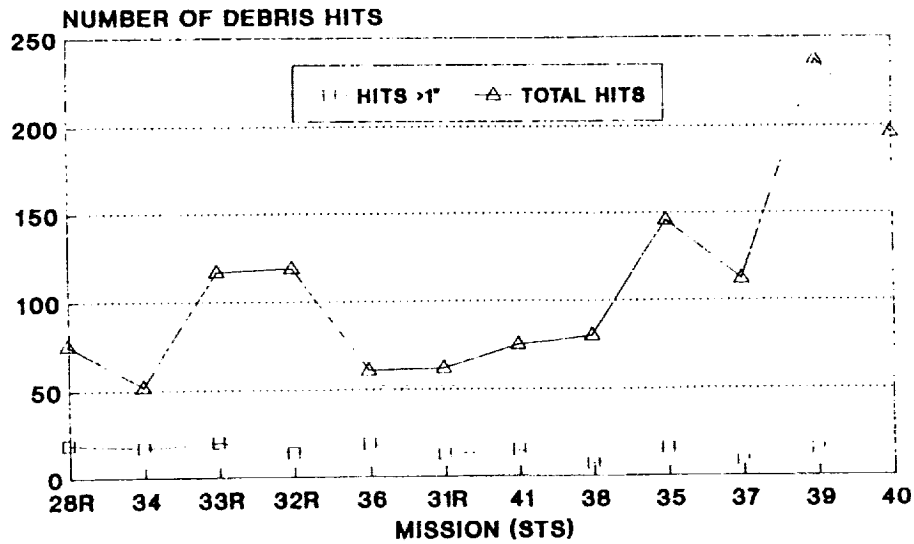
COMPARISON TABLE

STS-6	36	120
STS-7	48	253
STS-8	7	56
STS-9 (41-A)	14	58
STS-11 (41-B)	34	63
STS-13 (41-C)	8	36
STS-14 (41-D)	30	111
STS-17 (41-G)	36	154
STS-19 (51-A)	20	87
STS-20 (51-C)	28	81
STS-23 (51-D)	46	152
STS-24 (51-B)	63	140
STS-25 (51-G)	144	315
STS-26 (51-F)	226	553
STS-27 (51-I)	33	141
STS-28 (51-J)	17	111
STS-30 (61-A)	34	183
STS-31 (61-B)	55	257
STS-32 (61-C)	39	193
STS-26R	55	411
STS-27R	298	707
STS-29R	23	132
STS-30R	56	151
STS-28R	20	76
STS-34	18	53
STS-33R	21	118
STS-32R	15	120
STS-36	20	62
STS-31R	14	63
STS-41	16	76
STS-38	8	81
STS-35	17	147
STS-37	10	113
STS-39	16	238
STS-40	25	197

# COMPARISON TABLE



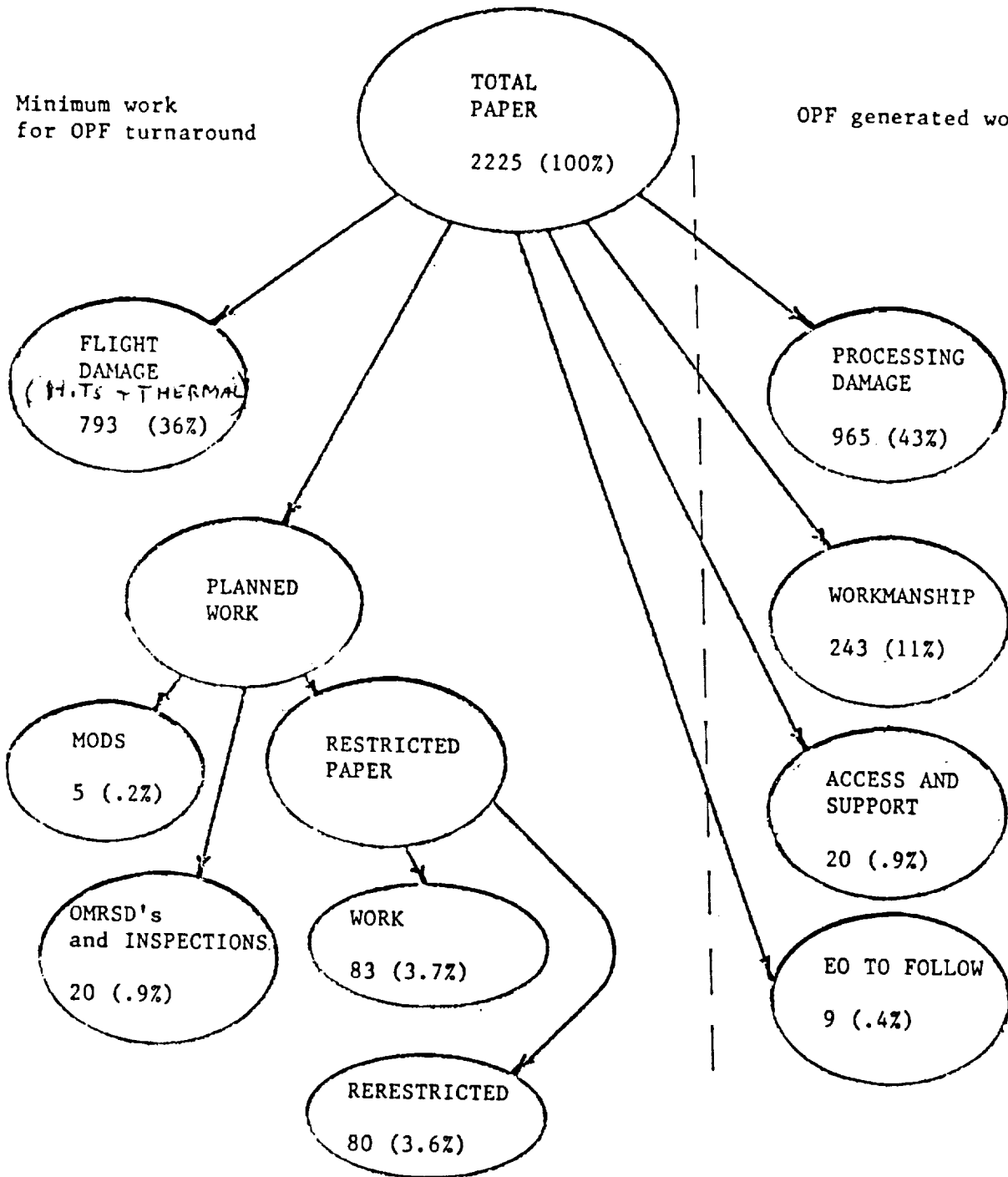
## ORBITER TPS DEBRIS DAMAGE STS-28R THROUGH STS-40





Minimum work  
for OPF turnaround

OPF generated work

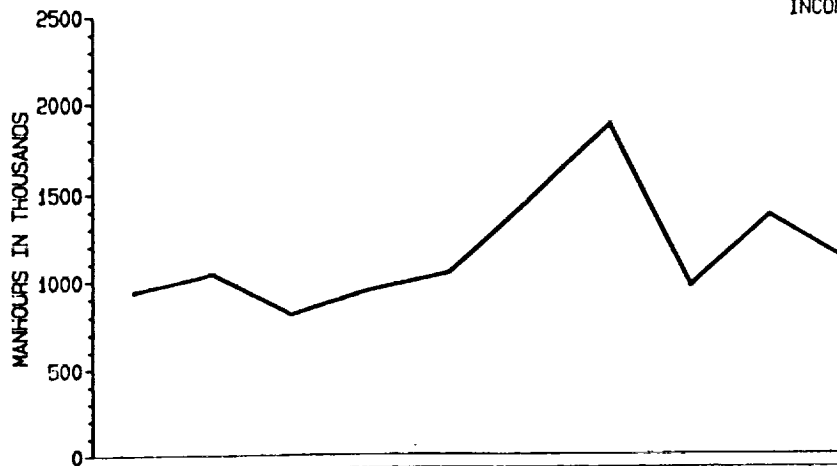


STS-34 TPS WADS

8/14/89

**PROCESSING MANHOURS PER FLOW**  
**IN THOUSANDS**  
**11 CURRENT FLOWS**

\*\* MANHOUR DATA  
 INCOMPLETE



MANHOURS IN 1000's	941	1046	813	953	1053	1459	1874	964	1369	1107	**
ORBITER	352	357	264	282	463	405	473	375	559	420	
TILE	117	188	98	136	251	200	183	154	162	167	
SRB	124	105	107	133	110	117	94	84	118	101	
ET	41	33	26	26	32	34	55	67	20	51	
INTEGRATION	200	236	212	238	207	535	859	168	352	224	
OTHER	109	116	120	139	128	113	208	116	158	144	
FLOW	33R	32R	36R	31R	41	38	35R	37	39	40	43

DATA SOURCE: LSOC PROGRAM OFFICE

**MLO601-9026 REPAIR PROCEDURES**

REPAIR	REPAIR TITLE
TPS-307	REPAIR OF TILE COATING FOR EROSION RESISTANCE
TPS-311	REPAIR OF DAMAGED RSI TILE
TPS-312	REPAIR OF DAMAGED THERMAL BARRIERS USING BLACK RTV
TPS-314	RSI TILE IML FILL
TPS-315	REPAIR OF DAMAGED GAP FILLERS USING HIGH PURITY SILICA COATING
TPS-319	RSI IML MACHINING
TPS-321	RSI TILE SIDEWALL TRIM
TPS-324	REPAIR OF RSI TILE IML DAMAGE
TPS-328	REWORK OF INSTALLED TILES WITH EXCESSIVE GAPS USING CERAMIC BONDED SHIMS
TPS-330	LARGE DAMAGE COATING REPAIR
TPS-335	FLEXIBLE INSULATION PLUG REPAIR
TPS-340	REPAIR OF FLEXIBLE INSULATION BLANKET ASSEMBLIES OUT-OF-TOLERANCE STEP CONDITIONS
TPS-341	REPAIR OF FLEXIBLE INSULATION BLANKET USING QUARTZ FABRIC PATCH/SEWING/SILICA COATING
TPS-342	FABRICATION OF MULTIPLE FLEXIBLE INSULATION BLANKETS
TPS-362	REWORK OF OVERTOLERANCE OML STEPS AND WAVINESS ON INSTALLED TILES
TPS-363	THERMAL PASSIVATION OF OUT-OF-TOLERANCE STEPS AND GAPS USING GAP FILLERS
TPS-364	RTV REFURBISHMENT AND UPPER SURFACE RTV REPAIRS
TPS-365	RCC REPAIR
TPS-367	SUBSTITUTION OF MBO135-085 (RTV 566) FOR MBO135-119 TYPE II (RTV 560)
TPS-368	BROKEN TILE REPAIR
TPS-369	REWORK OF MAIN LANDING GEAR DOOR FLOW RESTRICTORS
TPS-370	FABRICATION AND INSTALLATION OF MAIN LANDING GEAR DOOR THERMAL BARRIER PATCH
TPS-377	LARGE AREA REPAIR OF RSI COATING

## DESIGN CONSIDERATIONS

- COMPATIBLE MATERIALS (ON-BOARD, NATURAL)
- PROVIDE ASSOCIATED NDE (TOOLS/ANALYSIS)
- FIELD REPAIRABLE TECHNIQUES
- PROCESS CONTROL INSTALLATIONS
- BLIND INSTALLATIONS
- GENERIC DRAWING CHANGES
- NON-HAZARDOUS MATERIALS
- PARTS IDENTIFICATION

**10.3.3 Reentry Systems - Material Technology Needs  
by R.M. Ehret, Rockwell International**