AIA Project Report

on

High Bypass Ratio Turbine Engine Uncontained Rotor Events

and

Small Fragment Threat Characterization

1969-2006

Volume 2

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Appendix 5

Appendix 5 itemizes the witness marks left on the airplane by fragments, resulting from disk uncontainment.

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1970	HPT rim	?	A	small	-	1	.5" x .5"	non-impact resistant tank access panel .08" cast aluminum	Hole
1970			B	small	-	1	1 x .75"	non-impact resistant tank access panel .08" cast aluminum	Hole
1970			C	small	-	1	.5" x .5"	lower wingskin 0.95 7075-T351	Gouge
1970			D	small	-	1	1"x1"	lower wingskin 0.95 7075-T351	Gouge
1970			E	intermediate	10	1	7"x6"	lower wingskin 0.95 7075-T351	Gouge
1970B	HPT rim		No documentation						
1971	HPT disk		No documentation						
1971B	HPT disk		No documentation						
1972	FAN disk		No documentation						
1972B	LPT disk		No holes in airplane						
1973	FAN disk		No documentation						
1973B	HPC rim		No documentation						
1973C	HPT rim		No documentation						
1974	HPC rim		No holes in airplane						
1975	LPT disk	?	A	small	-	1	1" X1"	Wing l/e flap Nonmetallic Honeycomb Sandwich,	hole
1975			B	small	-	1	2 x2"	MLG door 0.071 Clad 2024-T3	hole
1975			C	Undetermined	-	1	8" x 2"	Inboard canoe fairing (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	hole with tear
1975			D	small		1	3" x 1"	Inboard canoe fairing (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1976	HPC rim	94% redline 980 ft/s	A	intermediate	-	1		Wing skin	impact mark
1976B	IPT disk		No documentation						
1976C	HPC rim		No holes in airplane						
1977A	HPC16 #1 engine	94% redline	A	Large.	-	1		wing skin Skin panel is Al plate 7075-T651, tapered from 0.286 to 0.374 depending on location	long gouge/crease ending in small puncture hole midway between pylon and fuselage, 6 ft aft of wing l/e
1977A		980 ft/s	B	small	-	1	2 sq inch	wing l/e flap 0.100 Clad 7075-T6	hole
1977A			C	small	-	1	4 sq inch	wing l/e flap 0.100 Clad 7075-T6	triangular hole (tear)
1977B	LPT disk	92% redline	A	intermediate	-	1		r/h wing l/e slat 0.090 Clad 7075-T6	penetrated with part embedded
1977B		590 ft/s	A	intermediate	-	2		wire bundle	wires severed
1977B			B	small	-	1		r/h wing l/edge 0.125 Clad 7075-T6	numerous small punctures
1977B			C	small	-	1		r/h outer flap,0.025 Clad 2024-T3	1 small hole
1977	LPT disk		No holes in airplane						
1977C	HPC rim	97% redline1010 ft/s	A	intermediate	0.7	1	3/32" deep	.04 Aluminum leading edge	dent
1978A	LPT disk		No documentation						

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1979	HPC disk	90% redline	A	small	-	1		Wing l/e slat 0.04 Clad 7075-T6	dent
1979		770 ft/s	B	small	-	1	1.5 x 3/32" slit	wing flap hinge fairing 0.080 Clad 2024-T42	hole
1979			C	small	-	1		wing flap hinge fairing 0.080 Clad 2024-T42	3 abrasion marks around hole B
1979B	HPC rim		No documentation						
1980A	HPT rim	94%	Cowl hinge pin bolt	static structure	-	1	2"x2"	0.125 Clad 2024-T3, fuselage outer skin only	hole
1980A	#3 engine	1060 ft/s		?	-			inbd slat .125 7075	nick
1980A				?	-			lower wingskin	scratch
1980B	HPT disk		No documentation						
1980C	HPC disk		No documentation						
1981	LPT disk	130%	F1	large	-	1	15" x 6" ricochet	Left MLG Inboard Door @ FS1421 .07 to .05 2024 T-3	Puncture / 2 Frames Severed
1981	#3 engine	830 ft/s	F10	small	-	1	3.0" x 3.0" ricochet	Right MLG Inboard Door @ FS1431 .07 to .05 2024 T-3	2 Punctures
1981			F11	small	-	1	1.0" x 6.0" 3.0" x 3.0" 1.0" x 2.0" ricochet	Right MLG Inboard Door @ FS1486, FS1496 and FS1496 .07 to .05 2024 T-3	3 Punctures
1981			F12	small	-	1	2.0" x 2.0" ea. Ricochet	Right MLG Inboard Door @ FS1447 .07 to .05 2024	2 Dents
1981			F13	large	-	1	0.25" Deep	L/E of VHF Antenna No.1	2 Gouges
1981			F14	small	-	1	1.0" x 0.40" ea.	Fuselage Skin @ FS1718 to FS1720 .07 to .2 2024 T-3	3 Gouges
1981			F15	small	-	1	0.5" x 0.5" ea.	Fuselage Skin @ FS1195 / 6 o/c; .07 7075	3 Gouges
1981			F16	small	-	1	1.0" x 0.25" ea.	Fuselage Skin between FS1321 and FS1381 / 6 o/c; .07 to .25 7075	6 Gouges / 2 Dents
1981			F17	small	-	1	1.0" x 0.25" ea.	Fuselage Skin between FS1281 and FS1361 / 6 o/c; .07 to .25 7075	5 Gouges
1981			F18	small	-	1	1.0" x 4.0" ea. ricochet	R/H Aft Lower Fuselage Fairing @ FS1541 and FS1561 non-metallic honeycomb	2 Gouges

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1981			F19a	small	-	1	small ricochet	R/H Fwd Lower Fuselage Fairing between FS1281 and FS1361 paper honeycomb	14 impacts
1981			F19	intermediate	0.31, 0.15	1	4.0" x 4.0" ea. Ricochet	R/H Fwd Lower Fuselage Fairing between FS1281 and FS1361, non-metallic honeycomb	5 Punctures disk web fragment F, stuck in hole, point first, 1.3"x9"x.3" and E, 4"x2"x.25" also stuck in hole
1981			F2	small	-	1	0.75" x 1.5" ricochet	Left MLG Inboard Door @ FS1381 .07 to .05 2024 T-3	Gouge
1981			F20	small	-	1	4.0" x 4.0" ricochet	R/H Aft Fuselage Fairing @ FS1630 paper honeycomb	dent/broke skin
1981			F21	small	-	1	1.0" x 0.4" 0.5" x 0.5"	Fuselage Skin between FS1621 and FS1641 / 6 o/c; .07 2024	1 Puncture / 7 Gouges
1981			F22	small	-	1	1" ricochet	Center MLG, L/H Door Strut @ FS1482 .05 7075	3 closed tears. 2 of them lie on a big U shaped crease
1981			F22a	small	-	1	.1" ricochet	Center MLG, L/H Door Strut @ FS1482 .05 7075	200 chips in paint
1981			F22b	small	-	1	1/4" ricochet	Center MLG, L/H Door Strut @ FS1482 .05 7075	13 dents
1981			F22c	small	-	1	1/8" ricochet	Center MLG, L/H Door Strut @ FS1482 .05 7075	24 small impacts
1981			F23	small	-	1	0.5" x 0.5" ricochet	Right MLG Inboard Door @ FS1436 .07 to .05 2024	Gouge
1981			F24	small	-	1	3.0" x 2.5"	R/H Lower Fuselage Skin @ FS1381 .25 7075	Puncture / Gouge
1981			F25	small	-	1	0.5" x 0.5"	Aft Lower Fuselage Skin @ FS1521 / 6o/c; .23 7075	Gouge
1981			F3	small	-	1	1.0" x 2.0" ricochet	Left MLG Inboard Door @ FS1386 .07 to .05 2024 T-3	Gouge
1981			F4	small	-	1	1" x 1" ea. Ricochet	Left MLG Inboard Door between FS1441 and FS1461 .07 to .05 2024 T-3	2 Gouges
1981			F5a	small	-	1		Center MLG, R/H Door Strut @ FS1471, .05 7075 T-6	84 small impacts
1981			F5	small	-	1	2.5" x 1.5" Puncture in Outer Skin, 3" Crack on Inner Skin ricochet	Center MLG, R/H Door Strut @ FS1471, .05 7075 T-6	Puncture / Skin Crack
1981			F6	small	-	1	2.0" x 2.5" ricochet	Center MLG, R/H Door Strut @ FS1501.05 7075 T-6	Puncture

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1981			F7	small	-	1	0.5" x 0.5" ricochet	Center MLG, R/H Door Strut @ FS1477 .05 7075 T-6	Dent
1981			F8	small	-	1	2.0" x 2.0" ricochet	Center MLG, R/H Door @ FS1421 .05 7075 T-6	6 Gouges / 1 Puncture
1981			F2	small	-	1	0.75" x 1.5" ricochet	Left MLG Inboard Door @ FS1381 .07 to .05 2024 T-3	Gouge
1981			F9	small	-	1	2.0" x 2.0" ea. Ricochet	Right MLG Inboard Door @ FS1418 and FS1415 .07 to .05 2024	2 Punctures piece blade airfoil found in wheel well
1981			F9a	small	-	1	ricochet	Right MLG Inboard Door @ FS1418 and FS1415 .07 to .05 2024	21 impacts
1981			L1	small	-	1	2" ricochet	Left MLG Strut Door L/E at Midspan .068 7075	Dent
1981			L10	small	-	1	2.0" Gouge x 1.0" Long	L/H Inboard Flap Lower Skin, at station X1FH 276.36, 6.0" Forward of T/E; .04 2024	Gouge
1981			L11	small	-	1	0.50" x 0.50" ricochet	L/H Inboard Flap Lower Skin at station X1FH 147.3, 15.0" Forward of T/E; .04 2024	Gouge
1981			L12	intermediate	-	1	ricochet 18.0" x 10.0" Hole Pushed Outboard 8.0"	L/H MLG Closure Rib at XCW 118 canT	Puncture / Severed
1981			L13	small	-	2	ricochet 1.0" x 1.0"	MLG Wheel Well Closure Rib Fairing directly Above and Forward of MLG Wheel Well Closure Rib	Puncture
1981			L14	large	-	1	15.0" x 10.0" x 2.0" Dent and 6.0" Long Puncture ricochet	L/H Inboard Flap L/E Skin Upper Half sta X1FH 149.3 to X1FH 140; .063 2024	Dent / Puncture
1981			L15	small	-	2	3.0" x 2.0" ricochet	L/H Inboard Flap L/E Upper Skin 1.0" Inboard of Flap Vane Inboard Track sta X1FH 149 .063 2024	Puncture
1981			L16	undetermined	-	1	6.0" x 5.0"ricochet	Inboard Flap Vane Bottom Skin form X1FH B3.9 to 140.6 at Inboard Edge (Fwd of Item 40) .063 2024	Puncture
1981			L17	undetermined	-	1	10.0" x 1.5"ricochet	Inboard Flap Vane Lower Skin at X1FH 140.6 .063 2024	Puncture
1981			L19	small	-	1	2.0" x 0.75"ricochet	Inboard Flap Vane at X1FH 159, 6.0" Fwd of T/E .063 2024	Puncture
1981			L2a	small	-	1	very small nicks and paint chipsricochet	L/H MLG Strut Door, 15" from Bottom of 0001, 5" Aft of L/E .016 7075	115 impacts

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1981			L2	small	-	1	1.5" Dia. Hole thru Inner and Outer Skinricochet	L/H MLG Strut Door, 15" from Bottom of 0001, 5" Aft of L/E .016 7075, 2 layers	Puncture
1981			L20	small	-	1	3.0" x 3.0" ricochet	L/H Inboard Flap Track Fairing Lower Fwd Edge X1FH 22.40 .125 2024	Tear / Gouge
1981			L21	small	-	1	0.75" x 0.75" ricochet	No. 1 Engine R/H Core Cowl (YN280) @ 2o/c Position .04 2024	2 Puncture
1981			L22	small	-	1	5.0" x 2.0" ricochet	No.1 Engine Turbine Reverser, 10.0" Fwd of T/E @ 1o/c Position .04 2024	Dent
1981			L22a	small	-	2	ricochet	No 1 engine cooling manifold .02 steel	scratch, no dent
1981			L23	small	-	1	1.0" x 0.25" ricochet	No.1 Engine Turbine Reverser, 3.0" Fwd of T/E @ 3o/c Position .04 2024	Puncture
1981			L24	small	-	1	0.12" x 0.75"	No.1 Engine Fan Reverser, 3" Fwd of T/E @ 3:30o/c Position .04 2024 (sandwich)	Gouge
1981			L25	small	-	1	2.0" x 3.0"ricochet	No.1 Pylon Aft Fairing @ sta YN435, 4.0" Below Wing Skin .06 2024	Puncture
1981			L26	small	-	1	2.0" x 0.25" 0.75" x 0.75" ricochet	No.1 Pylon Inboard Skin @ sta YN400 .06 2024	2 Gouges
1981			L27	small	-	1	1.0" x 1.5"ricochet	No.1 Pylon Lower Fairing @ sta YN395, 4.0" from Fairing T/E .06 2024	Gouge
1981			L28		-	1	12.0" x 3.0"ricochet	L/H Wing Lower Skin Panel at xors 200 (Fwd Half of Panel) .06 al	Dent
1981			L29	small	-	1	0.5" x 0.5"ricochet	Outboard Half of Panel (WING LOWER SKIN XORS 200); .06 Al	12 Small Dents
1981			L4	small	-	1	0.5" x 0.5"ricochet	L/H MLG Strut Door Outer Skin, 20" below Top Edge of Door and 10" forward of T/E .016 7075	Puncture, outer layer only
1981			L4a	small	-	1	very small nicks and paint chips ricochet	L/H MLG Strut Door Outer Skin, 20" below Top Edge of Door and 10" forward of T/E .016 7075	75 small impacts
1981			L6	small	-	1	2.0" x 0.25"ricochet	L/H Wing Fixed L/E Skin at xors 1045, 3" Aft of L/E; .125 7075	Gouge / Dent
1981			L7	small	-	1	0.50" x 0.50"ricochet	L/H Wing Flap Actuator Inboard Fairing, Inboard Side, 10" from Fairing L/E and 20" down from Wing Skin; .03 7075	Gouge

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1981			L8	small	-	1	2.0" Long ricochet	L/H Wing Outboard. Flap and Hinge Fairing , Inboard Side. 20.0" Aft of Fairing L/E, 5.0" Door from Wing Skin .03 to .06 7075	Gouge
1981			R1	small	-	1	0.5" x 0.25"	R/H Wing Outboard Flap @ X0F 585.377, 3.0" Aft of L/E; .05 2024	Gouge
1981			R10	small	-	1	2.0" x 2.0"	R/H Inboard Flap Lower Skin, 20.0" Aft of L/E @ X1F 285 .05 2024	Puncture
1981			R11	small	-	1	2.0" x 0.25"	Inboard Flap Lower Skin, 7.0" Fwd of T/E @ X1F 213 .05 2024	Puncture
1981			R15	small	-	1	1.0" x 0.1" ea.	Lower Wing Panel @ X0RS 130, Fwd of Gear Strut Cutout 0.125 Clad 7075-T6	2 Punctures
1981			r23	large	-	1	-	r/h wing skin panel ARB2602 xors 197 to 298 0.125 Clad 7075-T6	25 gouges
1981			R21	small	-	1	2"	Panel P/N 3031 @ X0RS 225 to X0RS 264 0.125 Clad 7075-T6	4 punctures
1981			r21a	small	-	1	1/4"	Panel P/N 3031 @ X0RS 225 to X0RS 264 0.125 Clad 7075-T6	7 dents
1981			r22	small	-	1	0.5"	r/ wing fixed l/e door at xors 190 to xors 230	10 punx
1981			r30	large	-	2	-	front spar web at xors 226	gouge
1981			r31	large	-	2	-	stiffener at xors 226 front spar	destroyed
1981			r25	large	-	2	24"	doubler deformation at r19	
1981			r29	large	-	2	1.5x.25 x.06" deep, 5 off	tee @xors230.6	gouge
1981			R14	small	-	2	1.5" x 0.5"	R/H Wing Upper Fixed R.E. Aceess Panel @ X0RS 231, Fwd of Grear Strut Cutout	Puncture
1981			R16	small	-	1	0.5" x 0.5"	Lower Wing Skin Fairing Panel, Inboard of X0RS 231, Fwd of Gear Strut Cutout .06 7075 by analogy to other fairings	Puncture
1981			R17	small	-	1	1.0" x 1.0" ea.	Access Panel 641 EB @ X0RS (?231?)	4 Punctures
1981			R19	large	-	2	X0RS 210 to X0RS250, 24.0" Long	Front Spar Lower Cap Fwd Flange Twisted and Bent Upwards ~2.0" along a 24.0" Span Centered on X0RS 231, Fwd Flange also Cracked at Fillet Radii, ~12.0"	Bent / Twisted / Cracked
1981			r40	large	-	3	10"x18"	r/h wing fixed l/e top skin xors231 fwd of front spar 0.125 Clad 7075-T6	puncture

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1981			r40a	large	-	2	> .5"	severed tube inside hole r40	puncture
1981			r41	large	-	2	3 off, .75x.1	front spar upper cap fwd flnge at XORS231	gouge
1981			r41a	large	-	2	3"	front spar fracture	broken
1981			r32	large	-	2	-	r/h wing fixed l.e. panel suport rib xors 235 0.125 Clad 7075-T6	destroyed
1981			r26	large	-	2	3" x.25"	front spar web stiffener xors237	gouged
1981			r42	undetermined	-	2	5"x4"	r/h wing fixed l/e top skin xors240 12" fwd of front spar	puncture
1981			r42a	undetermined	-	2	5 dents	r/h wing fixed l/e top skin xors240 12" fwd of front spar 0.125 Clad 7075-T6	dents
1981			r33	small	-	1	-	r/h inbd flap lower skin x1f 243 and 249 .05 2024	punctures
1981			r43	small	-	2	3"x3"	access panel on top side fixed l/e inbd of pylon at XORS 245	tear
1981			r34	large	25	2	-	closure rib inbd of droop leading edge xdle 304	destroyed
1981			r35	large	25	1	-	droop leading edge at xors 264 0.090 Clad 7075-T6	destroyed
1981			r36	large	25	2	-	droop leading edge drum support fitting	destroyed
1981			R20	small	-	1	1"	panel @ XORS 270 0.125 Clad 7075-T6	3 Punctures
1981			R20a	small	-	1	-	panel @ XORS 270 0.125 Clad 7075-T6	13 dents/scuffs of minimal depth
1981			R20b	small	-	1	-	panel @ XORS 270 0.125 Clad 7075-T6	20 impacts
1981			r20c	small	-	1	-	wingskin at XORS 270, at front spar 0.125 al	91 impacts, 1 closed puncture shaped like airfoil
1981			r24	large	-	1	8"x5"	r/ wing fixed l/e panel AB2510 at xors298 0.125 Clad 7075-T6	gouged/ torn area
1981			R13	small	-	1	0.25" x 1.5" ea.	R/H Inboard Flap Lower Skin 8.0" Aft of L/E @ X1F 162 .05 2024	3 Gouges
1981			R18	small	-	1	5.0" x 5.0" 1.5" x 0.75"	Skin Panel S0rS 231 / Stringer 52. Panel P/N ARB 2603 0.125 Clad 7075-T6	Dent / Puncture
1981			R2	small	-	1	0.5" x 0.5"	Outboard Flap Outboard Hinge Fairing Lower L/E .08 2024	Gouge / Dent
1981			R3	small	-	1	2.0" x 2.0"	Outboard Flap Lower Skin Mid-Chord @ X0F 520; .05 2024	Puncture

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1981			r39	small	-	2	3"x3"	r/h wing fixed l/e top skin at xdle 330, 12" aft of l/e 0.125 Clad 7075-T6	puncture
1981			R4	undetermined	-	1	1.0" x 5.0"	Outboard Flap Inboard Hinge Fairing 12.0" Fwd of T/E and 24.0" Down from Skin: .064 2024	Puncture
1981			r44	-	-	2	-	upper cap of closure rib, 15" aft of rib l/e	tear
1981			r45	-	-	1	2"	mlg r/h strut door inbd skin 3" aft of l/e 20" up from base	gouge
1981			r46	small	-	1	2" x2"	r/h mlg bogie beam gravel shield	5 Punctures
1981			R5	large	-	1	25.0" Long 0.5" x 0.25"	Outboard Flap Lower Skin Aft Edge at X0F 478 to 462 .05 2024	Gouge / Puncture
1981			R6	small	-	1	3.0" x 3.0" 1.5" x 1.5" 1.5" x 1.5" 0.5" x 0.5"	Inboard Flap Lower Skin @ X1F 261 to X1F 255, 18.0" and 21.0" from T/E .05 2024	4 Punctures
1981			R7	undetermined	-	1	2.0"	Inboard Flap Mid Span @ K1F 241, 18.0" from T/E .05 2024	Crack
1981			R8	undetermined	-	1	Small	Lower Flap Skin .05 2024	Gouge
1981			R9	small	-	1	1.0" x 1.0"	Inboard Flap Vane 10.0" from L/E @ X1FH 420 and 230; .063 2024	Punctures
1981		#9	xr1	large	3	1	25.0" Long 0.5" x 0.25"	right wing inboard Flap Lower Skin? Adjacent to wheel well disk impact f1 .05 2024	Gouge / Puncture
1981			xr1a	small	-	1	small	right wing inboard Flap Lower Skin? Adjacent to wheel well disk impact f1 .05 2024	6 impacts
1981				small	-	1	1.5" x 1.5"	12" fwd of front spar, XORS245 Lower Skin and Honeycomb at X1FH 149	Puncture
1981C	LPC disk	No documentation							
1981D	FAN disk	No documentation							
1981B	HPT disk	95%	1 - 150	small	-	1	-	l/e slats #1 above pylon .04 al 2014	abrasion + 150 impacts

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1981B	#1 engine	1070 ft/s	151, 152	small	-	1	-	l/e slat #2 on left of pylon between R3 and R4 .04 al 2014	2 punctures
1981B			153	undetermined	-	1	-	lower wing panel #1 7,11 to 7,47 up to 15,24 mm 4,8 to 5,26 up to 6,6mm in the pockets	.03 deep scratches
1981B			154	undetermined	-	1	-	#1 panel between R4-R5 fwd of front spar (6,6) to 8,13 (up to 15,24 ??) mm 4,8 to 5,26 in the pockets	3/16 (5mm) dent
1981B			155	small	-	1	-	precooler heat exchanger	blade particles went through, found lying on top
1981B			156	undetermined	-	1	-	panel 512 PB (underside wing, midway between pylon and fuselage, aft of fwd spar) aft edge 13,14 mm thick (or 20,07 ; or 6,1)	puncture and severe abrasion (.03" deep)
1981B			A	small	-	1	1.5"	lower fuselage between F42 and F43, ST 38 - ST 39 left side, below wing 2,3 mm Al	puncture by a piece of HPT2 blade 1" x 3/4"
1981B			157 - 171	small	-	1	-	lower fuselage between F42 and F43, ST 38 - ST 39 left side, below wing, 2.3 mm Al	14 impact marks
1981B			A	small	-	2	-	system1 air duct	hole both walls (particle A) 1" piece airfoil
1981B			A	small	-	3	3/8"	system 2 air duct	dent particle A
1981B			A	small	-	4	-	cabin floor station 42 honeycomb sandwich	dent particle A
1981B			B	small	-	1	-	lower fuselage between F42 and F43, ST 38 - ST 39 left side, below wing 2.3 mm Al	puncture particle B
1981B			B	small	-	2	-	system 2 pneumatic line	hole outboard wall only particle B
1981B			172 - 177	small	-	1	0.25"	pack inlet fairing, punctures did not damage fuselage underneath. Al	3x 0.25"punx, 2 abrasions

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1981B			178,179	small	-	1	0.5"	LH inbd flap actuator fairing, foil honeycomb sandwich	2x 0.5" punctures
1981B			180, 181	small	-	1	small	#4 LH flap actuator fairing foil honeycomb sandwich	2 small punctures
1981B			182, 183	small	-	1	1"	R/H oleo attached main gear door outer skin 0,8 to 1 mm reinforcement 1 mm	2x 1" punctures
1981B			184	small	-	1	2"	R/H oleo attached main gear door outer skin 0,8 to 1 mm reinforcement 1 mm	a 2" puncture
1981B			185	small	-	1	0.75"	#2 engine fan cowl, .036 aluminum honeycomb	a 0.75" puncture
1981B			186	small	-	1	1"	#2 engine transcowl, honeycomb sandwich with .04 and .036" Al facesheets	a 1" puncture in outer skin, not inner flowpath
1982A	HPT disk	98%	A	Intermediate.	-	1 ricochet	-	#1 pylon,via access door 419Vc	Ricochet off runway and through pylon
1982A	#2 engine	1105 ft/s		Intermediate.	-	2 ricochet	-	left wing #3 flap track beam fairing .020 OUTER SKIN .010 INNER SKIN .honeycomb sandwich	embedded in fairing
1982A				small	-	1 ricochet	-	left wing #2 flap track beam fairing honeycomb sandwich	3 dents, 1 hole, 18 dents, 3 holes, 1 crack
1982A				small	-	1 ricochet	-	left wing #3 flap track beam fairing honeycomb sandwich	2 holes
1982A				small	-	1 ricochet	-	left wing #4 flap track beam fairing honeycomb sandwich	1 hole
1982A				small	-	1 ricochet	-	left wing #5 flap track beam fairing honeycomb sandwich	2 holes
1982A				blade dovetail, 7/8" long	0.15	1, ricochet	1"x2"	lower right inboard fuel tank between rib 1 and 2, stn 80;.27" to .2" Al	hole
1982A				blade dovetail, 7/8" long	0.15	1, ricochet	1.5"x2.3"	lower right inboard fuel tank between rib 1 and 2, stn 8 .27" to .2"	hole
1982A				blade dovetail, 7/8" long	0.15	1, ricochet	4"	lower right inboard fuel tank between rib 2 and 3, stn6 .27" to .2"	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1982A				small	-	1, ricochet	1"	lower right wing access panel between rib 2 and 3, stn 10; .26 to .19"	dent
1982A				blade dovetail	0.164	1, ricochet	-	lower right inboard fuel tank rib 3 .26 to .19"	hole
1982A				small	-	1, ricochet	-	lower right inboard fuel tank rib 4 stn 7 .26 to .19"	penetrated (gash)
1982A				small	-	1 ricochet	0.08	#1 engine inlet 2 mm impact mark at 11 o/c Al skin /Al honeycomb	dent
1982A				small	-	1 ricochet	0.1	#1 engine inlet inner skin punx at 1 o/c Al skin /Al honeycomb	hole
1982A				small	-	1	-	#1 engine inlet outer skin punct 15 " aft of lip, at 4 o/c Al skin /Al honeycomb	skin punc
1982A				small	-	1	3	#1 engine -transcowl fairing (beavertail) , 11" from aft edge 2024 Al skins, .020, .025, .032, .040" skins	.8x.3" hole,
1982A				small	-	1 ricochet	2.6	#1 engine -transcowl at 4 o/c , 71 cm from fwd frame, 20 cm from bottom of cowl 2024 Al skins, .020, .025, .032, .040" skins	2.6"x1.6" puncture through outer skin
1982A				small	-	1 ricochet	-	#1 engine -transcowl outer skin 61 cm from fwd frame, 106 cm from bottom cowling 2024 Al skins, .020, .025, .032, .040" skins.	puncture with embedded piece Acoustic face sheet deformed but not punctured
1982A				small	-		0.8	1 puncture through inner and outer transcowl skin, 12" from t/e, 120 cm from bottom of cowl 8 o/c 2024 Al skins, .020, .025, .032, .040" skins.	puncture 0.8"x.8"
1982A				small	-	1 ricochet	12	transcowl at 2 o/c, trailing edge smashed in, inner skin torn 30 cm x 1 cm 2024 Al skins, .020, .025, .032, .040" skins.	nut and threaded piece bolt embedded in outer skin
1982A				small	-	1	1.6	transcowl outer skin 2024 Al skins, .020, .025, .032, .040" skins.	puncture
1982A				small	-	1	-	68 dents in transcowl 2024 Al skins, .020, .025, .032, .040" skins	dents

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1982A				small	-	1	2	#1 nozzle 3:15 o/c, 30 cm from l/e Inco 625	1x 2" hole thru outer + inner skin
1982A				small	-	1	-	#1 nozzle 20 dents Inco 625	dents
1982A				small	-	1	1.25	#1 nozzle 5 o/c , Inco 625	hole thru outer+inner inner skin
1982A				small	-	1 ricochet	-	#1 nozzle outer skin puncture 2 o/c Inco 625	puncture outer skin only
1982A				small	-	1 ricochet	-	#1 nozzle outer skin puncture 2:30 o/c Inco 625	puncture outer skin only
1982A				small	-	1,2 ricochet	-	#1 aft centerbody, left and right sides, 3 o'c and 9 o/c, 3.5 cm from cone tip trajectory is 5 degrees off horizontal, travelling upward.inco 625	puncture outer skin only
1982A				small	-	1	0.25	5 small holes at fancowl center .036 Al skin /Al honeycomb/	1/4" hole
1982A				small	-	1	-	19 dents on fan cowl surface .036 Al skin /Al honeycomb/	dents
1982A				small	-	1	-	#1 engine fancowl , 32" from bottom .036 Al skin /Al honeycomb/	dents
1982A				small	-	1 ricochet	1.6 x0.8"	#1 engine fancowl , 22" from bottom .036 Al skin /Al honeycomb/	hole
1982A				small	-	1	0.4"	#1 engine fancowl oil tank door and frame hit	hole
1982A				small	-	1	2.75"x1.6"	#1 engine core cowl 25 cm from bottom edge and 40 cm from t/e .04 Al	hole
1982A				small	-	1	2'x1.3"	#1 engine core cowl 50 cm from l/e and 91 cm from bottom edge 04 Al	hole
1982A				small	-	1	1"	#1 engine core cowl 18 cm from t/e and 51 cm from bottom edge 04 Al	hole
1982A				small	-	1	0.8"	# 1 engine core cowl, 18 cm from t/e and 101 cm from bottom edge 04 Al	hole
1982A				small	-	1	0.5"	# 1 engine core cowl, 18 cm from t/e and 101 cm from bottom edge	hole
1982A				small	-	1	-	#1 engine core cowl top right corner	2 small holes at top

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1982A			B	small	-	1	-	#1 engine core cowl , 3;30, 30 cm from fwd flange.	hole
1982A			B	small	-	2	-	LPT manifold .02 stainless steel Also axial leg manifold said dented at 3.30 same axial position.	crushed/buckled on aft side. On aft side, 1/4" away, impact mark on case and very small hole . No passthru of case (no internal mechanical damage)
1982A			B	small	-	3	0.25	LPT case .06 INCO 718	1/4" hole in LPT case
1982A				undetermined	-	1	-	aft pylon,piece blade found r/h wing/plylon fairing	
1982A				undetermined	-	1	-	left wing l/e above #1 pylon (door 414DR)	
1982A					-	1	-	#1 pylon (under wing) door 472AR, and bleed air duct inside was severed	
1982A				small	-	1	-	found inside #6?flap?,	full chord airfoil, 1/4" span
1982A					-	1	-	#1 pylon (top surface)	
1982A				small	-	1 ricochet	-	fuselage skin holed 19" below window, piece found undr seat 27j,	HPT blade platform, 1/2" x 1/2"
1982A				small	-	1	-	found in air conditioning CA2	piece thrmal shield (3 and 2/2 bolt holes length)
1982A				small	0.25	1	-	found in air conditioning CA2	2 blade dovetails, .25 lb each, 10 pieces blade or shank
1982A				small	0.035	1	-	fuselage skin holed, piece found stuck in wall by seat 29L .06 Al	HPT blade piece 1/2" x 1/2"
1982A				small	-	1 ricochet	-	fuselage skin atSTA1660, above window,at fwd cargo door .06 Al	2 punctures
1982A				small	-	1	-	fuselage skin at STA 2525, nearbottom .06 Al	1 puncture
1982A				small	-	1 ricochet	-	fuselage stn betweenSTA 2983 and 2559, below windows	50 punctures

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1982A				small	-	1 ricochet	-	fuselage skin betweenSTA 3354 and STA 3725, below cabin windows	8 punctures
1982A				small	-	1	-	fuselage skin at STA4361	1 puncture
1982A				small	-	1	-	fuselage skin at STA4467	1 puncture
1982A				small	-	1	-	fuselage skin at STA4762 aft of pax door 4	1 puncture
1982A				small	-	2 ricochet	-	center tank vapor seal between STA2718 and 2930	8 punctures
1982A				small	-	2 ricochet	-	center tank vapor seal between STA2718 and 2930	4 dents
1982A				small	-	1	-	vertical stabilizer l/e .04 Al	1 puncture
1982A				small	-	1	-	vertical stabilizer .04 Al	2 dents
1982A				small	-	1	-	found in rt wing l/e 8" inbd #2 engine .04 Al	stg 1 nozzle pair
1982A				large static	-	1	-	right wing fixed l/e access door 612HR .04 Al	NGV ring, 16 ", holed and severed electric wire. Found in hole
1982A				small	-	1	-	right wing fixed l/e access door 612GR .04 Al	HPT2 blade piece destroyed cooling fan motor
1982A				undetermined	-	1,2	-	right #1 slat .04 Al	hole in lower and upper surfaces
1982A				intermediate	-	1	-	left wing trailing edge near #2 flap track fairing fillet zones 533/ 587 in AMM .04 Al	pieces found inside; 12" circumf length HPT spacer (2.5 air hole embossments).
1982A				small	-	1	-	left wing trailing edge near #2 flap track fairing fillet zones 533/ 587 in AMM .04 Al	2 1/8" section fwd flange of thermal shield
1982A				small	-	1	-	left wing trailing edge near #2 flap track fairing fillet zones 533/ 587 in AMM .04 Al	stg 1 nozzle vane - 1 part airfoil
1982A				small	-	1	-	left wing trailing edge near #2 flap track fairing fillet zones 533/ 587 in AMM .04 Al	stg 1 HPT blade - 1 blade shank and 2 small pieces airfoil
1982A				small	-	1	-	left wing trailing edge near #2 flap track fairing fillet zones 533/ 587 in AMM .04 Al	stg 1 turbine shroud - 1 small corner piece

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1983B	HPC1	91%	No fragments released outside the nacelle						
1983B	#1 engine	680 ft/s							
1983	HPC disk	92%	A	small	-	1	puncture. 1"x.125"	right wing l/e, 18" inbd of pylon 0.050 Clad 7075-T6	hole
1983	#4 engine	930 ft/s	B	small	-	1	.75x.25x.07 deep	Rt wing l/e slat Nonmetallic Honeycomb Sandwich,	dent
1983			C	small	-	1	26 mpacts size of rivet head	right wing l/e 0.050 Clad 7075-T6	impacts not holes
1983			D	small	-	1	~100 small impacts up to.07" deep	right wing lower surface, l/e boundary to 18" aft of l/e 1.100 2024-T351	impacts not holes
1983			E	small	-	1	7"x0.5" gouge	#7 flap track fairing, inboard surface "Nonmetallic Honeycomb Sandwich,	impact not hole
1983			F	small	-	1,2	1 x .5" entrance, 2	#7 flap track fairing, inboard surface "Nonmetallic Honeycomb Sandwich,	through hole
1983			G	small	-	1	.75 x .5"	rt wing/fuselage fillet Fiberglass Honeycomb Panel	puncture
1983			H	small	-	1	series of scrapes	fuselage fwd of emergency door R5 0.062 Clad 2024-T3	impact
1983			I	small	-	1	x .5	fuselage at exit door R5 0.062 Clad 2024-T3	puncture
1983			J	small	-	1	1" holes	vertical stb, fwd right side, 4 ft above fuselage 0.14 7075-T651	puncture
1984	HPT disk		No documentation						
1985A	HPC disk	96%	A	small	-	1	1/4"	rt inbd elevator top (fold-down piece) 0.020 Clad 2024-T3	726 impacts
1985A	#2 engine	970 ft/s	B	small	-	1	1/4"	rt inbd elevator top 0.020 Clad 2024-T3	124 impacts
1985A			c	small	-	1	1/2"	rt inbd elevator top 0.020 Clad 2024-T3	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1985A			d	small	-	1	1/4"	rt inbd elevator top 0.020 Clad 2024-T3	10 impacts
1985A			d	small	-	1	1/2"	rt inbd elevator top 0.020 Clad 2024-T3	hole
1985A			E	small	-	1	1/2"	rt inbd elevator top 0.020 Clad 2024-T3	hole
1985A			F	small	-	1	1/2"	rt stab at inbd/outbd elev station 0.020 Clad 2024-T3	hole
1985A			F	small	-	1	1/2"	rt stab at inbd/outbd elev station 0.020 Clad 2024-T3	hole
1985A			F	small	-	1	1/4"	rt stab at inbd/outbd elev station 0.020 Clad 2024-T3	3 impacts
1985A			G	small	-	1	1" each	rt outbd elev top 0.020 Clad 2024-T3 0.020 Clad 2024-T3	2 holes
1985A			G	small	-	1	1/4"	rt outbd elev top 0.020 Clad 2024-T3	4 impacts
1985A			H	small	-	1	2" hole	left inbd elevator fold-down 0.020 Clad 2024-T3	hole
1985A			H	small	-	2	2" hole	left inbd elevator fold-down 0.020 Clad 2024-T3	hole
1985A			I	small	-	1	4" tear	left stab trail edge 0.020 Clad 2024-T3 with .025 plate	hole
1985A			J	small	-	1	2" hole	left outbd elevator top surface 0.020 Clad 2024-T3	hole
1985A			L	small	-		2 impacts 1/2" each	left outbd elevator top surface 0.020 Clad 2024-T3	impact
1985A			L	small	-		1 hole 1/2"	left outbd elevator top surface 0.020 Clad 2024-T3	hole
1985A			K	small	-		8 holes 1/2"	left outbd elevator top surface 0.020 Clad 2024-T3	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1985B	HPT spacer	98%	-	small	-	1	3 holes 1" each	droop leading edge lower surface,inboard of XOS 420 0.090 Clad 7075-T6	hole
1985B	#3 engine	830 ft/s%	-	intermediate	-	1	1 hole,1" x 4"?	droop leading edge lower surface,inboard of XOS 420 0.090 Clad 7075-T6	hole
1985B			-	intermediate	-	1	1 hole 4" x 1"?	droop leading edge lower surface,inboard of XOS 420 0.090 Clad 7075-T6	hole
1985B			-	intermediate	-	1	1 hole 4" x 4"	droop leading edge lower surface,inboard of XOS 420 0.090 Clad 7075-T6	hole
1985B			-	small	-	1	18 impacts, 1/4"	droop leading edge lower surface,inboard of XOS 420 0.090 Clad 7075-T6	no
1985B			-	small	-	2	1 hole, 1" diameter	droop leading edge upper surface,inboard of XOS 420 0.090 Clad 7075-T6	hole
1985B			-	undetermined	-	1	2 impacts 3" each	leading edge adjacent to pylon	no
1985B			-	undetermined	-	1	4 indented tears, 3" each	leading edge adjacent to pylon 0.125 Clad 7075-T6	hole no passthru
1985B			-	small	0.04	1		inboard leading edge slat lower surface v 0.125 Clad 7075-T6	hole Small. piece thermal shield, .75" x 1.5"
1985B			-	Small.	0.04	2	~1"	inboard leading edge slat upper surface v 0.125 Clad 7075-T6	hole piece thermal shield, .75" 3 fins wide, and 1.5" long, found embedded in slat upper surface
1985B			-	small	-	1	141 chips and dings, 10 closely spaced gouges leading to big hole	lower wing leading edge panels inboard of #3 pylon - small piece 0.125 Clad 7075-T6	no
1985B			-	intermediate	-	1	2.5" arc hole, 2 hole, extensive tearing connecting them,	lower wing leading edge panels inboard of #3 pylon 0.125 Clad 7075-T6	hole
1985B			-	intermediate	-	1	.75" hole connect to straight-edge 6" long, 2" across hole at panel breakaway.	lower wing leading edge panels inboard of #3 pylon 0.125 Clad 7075-T6	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1985B			-	small	-	1	11 larger impacts (1/2") and 537 smaller impacts (shotgun/ chips)	lower wing leading edge panels inboard of #3 pylon 0.125 Clad 7075-T6	no
1985C	LPT disk	90%	A	small	-	1	2"x1"	Vertical stabilizer Al Honeycomb Sandwich	Hole
1985C	#4 engine	580 ft/s%	B	small	-	1	1x1	Flap Nonmetallic Honeycomb Sandwich,	no record
1985C			C	small	-	1	2x1	Flap Nonmetallic Honeycomb Sandwich,	no record
1985C			D	small	-	1	1.5x1	wing/ body fairing Fiberglass Honeycomb Panel	no record
1985C			E	small	-	1	.5x.5	wing/ body fairing Fiberglass Honeycomb Panel	no record
1985C			F	small	-	1	3x2	wing/ body fairing Fiberglass Honeycomb Panel	no record
1985C			G	small	-	1	-	WING sta 190-210 and 85, between wing l/e and fwd longeron 0.050 Clad 7075-T6	dents
1985C			H	small	-	1	3x2 "	.071 clad 2024-T3 fuselage - aft cargo door	1 tear, 12 impacts
1985C			I	small	-	1	dent	0.062 Clad 2024-T3 fuselage sta 1684 or 1698?str 40R	dents
1985C			J	small	-	1	numerous impacts	0.062 Clad 2024-T3 fuselage sta 1480 to 2200, str 12r to 34R	dents
1985C			J2	small	-	1	15 impacts	0.062 Clad 2024-T3 fuselage sta 1685, 1720, 1719, 1730,1740,1742, 1780,1805,1925,2060,2200,2140,2 280,2315,2400; str 8r to 37R	dents
1985C			K	small	-	1	.5x.5	0.062 Clad 2024-T3 fuselage	dents
1985C			L	small	-	1	2x2	0.062 Clad 2024-T3 fuselage	hole
1985C			M	small	-	1	~60 impact marks, mostly smaller diametr than rivets	1.1 2024-T351 lower wing skin around hole	dents
1985C			M2	small	-	1		access panel in wing	hole
1985C			N	large	18	1	2"x8" hole made by disk piece	1.1 2024-T35 lower wing skin	puncture
1985C			N	large	18	2	-	0.620 7178-T651 Plate mid spar web	puncture

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1985C			N	large	18	3	-	0.900 7075-T651 upper wing skin	puncture
1985C			O	undetermined	-	1	-	inboard side #4 pylon (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, Grade B, Class 2, (MIL-C-7438) 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	no record
1985C			P	large static	2.3	1	impaled by LPT case fragment, 3 1/4" x 17"	right outboard flap Nonmetallic Honeycomb Sandwich,	hole-fragment in hole
1985C			Q	small	-	1	140+ small impacts	#8 flap track fairing (canoe7) outboard side near t/e Nonmetallic Honeycomb Sandwich	impact
1985C			R	small	-	1,2	one hole thru outboard and inboard surfaces	#8 flap track fairing outboard side Nonmetallic Honeycomb Sandwich	through hole
1985C			-	small	0.06	1		#8 l/e slat	NGV platform and support
1985C			-	small	-	1	hole	#7 canoe non-metallic honeycomb sandwich	1" x1/4" airfoil tip
1985C			-	small	-	1	hole	#6 canoe non-metallic honeycomb sandwich	1" x1/4" airfoil tip
1985C			S	undetermined	-	1	-	right side vertical fin Taper 0.160 (top of fuselage) to 0.118 (100" above fuselage), machined from 0.190 7075-T651	no record
1985C			T	small	-	1	minor impacts between leading edge longeron and fwd longeron	right horizontal stab 0.050 Clad 7075-T6	impact
1985D	LPT disk		No documentation						
1985E	HPC disk		No documentation						
1989B	LPC disk		No holes in airplane						

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1989	FAN disk	88%	1	small	-	1	1"	Rt inbd elevator 0.020 Clad 2024-T3	hole
1989	#2 engine	460 ft/s	2	small	-	1	1".5"	Rt inbd elevator 0.020 Clad 2024-T3	hole
1989			5	small	0.12	1	4"x1.3"	rt stabilizer torque box, outboard, 102" from t/e Skin 0.020 Clad 7075-T6 .	hole (impacted rib)
1989			8	10" static piece, found in hole	2	1,2	9x5, 14x2	outbd left stabilizer torque box 80" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	hole where skin only, skin+ rib remained in almost all in place. Fragment holed .02 but not .045" thick.
1989			9	undetermined	-	1,2	15x2	left stab torque box mid span 85" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	top surface and o/b rib
1989			11	small	-	1	2x1	left l/e, 143" from t/e 0.020 Clad 2024-T3	3 surface holes, no internal dmg. Holed skin, dented skin+plate.
1989			15	undetermined	-	1		middle left stab 70" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	4 gouges on surface, doubler (L shaped plate) not penetrated
1989			18	x shaped hole, like fan blade panel+ part-span shroud	2.3	1	13x6	middle of left stab torque box, 102" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	top surface
1989			19	1.6"x5.6" fan blade tip found in hole	0.25	1	12x4	middle of left stab torque box, 125" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	hole in top surface
1989			20	small	-	1,2	6x2	middle of left stab torque box, 125" from t/e Skin 0.020 Clad 7075-T6 with .025 doubler Plate, both holed	top surface, rib damaged, lower skin hit but not holed
1989			21	small, 5"x5" fan blade tip and 1/2 part span damper found in hole	.75, 1.25	1	4x2	middle of left stab torque box, 127" from t/e Skin 0.020 Clad 7075-T6	top surface
1989			23	undetermined	-	1,2	18x18	rt inbd detachable elevator 54" from t/e 0.020 Clad 2024-T3. Broke through doubler also (likely .025")	through hole
1989			24	small	-	1,2	3x1	rt inbd detachable elevator 44" from t/e 0.020 Clad 2024-T3	through hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1989			25	small. Likely fan blade platform	0.5	1,2,3	5x2	rt inbd stab aft of spar, 106" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	through hole, system 3 hyd line damage
1989			26	small	-	1,2	2x1	rt inbd stab aft of spar, 95" from t/e Skin 0.020 Clad 7075-T6 with .025 thick 7075-T651 Plate	through hole
1989			27	small	-	1	5x1, 3", 3"	rt inbd stab aft of spar, 95",100,102" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	top surface holes
1989			28	undetermined	-	1	4	rt inbd stab aft of spar, 108" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	surface cut, no passthru
1989			29	undetermined	-	1	5.5	rt inbd stab aft of spar, 95" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	tear thru surface, no damage to systems beneath
1989			30	undetermined	-	1,2	11x5	rt inbd stab aft of spar, 87" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	through hole
1989			31	undetermined	-	1,2	10x9	fwd edge of rt inbd detachable elevator Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	hole thru elevator and fairing
1989			34	complete booster blade found in hole	0.3	1,2	4x1	rt spar o/b of midpoint, 85" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	hole, damage to rib below
1989			42	small	-	1,2	1x2	rt inbd elevator 51" from t e 0.020 Clad 2024-T3	through hole
1989			43	blade piece	-	1,2	5x3	rt inbd elevator 55" from t/e 0.020 Clad 2024-T3	through hole like blade fragment
1989			44	small	-	1	1x1	rt inbd elevator 52" from t/e 0.020 Clad 2024-T3	upper surface only
1989			45	small	-	1	2x.3	rt inbd elevator 36" from t/e 0.020 Clad 2024-T3, also thru doubler likely .025"	hole in upper surface
1989			46	small	-	1	.5x.3	rt inbd detachable elevator 41" from t/e 0.020 Clad 2024-T3	hole in top surface, bulge in lower surface
1989			47	small	-	1,2	.3x.3	rt inbd detach elevator 32" from t/e 0.020 Clad 2024-T3	through hole
1989			48	small	-	1,2	1x2	rt inbd detach elevator 25" from t/e 0.020 Clad 2024-T3	through hole
1989			60	part span damper and mid-section fan blade	1.25	1	14x10	aft of left spar nr stab separation edge 0.020 Clad 2024-T3	top surface hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1989			65	small	-	1	4.25" long closed crack	left detachable elev. 48" from t/e 0.020 Clad 2024-T3	top surface crack, no passthru, rib dented.
1989			66	small	-	1	.5"	left detachable elev. 42" from t/e 0.020 Clad 2024-T3	2" closed slice upper surface
1989			67	small	-	1	0.5	left detachable elev. 56" from t/e 0.020 Clad 2024-T3	upper surface
1989			68	small	-	1	2.5"	fwd of l elevator 66" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	2 slices in top surface
1989			69	fan blade fragments	-	1,2	large	o/b of rt inbd actuator, 90" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	damaged hyd lines 1,2
1989			70	large	-	1	large	o/b l/e of rt stab 0.020 Clad 2024-T3	through hole from disk piece
1989			71	small	-	1	0.5"	middle rt stab torque box 128 " from l/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	surface , did not penetrate top plank
1989			72	small	-	1	0.5"	middle rt stab torque box 136 " from l/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	surface , did not penetrate top plank
1989			73	undetermined	-	1	-	middle rt stab torque box 132 " from l/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	surface closed crack , did not penetrate top plank
1989			74	small	-	1	0.5"	middle rt stab torque box 129 " from l/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	surface , did not penetrate top plank
1989			75	small	-	1	1.5" and 2.5"	middle rt stab torque box 124 " from l/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	2 surface cuts, did not penetrate top plank
1989			90	small	-	1	2x2	mid span right aft box, aft of rear spar, inbd of outer actuator Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	top surface hole, broke doubler
1989			91	undetermined	0.3	1	7"	mid span right aft box, o/b of outer actuator, 66" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	hole through top surface only
1989			93	undetermined	-	1,2	10"	Rt inbd detachable elevator 38" from t/e 0.020 Clad 2024-T3	through hole
1989			94	small 1" x 2" blade piece	0.06	1	4"	rt inbd stab aft of spar, 82" from t/e Skin 0.020 Clad 7075-T6 with 1.75 7075-T651 Plate	top surface only cut, piece found in hole
1989			a	undetermined	-		-	left lower rudder	-

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1989			b	undetermined	-		-	left lower rudder	-
1989			c	undetermined	-		-	right lower rudder	-
1989			d	undetermined	-		-	right lower rudder	-
1989				undetermined	-		-	Many dents etc not documented because ground impact damage confused the source of the dent	-
1990	HPT rim	0.91		small	-	1	5" x5"	left horizontal stab l/e sta 264 .04 Al	5x5" impact, two 1/2" gouges
1990	#1 engine	1010 ft/s		small	-	1	3"	#2 engine fan cowl Al honeycomb sandwich	3x3" dent
1990				small	-	1	-	#2 engine nose cowl Al honeycomb sandwich	scratches @3:00, burnished out
1990				small	-	1	-	lef stab l/e sta 276 .04 Al	3 dents
1990				small	-	1	-	wing/body fairing cracked aft of t/e flap#2 fiberglass composite	
1990				small	-	1	-	#2 flap track fairing non metallic honeycomb sandwich	4 dents lwr inbd
1990				small	-	1	-	inner aft flap lower surface .032 Al	5 dents
1990				small	-	1	-	inbd foreflap lwr aft surface .032 Al	large dent
1990				small	-	1	-	fore flap l/e inbd of #2 track fairing .032 Al	dent
1990				small	-	1	-	inbd fore flap lwr surf 48" inbd of gear strut .032 Al	dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1991	HPT disk	0.9	1	small	-	1	-	# 1 engine fixed nozzle CRES Honeycomb,	2 punctures w/o passthru
1991	#2 engine	1030 ft/s	2	small	0.004	1	0.25	# 1 engine fixed nozzle CRES Honeycomb,	1 puncture with .25" piece stuck in it
1991			3	small	-	1	.5",.25"	#1 engine transcowl Composite bondment	2 punctures, one just surfaced on the inner wall
1991			4	small	-	1	1", .5", .5"	#1 engine core cowl 0.040 Al 2024-T81	3 punctures, one of which dented LPT tube below
1991			5	small	-	1	-	#1 engine core cowl 0.040 Al 2024-T81	4 dents
1991			6	small	0.001	1	-	#1 engine inner cowl 0.020, 0.032, 0.040, 0.071 Clad Al 2024-T81	6 impacts
1991				small	0.004	2	-	engine LPT cooling manifold .02 stainless steel 321	dent with puncture hole
1991			7	small	0.02	2	-	inside packs bay	
1991			8	small	0.02	3	-	inside packs bay, air conditioning valve	
1991			9	small	0.06	2	-	inside packs bay, smaller duct .028 Ti BMS 7-21 Grade II	3 punctures
1991			10	small	0.06	2	-	inside packs bay, burst duct.028 Ti BMS 7-21 Grade II	4 dents
1991			11	small	0.06	3	-	inside packs bay, burst duct .028 Ti BMS 7-21 Grade II	1 large hole causing duct burst
1991			12	small	0.06	1	-	packs bay skin - inner surface - flat composite panels	48 little holes
1991			13	small	0.06	2	-	packs bay skin - inner surface composite stiffeners	21 little holes
1991			14	small	-	1	-	packs bay outer surface 0.071	330 impact marks including holes
1991			15	large	-		-	Wing leading edge near NO decal Range 0.050" to 0.110" Al	1 gash, same length as N upright
1991			16	large	-		-	Flap track fairing - 2nd inboard from wingtip 0.06 Al	1 large impact
1991			17	small	-		-	Flap track fairing - 2nd inboard from wingtip 0.06 Al	3 small impacts
1991			18	small	-	1	0.25	Dry bay access panel 0.06 Al	1 hole (rivet-size)
1991			19	small	-	1	0.25	Dry bay access panel 0.06 Al	1 hole 2x rivet-size

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1991			20	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.03 deep dent
1991			21	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.03 deep dent
1991			22	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.032 deep dent
1991			23	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.035 deep dent
1991			24	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.035 deep dent
1991			25	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.035 deep dent
1991			26	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.035 deep dent
1991			27	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			28	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			29	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			30	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			31	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			32	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			33	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.04 deep dent
1991			34	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.05 deep dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1991			35	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.05 deep dent
1991			36	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.05 deep dent
1991			37	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.05 deep dent
1991			38	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.053 deep dent
1991			39	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.054 deep dent
1991			40	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.055 deep dent
1991			41	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.06 deep dent
1991			42	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.06 deep dent
1991			43	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.08 deep dent
1991			44	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	0.11 deep dent
1991			45	small	-	1	-	Wing near disk- hole, WS 283.7 to 261.2 and nearby Al 2324 T39, .25 thick	552 additional impacts, depth not measured
1991			46	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	1850 impacts, depth not measured
1991			47	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.024 deep dent
1991			48	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.03 deep dent
1991			49	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.03 deep dent
1991			50	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.03 deep dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1991			51	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.033 deep dent
1991			52	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.035 deep dent
1991			53	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.035 deep dent
1991			54	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.035 deep dent
1991			55	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.038 deep dent
1991			56	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.04 deep dent
1991			57	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.04 deep dent
1991			58	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.043 deep dent
1991			59	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.043 deep dent
1991			60	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.043 deep dent
1991			61	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			62	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			63	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			64	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			65	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			66	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			67	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.05 deep dent
1991			68	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.051 deep dent
1991			69	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.055 deep dent
1991			70	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.064 deep dent
1991			71	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	0.11 deep dent
1991			72	small	-	1	-	wing underside - impact zoneAl 2324 T39, .25 thick	50 dents
1991			73	large	-	1	1x 1.5"	wing underside - impact zone Al 2324 T39, .25 thick	wing hole made by disk piece

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1992	HPC spool	0.97	-	small	0.64	1	-	XORS 140 wing l/e .09 02024	hole
1992	#1 engine	1000 ft/s	-	small	-	1	1x1x.125	wing 6.5" aft of rear spar cenetrline, 22" o/bd of fillet panel edge Composite Skin panel	dent
1992			-	large	-	1	2.4x.6	wing 14" fwd front spar cenetrline Skin panel is .09 Al plate 7075-T651	gouge
1992			-	large	-	1	1.5x0.7	wing 24" fwd front spar centerline Skin panel is .09 Al plate 7075-T651	gouge
1992			-	large	-	1	3x1.5	wing 24" fwd of front spar centerline Skin panel is .09 Al plate 7075-T651	gouge
1992			-	large	-	1	2x1	wing 5" fwd of front spar centerline Skin panel is .09 Al plate 7075-T6514	gouge
1992			-	small	-	1	small	wing just fwd of front spar Skin panel is.09 Al plate 7075-T651	54 impact marks
1992			-	small	-	1	1x.5	wing 20" fwd of front spar centerline Skin panel is .09 Al plate 7075-T651	nick
1992			-	small	-	1	2.5x1.0	wing 26" fwd front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	2x1.0	wing 14" fwd front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	5x4	wing 10" fwd of front spar centerlineSkin panel is Al plate .09 7075-T651	puncture
1992			-	small	-	1	2x1.6	wing 8" fwd of front spar centerline Skin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	2x3	wing 8" fwd of front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	1x1	wing 23" fwd of front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	1.5x1	wing 18" fwd of front spar centerlineSkin panel is.09 Al plate 7075-T651	puncture
1992			-	small	-	1	1.5x1	wing 9" fwd of front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1992			-	small	-	1	2.3x2	wing 6" fwd of front spar centerlineSkin panel is .09 Al plate 7075-T651	puncture
1992			-	small	-	1	1.5x.5	wing 6.5" aft of rear spar cenetrline, 22" o/bd of fillet panel edge Skin panel is composite honeycomb sandwich	puncture
1992			-	small	-	1	3x4	slat, 20" outbd of #4 slat track	puncture
1992			-	small	-	1	4x`.5x.35	inboard flap track fairing 0.080 Clad 2024-T42	dent
1992			-	small	-	1	2.2x1.0	inboard flap track fairing 0.080 Clad 2024-T42	gouge
1992			-	small	-	1	.7x.1	inboard flap track fairing 0.080 Clad 2024-T42	hole
1992			-	small	-	1		wing, #4 slat track cover plate corner	fracture
1992			-	small	-	1		wing, #3 slat track cover plate corner	fracture
1992			-	large	-	1	1.45x1.2	wing lower skin	gouge
1992			-	large	-	1	1.5x.7	wing lower skin	gouge
1992			-	large	-	1	2x1.5	wing 12" inbd of #4 slat track	puncture
1992			-	large	-	1		XORS 159 skin	crack along rivet line from large disk piece impact
1992			-	large	-	1	14x6, 1.05" deep	wing lower skin	dent
1992			-	large static	3.4	1	3x1	wing 8" aft of front spar centerline XORS 185	puncture
1992			-	large	-	1	.7"x.5"	wing XORS115 between str 50 and 52	puncture - may be 2 of them
1992			-	small	-	1	2x.4	wing lower skin	scratch
1992			-	small	-	1	.74x.5	6"aft of front spar centerline, 30" o/bd of #1 pylon panel edge	scratch
1992			-	small tailpipe	-	1	3"x2"	l/h horizontal stabilizer l/e .02 2024	dent
1992B	LPT disk	No documentation							

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1993	HPC disk	93% red line	-	large	-	1	4 posts	underside left wing	gouge near fuel tank
1993	#1 engine	900 ft/s	-	small	-	1	-	underside left wing	21 light impacts
1993			-	small	-	1	1.5	left wing l/e slat	1.5" penetration
1993			-	small	-	1	-	left wing l/e slat	15 impacts
1993			-	small	-	1	-	fuselage from wing root to lower red nav light .063 Al	50 impact marks
1993			-	large static	-	1	8"	RAT fairing for a/c packs. Non-metallic honeycomb	holed by static external component
1993			-	small	-	1	-	RAT fairing for a/c packs Non-metallic honeycomb	5 impacts with piece compressor airfoil stuck in fairing
1993			-	small	-	1	-	fuselage .063 Al	first layer of skin punctured
1993			-	small	-	1	-	fuselage .063 Al	nick below windows but above wing
1993			-	small	-	1	-	fuselage above RAT fairing.063 al	
1994	IPC Disk		No documentation						
1995A	HPC disk	97% red line	-	large	-	1	3.5 x 8.75 " hole in upper surface, 3.5 x 9.5 " hole in lwr surface, 24 " o/b of l/e amd 34.5" fwd of aft edge.	right elevator 0.050 Clad 2024-T3	through hole
1995A	#2 engine	640 ft/s							
1995B	HPC disk	98% red line, 550 ft/s	No aircraft damage						
1995C	LPT disk		No documentation						

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1996	LPC disk		No aircraft damage						
1997	HPC rim	93% red line	-	small	-	1	2" x1"	fuselage stn 720 near wing root0.150 Clad Al 2024-T3	Hole
1997	#1 engine	460 ft/s	-	small	-	2	1", 0.5"	air conditioning manifold .028 Ti	2 dents
1997			-	small	-	1	1"	Fuselage skin panel below window 19	dent
1997			-	tailpipe	-	1	-	Left wing aileron 2 holes Skin-Graphite/Epoxy Honeycomb sandwich	2 holes
1998A	HPC disk		No aircraft damage						
1998B	HPT disk		No documentation						
1998C	HPT rim		No documentation						
1999	HPT seal	92% red line		large	-	1	50"x22":	left vert stab interface between fwd front spar fitting and VS 0.040 Clad 2024-T3	hole
1999	#1 engine	750 ft/s		large	-	1	12"x5" skin damage	left vert stab, aft of big hole 0.040 Clad 2024-T3 plus 0.020 Clad 2024-T3 Doubler (Aft) OR 0.010 Clad 2024-T3 Doubler (Fwd)	skin
1999				large	-	1	18"x 14" hole, VS rib fin station 81.1 cut in half	left vert stab, aft of big hole 0.040 Clad 2024-T3 plus 0.020 Clad 2024-T3 Doubler (Aft) OR 0.010 Clad 2024-T3 Doubler (Fwd)	hole
1999				small	-	3	0.25 x 1 left hand chord, fin stn 69.44 and 90.33 minor damage	left vert stab, aft of big hole 0.040 Clad 2024-T3 plus 0.020 Clad 2024-T3 Doubler (Aft) OR 0.010 Clad 2024-T3 Doubler (Fwd)	dent
1999				small	-	1	vertical fin rear spar l/h chord, nick (.04 deep, 1'x .25" diameter)	left vert stab, aft of big hole 0.040 Clad 2024-T3 plus 0.020 Clad 2024-T3 Doubler (Aft) OR 0.010 Clad 2024-T3 Doubler (Fwd)	
1999				small	-	1	tear at FS 1008, 6" from t/e, 7"x1"	left rudder Non metallic honeycomb	tear
1999				large static	-	1	paint scrape , 4 windows aft of exit 2L	fuselage 0.063 Clad 2024-T3 with 0.056 Clad 2024-T3 Doubler	dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
1999				large static	-	1	piece of T/R wedged between window and window frame	fuselage Window Frame - 7075-T73 Die Forging	dent
1999				large	-	1	puncture through both skins, 8"x4"	airplane tailcone, non-metallic honeycomb	hole
1999					-	1	dent, 2 ft from fuselage	l/h horiz stab l/e 0.040 Clad 2024-T3	dent
1999				small	-	1	puncture 3.5 ft from fuselage, 2.5"x1"	l/h horiz stab l/e 0.040 Clad 2024-T3	hole
1999				small	-	1	4 holes	wing l/e outbd pylon non metallic honeycomb	hole
1999				large	-	1	big dent	wing l/e upper surface, outbd pylon non metallic honeycomb	dent
1999				small	-	1	2 holes or impact marks	wing l/e to pylon fillet 0.090 7075-T6	dent
1999				small	-	1	hole	wing access panel underneath Al Alloy	hole
2000A	HPC spool	79% red line	1		-	1	-	wing,0.25 Al	impact marks, dents
2000A	#2 engine	760 ft/s	2	small	-	1	-	fuselage access door fwd of MLG door non-metallic Honeycomb Sandwich	~50 small impact marks
2000A			3	small	-	1	2"	fuselage access door fwd of MLG door non-metallic Honeycomb Sandwich	blade stuck in skin
2000A			4	large	-	1	1 ft	fuselage access door fwd of MLG door non-metallic Honeycomb Sandwich	dent
2000A			5	small	-	1	3/4 x1/2" dent	#1 fan cowl 0.010 Glass Fabric Non-metallic Honeycomb sandwich	dent
2000A			6	small	-	1	1/4x1/2" dent	#1 fan cowl 0.010 Glass Fabric Non-metallic Honeycomb sandwich	dent
2000A			7	small	-	1	3/4x3/4" dent	#1 fan cowl 0.010 Glass Fabric Non-metallic Honeycomb sandwich	dent
2000A			8	small	-	1	4x1 1/2" dent	#1 fan cowl 0.010 Glass Fabric Non-metallic Honeycomb sandwich	dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000A			9	small	-	1	1 1/2 x 1 1/2" dent	#1 pylon fairing 0.063 + 0.050 Doubler - Clad Al 2024-T42 AND	dent
2000A			10	small	-	1	1"x1" dent	#1 pylon fairing 0.063 + 0.050 Doubler - Clad Al 2024-T42 AND	dent
2000A				n/a	n/a	1	-	slat 8 0.050 Clad 7075-T6	secondary fire damage
2000A				n/a	n/a	1	-	slat 7 0.050 Clad 7075-T6	secondary fire damage
2000A				n/a	n/a	1	-	RH inbd aileron Skin-Graphite/Epoxy Honeycomb sandwich	secondary fire damage
2000A				n/a	n/a	1	-	RH inbd, outbd flaps Skin - 0.125 Al 2024-T3 Chem-milled to 0.019 min. Core-Al Honeycomb	secondary fire damage
2000A				n/a	n/a	1	-	wing fived l/e Skin-Fiberglass/ Epoxy -Nonmetallic honeycomb	secondary fire damage
2000B	HPT disk	92% red line	1	large	-	1	tore a hole 8"x16"	wing underside .32" plate	hole
2000B	#1 engine	1060 ft/s	2	large	-	3	tore a hole 1" wide for 2/3 the web	fwd spar web 0.28 2024-T351	hole
2000B			3	large	-	4	tore a hole 12"x28"	wing top surface .27" plate	hole
2000B			4	large	-	2	-	lower chord .36" plate	
2000B			5	small	-	1	embedded blade platform and piece of case	pax a/c fuselage panel	hole
2000B			6	small	-	1	-	fuselage by overwing exit door	4 punctures
2000B			7	small	-	1	-	fuselage by overwing exit door	300 dents
2000B			8	small	-	1	-	wing surface	660 impact marks small fragments
2000B			9	small	-	1	-	#2 transcowl	1 puncture. No pass-thru
2000B			10	small	-	1	-	#2 transcowl	6 gouges
2000B			11	small	-	1	0.8"	pylon skin Between NSTA 375 and 408, above NWL 127 0.16 Clad Al 2024-T3 - Skin+Doubler	4 punctures
2000B			12	small	-	1	-	pylon skin Between NSTA 375 and 408, above NWL 127 0.16 Clad Al 2024-T3 - Skin+Doubler	12 gouges

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000C	LPT disks	151% red line	1 ntsb hole 2	large lpt1	-	4	4"x4" hole	fuselage , 1 ft below 2nd window fwd of L4 door 0.050 OR 0.056 Clad 2024-T3	hole
2000C	#1 engine	890 ft/s	2 ntsb hole 5	large lpt1	-	4	4"x4" hole	fuselage 7 ft below 2nd window fwd of L4 door .072 2024-T3	hole
2000C			3 ntsb hole 6	large lpt4	-	3	15" x 4" hole	wing root fairing fwd of L4 door Fiberglass Honeycomb Panel	hole
2000C			4	small	-	4	2" x 2" hole	wing root fairing fwd of L4 door Fiberglass Honeycomb Panel	hole
2000C			5 ntsb hole 3	intermediate lpt1	-	4	2" x 2" hole, door lock mechanism inside broken	L4 door 0.062 Clad 2024-T3	hole
2000C			6	small	-	4	2"x1" dent	L4 door, 6" below window 0.050 Clad 7075-T6	hole, no passthru
2000C			7	small	-	4	impact mark on upper right corner of window	L4 door, window 1/4" hole outer panel	hole
2000C			8	small	-	4	1"x1" dent	L4 door lower rt corner 0.062 Clad 2024-T3	dent
2000C			9	small	-	4	1"x1" hole	fuselage skin below L4 0.18 Clad 2024 T351	gouge
2000C			10	small	-	4	1"x1" hole	fuselage skin below L4 0.16 Clad 2024 T351	hole
2000C			11	large lpt4	-	3	18" x 13" hole	wing root fairing under L4 fiberglass honeycomb	hole
2000C			12	large lpt4	-	5	4"x4" hole	wing root fairing under L4 fiberglass honeycomb (the push-out hole)?	hole
2000C			13	small	-	4	1'x1"	main cargo door 0.071 Clad 2024-T3	-
2000C			14	small	-	4	impact mark on upper right corner	cargo door fwd window	dent
2000C			15 NTSB hole 1	large LPT1	-	4	2"x1" hole	cargo door between p relief ports and window line 0.071 Clad 2024-T3	hole
2000C			16	small	-	4	1"x1" dent	4th/ 5th window in cargo door	dent
2000C			17	large lpt4	-	1	gouges as of disk posts	left wing outboard of #1 engine, next to vertical hole in pylon 0.95 7075-T351	scratch
2000C			18	small	-	1	125 small paint chips/minor impacts adjacent tp post tracks	left wing outboard of #1 engine, next to vertical hole in pylon 0.95 7075-T351	dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000C			19		-	1	numerous dents up to 18" aft of flap bay	left wing outboard of #1 engine, aft of l/e flap bay 0.95 7075-T351	dent
2000C			20	large	-	1	6" x 1.5" hole 1 ft aft of vent	left wing tip aft of tank vent 0.016 Al Honeycomb Sandwich	hole
2000C			21	large	-	1	4"x3" hole 3 ft aft of vent	left wing tip aft of tank vent 0.016 Al Honeycomb Sandwich	hole
2000C			22	large	-		6" x 2" hole	#3 flap jackscrew fairing Nonmetallic Honeycomb Sandwich	hole
2000C			23	small	-		1"x1" dents	#3 flap jackscrew fairing outboard side Nonmetallic Honeycomb Sandwich	dent
2000C			24	large	-		2" wide hole at bottom	#2 flap jackscrew fairing Nonmetallic Honeycomb Sandwich	hole
2000C			25	large	-		6"x6" hole outbd side	#2 flap jackscrew fairing Nonmetallic Honeycomb Sandwich	hole
2000C			26	large	-		18"x8" hole inbd side, in line with the 6"	#2 flap jackscrew fairing Nonmetallic Honeycomb Sandwich	hole
2000C			27	small	-		~40 smal 1'x1" holes	#2 flap jackscrew fairing Nonmetallic Honeycomb Sandwich	holes
2000C			28	large	-	1	11"x9"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	holes
2000C			29	small	-	1	5"x3"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	holes
2000C			30	small	-	1	5"x4"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	holes
2000C			31	small	-	1	3"x2"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	holes
2000C			32	small	-	1	39 small	#1 flap jackscrew fairing outboard side, impacts Nonmetallic Honeycomb Sandwich	dent
2000C			33	small	-	1	129 small	#1 flap jackscrew fairing outboard side, impacts Nonmetallic Honeycomb Sandwich	dent
2000C			34	small	-	1	2"x1"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000C			35	small	-	1	1"x1"	#1 flap jackscrew fairing outboard side, holes Nonmetallic Honeycomb Sandwich	hole
2000C			36	small	-	1	1"x1" hole	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			37	stage 4 blade dovetail embedded in one of these holes	-	1	2"x2" hole	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			38	small	-	1	2"x2" hole	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			39	small	-	1	2"x2" hole	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			40	small	-	1	3"x3" hole	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			41	small	-	1	dents numerous	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	dent
2000C			42	small	-	1	pinholes	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			43	large	-	2	outbd link side torn, connecting rod broken	l/e flap 1 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			44	large	-	1	6"x1" hole	l/e flap 2 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			45	large	-	1	12"x2" hole	l/e flap 2 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			46	small	-	1	1"x1/2' hole	l/e flap 3 outboard of #1 engine Nonmetallic Honeycomb Sandwich	hole
2000C			47	large	-	2	6"x6" hole outbd side	l/e flap bay 1 outboard of #1 engine 0.050 Clad 7075-T6	hole
2000C			48	small	-	1	airfoil shaped holes	l/e flap bay 1 outboard of #1 engine 0.050 Clad 7075-T6	hole
2000C			49	small	-	2	2"x2" hole in rib between linkage supports	l/e flap bay 2 outboard of #1 engine 0.050 Clad 7075-T6	hole

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000C			50	small	-	2	2"x2" hole inbd rib for inbd linkage support	l/e flap bay3 outboard of #1 engine 0.050 Clad 7075-T6	hole
2000C			51	large	-		18"x6" hole	inboard rear flap 0.071 Clad 2024-T3	hole
2000C			52	large	-	3	impact mark at o/b end	inboard center flap clevis Forged Al 7075-T73	hole
2000C			53	intermed	-	1	3"x3" section missing from l/e	outbd fwd flap 0.071 Clad 2024-T3	hole
2000C			54	large	-	1	10"x1" hole	outbd center flap inbd of #2 jackscrew fairung 0.071 Clad 2024-T3	hole
2000C			55	large	-	1	6"x2" hole	outbd center flap at #2 jackscrew fairung 0.071 Clad 2024-T3	hole
2000C			56	large	-	1	11"x6" hole in middle	outbd rear flap 0.055 Clad Al 7075-T6	hole
2000C			57	small	-	1	1"x1" hole nr inbd edge	#3 spoiler Lower Skin: 0.050 Al 7075-T6 chem-milled to 0.016 min Upper Skin: 0.020 Clad 78075-T6 Core: Al Honeycomb	hole
2000C			58	large	-	1	15"x1" hole nr outbd edge	#2 spoiler Lower Skin: 0.050 Al 7075-T6 chem-milled to 0.016 min Upper Skin: 0.020 Clad 78075-T6 Core: Al Honeycomb	hole
2000C			59	large	-	1	12"x6" hole at bottom	#1 pylon aft fairing inbd side (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, Grade B, Class 2, (MIL-C-7438) 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	hole
2000C			60	large	-	1	6" hole from bottom to top	#1 pylon aft fairing outbd side (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, Grade B, Class 2, (MIL-C-7438) 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	hole
2000C			61	large	-	2	-	#1 mount drag link	impact mark
2000C			62	small	-	1	3x 1"x1' dents	#2 pylon outbd side (outer skin) 0.016 Clad 2024-T81, 5056 Aluminum Alloy Honeycomb, Grade B, Class 2, (MIL-C-7438) 0.020 Doubler, 2024-T81 (inner skin) 0.016 2024-T81	dent

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2000D	HPT disk		No documentation						
2000E	LPT rim		No documentation						
2001	LPT rim		No documentation						
2002A	HPC disk	93% red line	1	large static	2.2	1		scratches in wingskin aft of front spar	
2002B	HPT rim	92% red line	1	large	-	1	4" wide track	#1 pylon 0.16 Clad Al 2024-T3 - Skin+Doubler	4" wide hole /track of disk up side-skin
2002B	#1 engine	1070 ft/s	2	large	-	1	24"	#5 l/e flap 0.050 Clad 7075-T6	l/e destroyed for 2' ft outboard of engine by big piece of disk (WS 404 to 465)
2002B			3	small	-	1	3"	outbd wing l/e non metallic honeycomb sandwich	3" triangular hole
2002B			4	small	-	1	.25"	#5 l/e flap 0.050 Clad 7075-T6	33 small impacts near big hole - not punctures
2002B			5	small	-	1	2", 4"	#2 t/e flap canoe non metallic honeycomb sandwich	2 holes, inbd side, 2" to 4" diameter
2002B			6	large	-	1	-	wing skinat WS 404 to 465, 0.25 Al	gouges removed by blending
2004	HPT rim		No documentation						
2005	HPC disk		No airplane damage						

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2006A	LPT disk	90% red line	1A	large	-	1	13x12x7"	wing l/e + rib	Hole with disk piece in it
2006A	#3 engine	540 ft/s	-	large	-	1	-	pylon inbd side .09 Ti	disk post tracks
2006A			-	large	-	1	-	pylon outbd side .05 CRES	disk post tracks, at least 19
2006A			2	large	-	2	5x5"	top of wing near big hole+ disk	tear
2006A			3	large	-	1	2.75x.5	bottom of wing	-
2006A			4	large	-	1	4.25x9.5"	wing underside l/e - beside access panel 618BB 0.125 Clad 7075-T651	tear
2006A			6	small	-	1	4.5x1"	wing underside l/e 0.125 Clad 7075 T651	hole with entire LPT2 blade sticking in it
2006A			5	small	-	1	2.5x1.5"	wing underside l/e 0.125 Clad 7075-T651	hole
2006A			7	undetermined	-	1	missing panel	wing underside access panel 611BB 0.090 Clad 7075-T6	missing panel
2006A			-	small	-	1	140 impacts	aft of missing panel and aft of front spar	paint chips
2006A			8	undetermined	-	1	3x1	wing underside	hole
2006A			9	undetermined	-	1	1.5x3	l/e slat #2 0.100 Clad 7075-T6	hole
2006A			10	large	-	1	8x5"	wing l/e 0.125 Clad 7075-T651	tear
2006A			11C	undetermined	-	1	1"x.25"	wing skin puncture	hole + fuel leak
2006A			-	large	-	1	-	wing inbd of pylon	post tracks (38+ posts)
2006A			14D	intermediate	-	1	3x3, 3x1, 1x.5",	inbd flap hinge fairing 0.040 Clad 2024-T42	3 holes scuff mark and tracks
2006A			16	large	-	1	14"x11"	slat #3 outbd of pylon 0.100 Clad 7075-T6	hole
2006A			17E	large static	-	1	2x12" l/e hole with cowl hold-open rod embedded	slat #3 between tracks 7 and 8 0.090 AL Clad 2014-T6	hole
2006A			-	large	-	1	5" disk post tracks (continuation from wing)	RH #2 flap fairing outbd side	post tracks
2006A			12	small	-	1	2"x1" hole, vertical hanger and vertical web to aux tank side panel also broken	fwd wing/body fairing panel 154CB 0.063 Al Clad 7075-T6	hole
2006A			-	small	-	2	-	lower auxiliary tank side panle vertical web	hole, no pass-thru

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2006A			12	small	-	1	1.5x.25	fwd wing/body fairing panel 154CB 0.063 Al Clad 7075-T6	scuff mark
2006A			13	small	-	1	3x3, 3x4, 2.5x1"	aft wing root fillet	3 scuffmarks
2006A			-		-	1	-	r/h/ mlg door up-lock	ripped off
2006A			15	small	-	1	2 scuffs of 1"x2"	r/h mlg panel 0.050 Al Clad 7075-T6	scuff
2006A			18		-	1	?	wing l/e	?
2006A			19	large	-	1	3x8"	wing underneath	3x8" torn skin
2006A			20	small	-	1	1.5x.25 scuff and skin tear	slat #7	scuff
2006A			21		-	1	9.5"	wing surface at slat #7	scuff
2006A			22G		-	1	14.5"	wing surface in line with #8 slat middle	scuff
2006B	HPT disk	94% red line	C1	large (bore +rim)	-	1 (ricochet)	-	fuselage	
2006B	#1 engine	1060 ft/s	-	small	-	1	-	lower fuselage at sump drain tank	100 non-penetrating impacts
2006B			-	Large B #4 rim 1/8 (6 blade slots with 4 fir-trees in place)	-	1	-	l/h pylon lower chord and web 0.063 + 0.050 Doubler - Clad Al 2024-T42 AND	damaged
2006B			-	small	-	1	-	#2 engine core cowl 0.040 Clad Al 2024-T81 0.032 Doubler	83 impacts, 1 was a hole and one a crack
2006B			C2	large	-	1	-	LH wing skin plank #1, #2 .25 Al	gouges
2006B			C3	undetermined	-	1	-	LH ECS bay door damage Non metallic honeycomb	-
2006B			C2	large	-	2	6"	fuselage center tank above ECS bay	gouge 6", leaking thru fasteners
2006B			C2	large	-	2	-	fuselage ECS AC duct	HPT1 disk pieces embedded
2006B			C2	large	-	3	-	fuselage sta 907 cut through	hole
2006B			C2	large	-	4	-	LH keel beam lower flange damaged	hole
2006B			C2	large	-	5	-	RH keel beam severed	hole
2006B			C2	large	-	6	23"	r/h wing #2 plank forward of main fuel pump .25 Al	23" gouge plus puncture
2006B			C2	large	-	7	3.5"	r/h wing #3 plank l/e seam .25 Al	3.5" gouge
2006B			C2	large	-	8	8"	#2 pylon 8" wide hole from exhaust nozzle, up through pylon aft fairing sidewall.0.063 + 0.050 Doubler - Clad Al 2024-T42	8" wide

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2006B			C2	large	-	9	-	#2 pylon diagonal brace H 2.7280" Min. Dia. 7075-T73 Extruded Tube	severed
2006B			C2	large	-	10	-	#2 pylon heatshield	severed
2006B			C2	large	-	11	-	#2 engine exhaust nozzle CRES Honeycomb, 0.045 Outer Skin, 0.200 Honeycomb Core, 0.020 Inner Perforated Skin	1/3 disk embedded in outbd side
2006B			-	small	2.4	Unknown	-	#2 engine exhaust nozzle CRES Honeycomb, 0.045 Outer Skin, 0.200 Honeycomb Core, 0.020 Inner Perforated Skin	HPT1 dovetail embedded in inbd skin,16 impacts an 5 of them penetrated
2006B			-	small	-	1	-	#2 engine fan cowl non metallic honeycomb	56 impacts
2006B			-	small	-	1	-	#2 engine inlet non metallic honeycomb	18 impacts
2006B			-	small	-	1	-	#2 engine revesrer non metallic honeycomb	35 impacts
2006B			-	small	-	1	-	#5 slat 0.050 Clad 7075-T6	dent
2006B			-	small	-	1	-	#5 slat 0.050 Clad 7075-T6	HPT1 blade embedded at I/b edge
2006B			-	small	-	1	-	#5 slat 0.050 Clad 7075-T6	puncture o/b of pylon
2006B			-		-	1	10"	#5 slat A 0.050 Clad 7075-T6	10" puncture of lower skin
2006B			-	small	-	1	-	#5 slat A 0.050 Clad 7075-T6	~2400 nicks
2006B			-		-	1	3"	#5 slat A 0.050 Clad 7075-T6	3" puncture of lower skin
2006B			-	large	-	1	-	#5 slat I/b linkage	aft attach point broke
2006B			-	small	-	1	1"	#5 slat lower skin 0.050 Clad 7075-T6	1" puncture, 30" from o/b end
2006B			-	small	-	1	1.5"	#5 slat lower skin D0.050 Clad 7075-T6	1.5" puncture
2006B			-	small	-	1	1"	#5 slat lwr skin0.050 Clad 7075-T6	1" hole, 6.5" o/b of I/b drive arm
2006B			-	small	-	1	-	#5 slat lwr skin0.050 Clad 7075-T6	6" o/b from above, gouges
2006B			-	small	-	2	-	#5 slat upper nose skin	5" inbd of dent below
2006B			-	small	-	2	-	#5 slat upper skin	puncture
2006B			-	small	-	2	-	#5 slat upper skin	dent 25" from o/b end
2006B			-	small	-		1.5x.75"	#5 slat wedge 23" from I/b edge	1.5x.75" puncture

Event ID #	Spool, stage	disk rotational speed, (fraction of redline)	fragment ID	Fragment classification	Fragment Mass (lbs)	Layer of structure impacted	Dimension of witness mark	Structure impacted	Penetration
2006B			-	small	-		2"	#5 slat wedge B	2" hole
2006B			-	small	-	1	2"	#5 slat wedge lower slin 13.5" from l/b edge	2" hole
2006B			-		-	1	-	fuselage beacon at butt-line 0; F	light broken
2006B			-	small	-	1	1" x3"	l/h wing #2 tank access panel	puncture o/b of pylon
2006B			-	large	-	1	8.5", 11.8", 15"	l/h wing fixed l/e access panel	holes o/b anti-ice duct 8.5", 11.8", 15"
2006B			-		-	1	2"	l/h wing fixed l/e access panel	2" puncture 5" away from drive arm
2006B			-		-	1	3 x 2"	l/h wing l/e access panel E	3x2" puncture
2006B			C1	large	-	1	14 x 8"	l/h wing-body fairing panrl 193PL G	14x8" puncture with HPT disk piece embedded and 8x2" puncture
2006B			-	large	-	1	3"	LH wing access panel	3" puncture surrounded by scratches
2006B			-		-	1	-	LH wing skin fixed l/e inbd of fuel panel	puncture
2006B			-	small	-	1	-	LH wing skin inbd/fwd of dry bay access panels .25 Al	gouges +150 nicks

Appendix 9
Small fragments recovered from the airplane

Small Fragment Masses Retrieved after Disk Uncontainment
1970 - 2006

This data is limited to events where a small fragment from the engine was collected from a hole in the airplane, or photographed in the hole, following disk uncontainment.
Most holes do not have fragments collected from them. Lower energy impacts (where the fragment bounced off) would not have had fragments collected.
Large fragments found embedded in structure are not included.

Event 2000A

Mass in range .07 - .09lbs

HPC6 blade,1.75” long, ½“ chord

Tangential speed at burst 759 ft/s

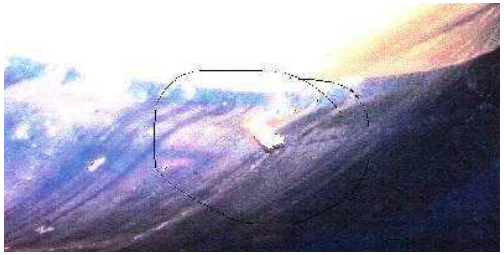
Fragment picture not available

Blade stuck in skin, tip first.

Non-metallic honeycomb sandwich, fuselage access door.

Incident angle 30-60 degrees

Structure hole picture



Event 2000B

Mass estimate 0.26 lbs,

1”x1”x1”, HPT1 blade firtree and platform, Tangential speed at burst 1058 ft/s

Fragment picture not available

Blade stuck in skin, root first.

Non-metallic honeycomb sandwich, fuselage access door.

Incident angle 60-90 degrees

Event 2000C

Mass estimate 0.24 lbs,

Dimensions 1” x 1” x 1.5”,

LPT1 blade firtree and platform

Tangential speed at burst 888 ft/s

Fragment picture

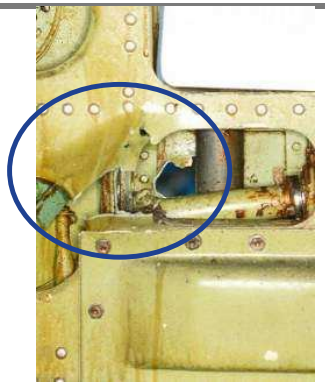
L4 door

0.062 Clad 2024-T3, severed locking mechanism inside

2” x 2” hole

Incidence angle 60-90 degrees

Structure picture



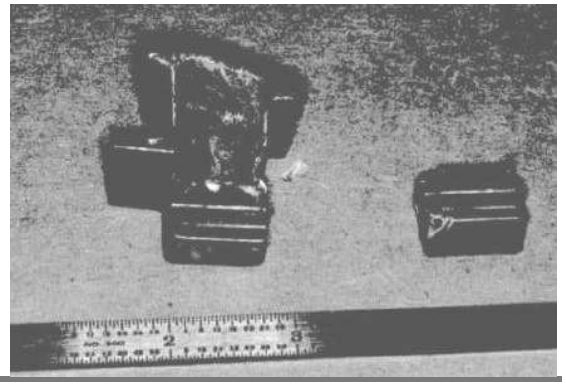
Event 2000C

Mass estimate 0.4 lbs,

1” x1” x1.5”, LPT4 blade firtree

Tangential speed at burst 888 ft/s

Fragment picture



L/e flap

Firtree embedded in non metallic honeycomb sandwich

Incidence angle 60-90 degrees

Structure picture not available

Event 2006A

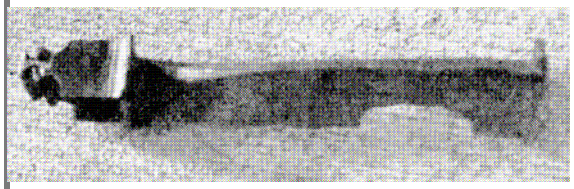
Mass estimate 0.2 to 0.3 lbs

LPT2 blade

Airfoil is 5.5”x 1.5”x.1”; platform/firtree is .75” circumferential x 1” radial

Tangential speed at burst 540 ft/s

Fragment picture



Wing leading edge lower surface

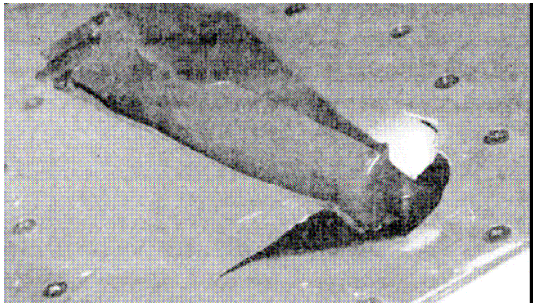
0.125 Clad 7075-T651

LPT2 blade embedded in hole, root first

Incidence angle 60-90 degrees

4.5”x1” hole

Structure picture



Event 2006B

Mass estimate 2.4 oz,

HPT1 firtree embedded

Tangential speed at burst 1063 ft/s

The firtree initially travelled with the disk and broke off during subsequent ricochets and impacts.

Likely not representative for energy calculations.

Fragment picture not available

Structure hole definition

Firtree embedded in nozzle.

#2 engine exhaust nozzle

CRES Honeycomb,

0.045 Outer Skin, 0.200 Honeycomb Core, 0.020 Inner Perforated Skin

Structure picture not available

Event 2006B

Mass estimate 0.31 lbs,

HPT1 blade , estimate dimensions 2” x 0.75” x 0.75”,

Tangential speed at burst 1063 ft/s

Fragment picture not available

Blade embedded in slat

0.050 Clad 7075-T6

Structure picture not available

Event 2006B
Fragment undefined
Tangential speed at burst 1063 ft/s

Fragment picture not available

Blade embedded in canoe fairing

Structure picture

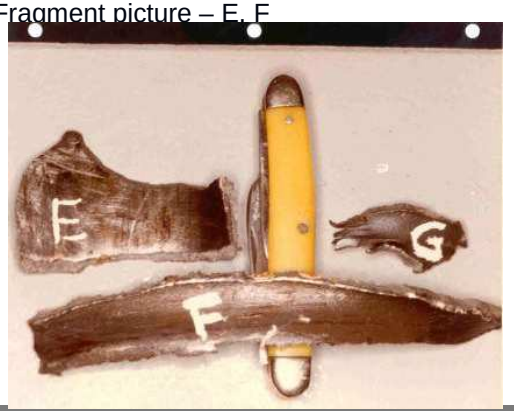
Event 1981

Disk web fragments 5 oz and 2.5 oz,

Dimensions 1.3”x 9” x0.3” and 4” x 2” x .25”

Tangential speed at burst 830 ft/s

Fragment picture – E, F



Fragments embedded in fuselage fairing (non metallic honeycomb)

Structure picture

Event 1985B

Small pieces seal, each 0.75” x 1.5”x 0.2”, 0.7 oz

Tangential speed at burst 830 ft/s

Fragment picture

Fragment embedded in inboard leading edge slat lower surface 0.125” Clad 7075-T6

Fragment embedded in inboard leading edge slat upper surface 0.125” Clad 7075-T6

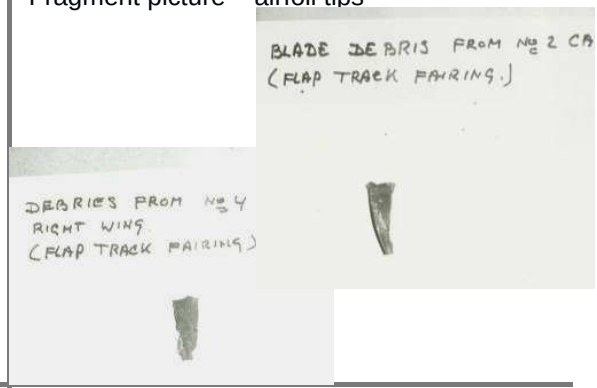
Event 1985C

1 oz nozzle guide vane platform (static part)

2 LPT blade airfoil tips 1"x ¼", est. 0.25 oz

Tangential speed at burst 580 ft/s

Fragment picture – airfoil tips



NGV platform embedded in #8 leading edge slat

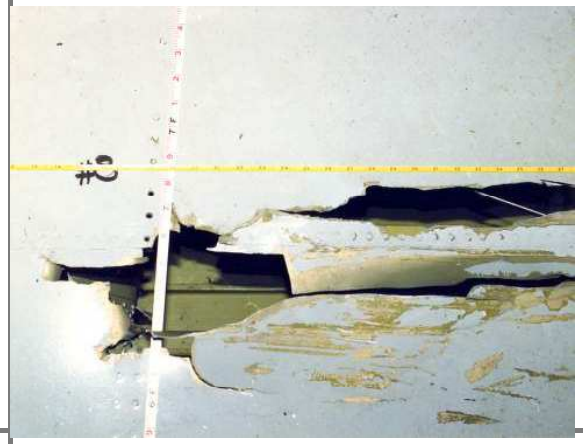
Airfoil tips embedded in canoe fairings (non-metallic honeycomb sandwich)

Event 1989

10” IGV inner shroud (static part), 32 oz incident at 45 degrees (hole 8)

Fan stub shaft nut, ½” diameter, 2 oz incident at 15 degrees (hole 5)

Tangential speed at burst 460 ft/s



Nut found in right stabilizer torque box

Holed+ passed through 1 layer 0.020” Clad 7075-T6 leaving a 4”x1.3” hole

Shroud found in outboard left stabilizer torque box 80" from trailing edge. Holed+ passed through 1 layer 0.020” Clad 7075-T6 leaving a 9”x5” hole

Event 1989

Fan blade airfoil piece with part-span shroud, 37 oz, 45 degrees incident angle Hole **18**

1.6"x 5.6" fan blade tip found in hole, 4 oz, incident at 45 degrees Hole **19**

Tangential speed at burst 460 ft/s

Fragment picture not available

Fan blade airfoil piece passed through single layer of .02 7075 leaving a 13”x6” hole

Fan blade tip passed through single layer 7075 leaving a 12”x4” hole

Structure picture not available

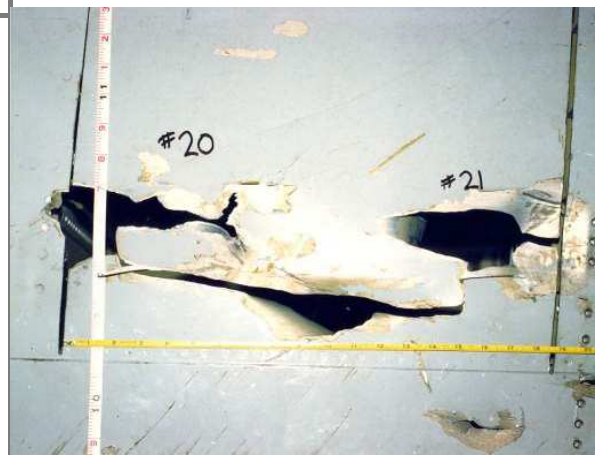
Event 1989

5"x5" fan blade tip and 1/2 part span damper, incident at 45 degrees, 12 oz and 20 oz (hole 21)

Tangential speed at burst 460 ft/s

Fragment picture not available

Fragments passed through a single layer of .02 7075 leaving a 4”x2” hole

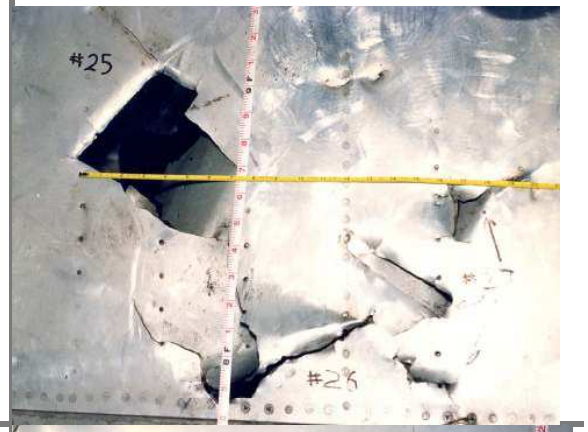


Event 1989

Fan blade platform, 8 oz, incident at 75 degrees hole 25

Booster blade, 5 oz, incident at 45 degrees hole 91

Tangential speed at burst 460 ft/s



Platform Holed 2 layers of .02 7075 leaving 5”x2” hole

Booster blade holed and passed through 1 layer .02 7075 and damaged rib below (.02 7075) leaving 4”x1” hole

Event 1989

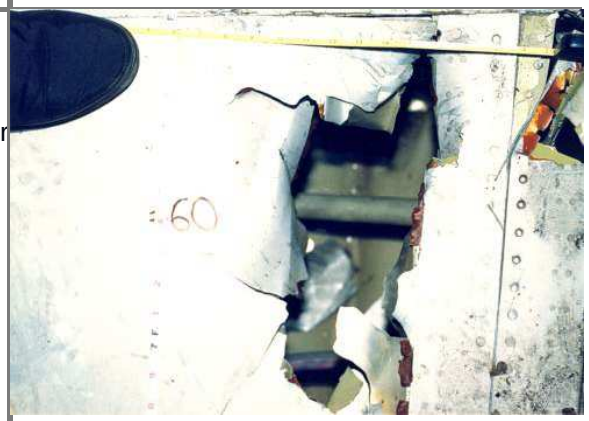
part span damper and mid-section fan blade, 20 oz incident at 75 degrees Hole 60

small 1" x 2" blade piece, 1 oz, incident at 75 degrees **hole 94**

Tangential speed at burst 460 ft/s

damper holed and passed through 1 layer of .02 2024 leaving 14”x10” hole

Airfoil piece holed and passed through 1 layer of .02 7075 leaving 4” hole

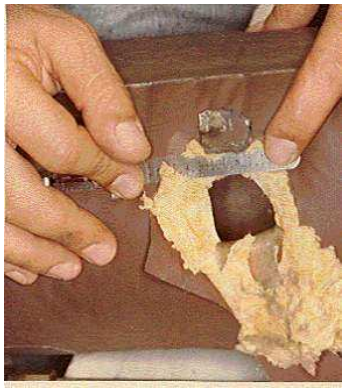


Event 1981B

HPT2 blade fragment, 1” x.75”, 1.5 oz

Tangential speed at burst 1070 ft/s, incident angle 40 degrees

Blade holed lower fuselage skin (.09 Al), 1.5” hole, then both walls of ECS duct, lodged in cabin floor honeycomb sandwich



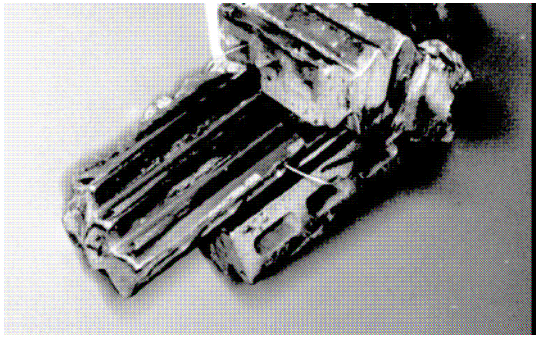
Event 1982A

3 HPT blade firtrees, .15 lb, 7/8” long

1 HPT blade firtree, .164 lb

Tangential speed at burst 1105 ft/s

Incident angle 20 degrees



fragments holed and passed through wingskin panel between ribs, 0.2 to 0.27” Al

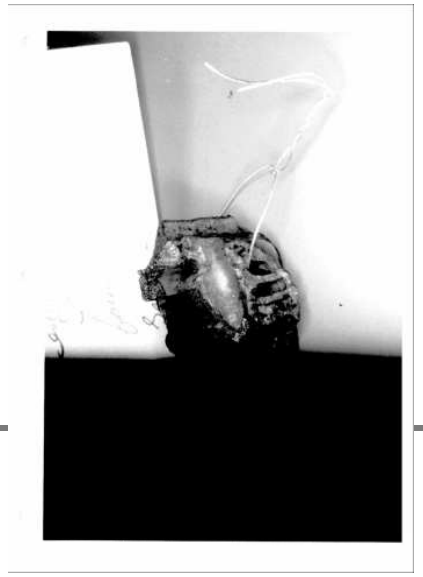
Hole sizes 3x 5 cm, 4x6 cm, 10 cm

.164 lb firtree holed and passed through .19 to .26 Al wingskin

Event 1982A

HPT blade platform 0.5” x 0.5”

Tangential speed at burst 1105 ft/s



Fuselage skin holed (.09 Al), cabin floor holed (honeycomb sandwich), piece found under seat 27J

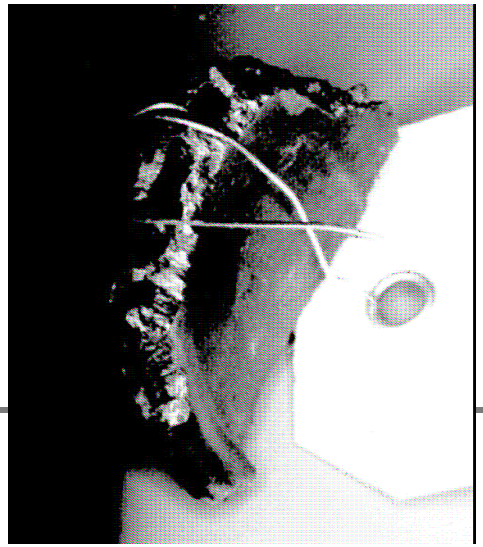
Structure picture not available

Event 1982A

Airfoil fragment, estimate .07 lb, 1.8” x .5”

Tangential speed at burst 1105 ft/s

Blade embedded in #6 flap



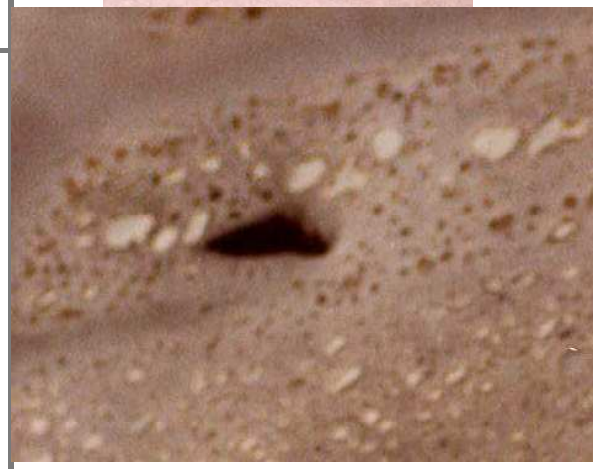
Structure picture not available

Event 1982A

HPT airfoil piece ½" x ½", .035 lb

Tangential speed at burst 1105 ft/s

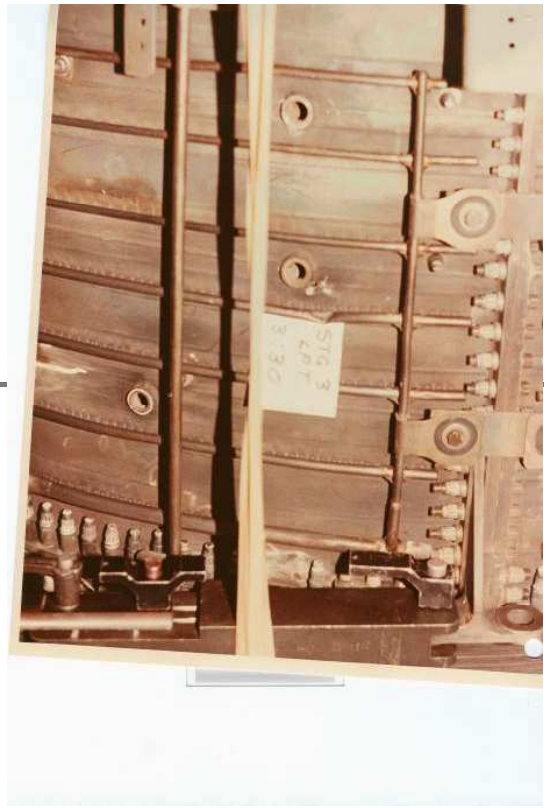
Blade embedded in cabin wall at seat 39L or 29L



Event 1982A

HPT small piece (not collected)

Tangential speed at burst 1105 ft/s



Blade passed through .04 Al core cowl

Dented .02 stainless steel tube

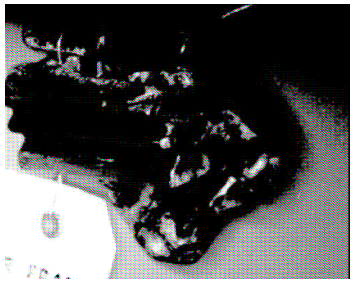
Holed (no passthru, ¼" hole) LPT case .02 INCO 718

Event 1982A

2 HPT dovetails, .25 lb each, and 10 pieces blade or shank

Tangential speed at burst 1105 ft/s

Fragment picture



Fragments found in air conditioning CA2

Structure picture not available

Event 1991

HPT2 fwd convex platform .07 oz, ¼" piece

Tangential speed at burst 1030 ft/s

Incident between 60 and 90 degrees

Fragment picture not available

fragment embedded in # 1 engine fixed nozzle CRES Honeycomb,

0.045 Outer Skin, 0.200 Honeycomb Core, 0.020 Inner Perforated Skin

Structure picture not available

Event 1991
.02 oz, piece of HPT blade or nozzle
Tangential speed at burst 1030 ft/s
Incident between 60 and 90 degrees

Fragment picture not available

fragment embedded in #1 engine inner cowl 0.020”, 0.032”, 0.040”, 0.071” sandwich structure Clad Al 2024-T81

Structure picture not available

Event 1991

.07 oz fragment HPT

Tangential speed at burst 1030 ft/s

Incident angle 60-90

Holed opposite engine .04” Al 2024 core cowl, hit LPT cooling manifold inside (.02 CRES), made dent with small puncture hole (no passthrough)

Event 1991

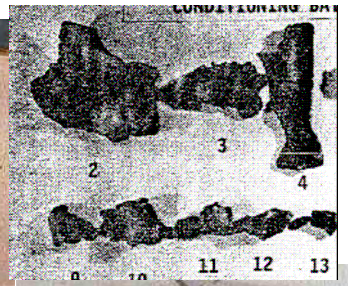
a) HPT damper land 0.24 oz

b) 3 pieces between .05 and 1.4 oz

c) 4 pieces between .05 and 1.4 oz

Tangential speed at burst 1030 ft/s

Incident angle 30-60



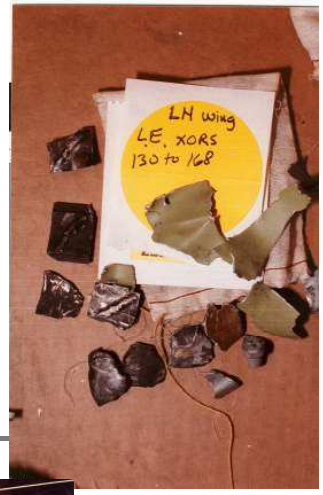
48 Pieces holed wall of packs bay (fiberglass panel) and 21 more holed wall of packs bay and underlying fiberglass ribs. They then:

(a) Holed air conditioning valve

(b) 3 Holed ECS duct, .028” Ti BMS 7-21

(c) 4 Dented ECS duct 028” Ti BMS 7-21

Event 1992
0.64 oz HPC vane platform,
Tangential speed at burst 1000 ft/s



Fragment holed/ found inside in XORS 140 wing l/e .09" Al 2024