NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

March 11, 1998

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

DCA97MA059

A. ACCIDENT

Location: Miami International Airport, Miami, Florida

Date: August 7, 1997

Time: 1238 Eastern Daylight Time[1]

Aircraft: McDonnell Douglas DC-8-61, N27US, Fine Air

B. POWERPLANTS GROUP

George Anderson Group Chairman	National Transportation Safety Board Washington, D. C.
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C. SUMMARY

At 1238 on August 7, 1997, a Fine Air DC-8-61 airplane, operating under 14 CFR 121 as a cargo flight, crashed shortly after takeoff from runway 27R at Miami International Airport, Miami, Florida. According to eyewitness reports, shortly after rotation, the airplane climbed rapidly and was in what appeared to be an unusually nose-high attitude. After reaching an

[1] All times reported herein are stated in reference to a 24-hour clock. All relative (clock) positions within the engine are reported as viewed from aft looking forward.

undetermined altitude above the departure end of the runway, the airplane's nose was observed to lower and the airplane descended rapidly. The airplane crashed 3,000 feet from the end of the runway, striking a small building located on the extended runway centerline. The airplane was destroyed and all of its occupants were fatally injured.

D. DETAILS OF THE INVESTIGATION

1.0 ENGINE INFORMATION

The airplane was powered by four Pratt & Whitney JT3D-3B engines that were equipped with fan and core thrust reversers. This model of the JT3D weighs approximately 4,340 pounds and delivers a maximum thrust of up to 18,000 pounds. It is an axial flow turbofan engine having a multistage split compressor, an 8-can combustion chamber, and a split 4-stage reaction-impulse turbine. (Figure 2).

The powerplants group was formed and began the examination of the engines at the accident site on August 8, 1997. All four of the engine assemblies were found separated from the airplane. Engine subassemblies, portions of cowling, and various rotating fan and turbine blades were found in multiple locations around the crash site. Figure 1 shows the primary engine wreckage locations in respect to the airplane point of impact. Four parallel ground depressions or grooves averaging approximately 3 feet wide by 7 feet long were found in the soil approximately 77 feet west of the facing wall of the building. The lateral separation of the grooves are consistent with the installed engine positions on the airplane. Groups of fractured and deformed turbine blades and vanes were found in the vicinity of each of the depressions. The engines separated from the pylons by fracture of either the aft engine attach point or tearing of the pylon structure to which the engine mounts were attached. All engines had significant denting at the 6 o'clock position on the turbine nozzle case that intruded into the turbine blades' plane of rotation. There was significant bending and fracture on the turbine blades of all four engines. The fan, compressor, and combustion chamber cases of all of the engines suffered much less damage than the turbines. There was no evidence of penetrations of the engine cases. The outer nacelle panels and pylons indicated varied exposure to heat that burned and blistered the paint but there was no damage consistent with an in-flight fire involving the engine. The thrust reversers were separated from all the engines and only one of the assemblies was found intact enough to establish that it was fully stowed at impact.

All four engine serial numbers were the same as recorded in the maintenance records. For further information on the engine data, including configuration, service life, and maintenance history, see the maintenance records group chairman's factual report. The type and location of damage noted on all four engines was generally the same. Heat discoloration of some outer surfaces varied between engines but was consistent with the postcrash fire patterns. The internal condition of the engines was not examined on-site and teardown inspections were not conducted.

2.0 ENGINE NUMBER 1, S/N 669677

2.1 INLET/FAN

The nose cowl (inlet) was completely separated from the engine and lying within ten feet of the forward end of the engine core. The leading edge of the cowl was crushed and abraded while the lower portion, comprising about 1/3 of the circumference centered at the 6 o'clock position, was missing. The external surfaces showed some scorching that was generally limited to small areas. The first stage fan blades were either missing or fractured at varying lengths above the blade platform. Fractured, bent, and impact-damaged blade fragments were found within approximately a fifteen foot radius of the engine inlet. The nose bullet was dented but remained intact. Looking into the engine from the inlet, some foreign object damage was noted on the leading edge of the second stage fan blades. There was no evidence of blade rub or impact marks on the upper half of the inlet case. The lower half was packed with foreign material to at least the second fan stage. Also, no penetrations, fracturing, or flange separations were noted on the following cases of the fan section: the inlet case, the front compressor front case and the fan discharge case. The inlet guide vanes (IGV) in the lower half of the engine were fractured and missing. The fractures on these IGV's were noted at both the inner and outer shroud attach points.

2.2 EXTERNALS AND ACCESSORIES

The main accessory gearbox was separated from the engine core and was not specifically identified although gearbox components were found along the debris path that began at the ground depressions near the building and extended along the airplane's direction of travel and ended at the engine core location. The fan section cowls were found in the debris path. The engine cowls, were missing and were not found in the debris path. A portion of the aft thrust reverser outer sleeve was found approximately 50 feet behind the engine. The constant speed drive and a generator frame (no serial number) were located within fifty feet of the engine.

2.3 LOW PRESSURE COMPRESSOR

The front compressor rear case was mostly obscured by wreckage but the visible external areas showed no penetrations or flange separations. No inspection of the low pressure compressor (LPC) rotating members was made.

2.4 HIGH PRESSURE COMPRESSOR

The intermediate case that houses the high pressure compressor (HPC) was deformed and dented on the lower half. There were no penetrations observed on this case but the aft flange (G flange) was torn in the 7 to 8 o'clock position. No internal inspection was made of the HPC.

2.5 DIFFUSER/COMBUSTOR

The diffuser and combustion outer cases had damage that was generally limited to the lower part of the case extending from approximately 4:30 to 7:30 o'clock. This

damage included inward denting, deformation, and scoring marks that were generally oriented in the longitudinal direction. A fracture extended the entire 360 degrees around the case approximately 4 inches aft of "K" flange. No inspection of internal parts could be made through this fracture due to the presence of what was probably a turbine outer airseal. No inspection was made of the combustor interior.

2.6 HIGH PRESSURE TURBINE

The turbine nozzle case was deformed, torn, and dented. A tear was noted in the plane of the 2nd stage rotor, extending approximately 180 degrees and centered on the 7 o'clock position. Inward denting was observed primarily on the underside of the case centered at the six o'clock position. There were also circumferentially oriented compression folds located approximately halfway between the flanges and centered at the 9 to 12 o'clock position. The high pressure turbine (HPT) blades could not be fully inspected by viewing through the intact stage 2 vanes. Some blade fracturing was observed along with heavy debris.

2.7 LOW PRESSURE TURBINE AND TURBINE EXHAUST CASE

The turbine exhaust case (TEC) was separated from the engine and was located approximately 50 feet behind the engine in the direction of the initial impact point. The LPT rotors could be viewed directly because the TEC had separated from the turbine nozzle case generally along the "L" flange. The engine attach points were all in place on the rotor. Most blades were fractured at approximately 2/3 span. All blades had substantial trailing edge (TE) damage and very little leading edge (LE) damage. Stage 3 blades were all fractured close to the blade root platforms. Stage 4 blades were either fractured adjacent to the blade root platforms or bent opposite to the direction of rotation. The bent blades were almost all bent to the point where they were tangent to the rim. Numerous blade and vane airfoils were located on the ground in the vicinity of the final location of the engine and along the path the engine followed from its initial impact point. All the vane airfoils had TE damage and essentially no LE damage. The number 6 bearing inner race, roller cage, and some of the roller bearings were in place on the LPT rear hub. The silver plating appeared intact and untarnished. The roller bearings present were free of scoring , stains, oxide colors, or deformation.

2.8 THRUST REVERSER ASSEMBLIES

Portions of the aft thrust reverser assembly, which did not include the actuating linkages, were found beside the TEC. There was extensive fracture, tearing, and deformation and it was not possible to determine if it was deployed before impact.

3.0 ENGINE NUMBER 2, S/N 645400

3.1 INLET/FAN

The nose cowl was separated from the engine. The cowl structure was fractured approximately 4 inches forward of "A" flange. The nose bullet covering the number 1

bearing sump was missing. One of the two forward side cowls was still in place on the engine and its exterior paint was not substantially heat damaged. The aft engine side cowls were missing. The inlet case had 18 IGV's present. Five IGV's were fractured on the inner and outer shrouds and were missing. All the vanes present had TE damage. This damage consisted of about 1 inch of foldover in the direction of rotation and was extended approximately six inches, radially centered at about 2/3 of the vane span. There were 6 empty C1 fan blade slots observed on the hub. All but one of the fan blade roots remaining had their airfoils fractured just above the platform. Four adjacent C2 blades that remained were bent opposite the direction of rotation. Light blade rubbing was noted on the case inside diameter in both C1 and C2 stages. Numerous fractured C1 and C2 blades remained in the extensive debris observed in the bottom of the fan cases. The number 1 bearing roller cage had its silver plating intact with no discoloration present. There was also no mechanical damage seen on the individual rollers.

3.2 EXTERNALS AND ACCESSORIES

The fuel control unit and portions of the gearbox were found still attached to the engine. The gearbox case was fractured and the interior surfaces contained trace amounts of lubricating oil. There was no unusual discoloration or smell to the oil.

3.3 LOW PRESSURE COMPRESSOR

The front compressor rear case was obscured by the remaining cowling and debris and was not inspected. No inspection of the (LPC) rotating member was made.

3.4 HIGH PRESSURE COMPRESSOR

The HPC case and rotating members were not inspected.

3.5 DIFFUSER/COMBUSTOR

A large radially inward impact dent was present on the rear of the combustion chamber rear case at the 6 o'clock position.

3.6 HIGH PRESSURE TURBINE

The turbine nozzle case was fractured 360 degrees approximately 5 inches forward of "L" flange. There were no other fractures, but a large inward dent was centered at the 6 o'clock position, near the "K" flange. The restricted view of the HPT stage showed debris and some indications of blade damage and fracture.

3.7 LOW PRESSURE TURBINE AND TURBINE EXHAUST CASE

All three LPT rotors were exposed due to the fracture and separation of the aft end of the turbine nozzle case. All LPT disks were intact. The 2nd stage LPT blades had predominantly TE damage and were all fractured. Approximately 190 degrees of the blades were

fractured at the platform while the rest were fractured at lengths that varied from ¼ to ¾ span. The 3rd LPT rotor had ¾ of the blades fractured at the platform and the rest were completely missing from the disk. The 4th disk had all but 28 blades fractured at the platform. The remaining blades were bent opposite to the direction of rotation with moderate TE damage. The number 6 bearing was exposed and the roller cage and inner race were still in place. The roller cage had most of the roller bearings in place. There was no damage or abnormal wear to either the rollers or the exposed surfaces of the bearing inner race.

3.8 THRUST REVERSER ASSEMBLIES

The aft thrust reverser assembly was not found or identified in the general wreckage at the crash site.

4.0 ENGINE NUMBER 3, S/N 632752

4.1 INLET/FAN

This engine core serial number was identified by locating the C1 fan disk's inscribed part and serial number and checking them against the engine records. The nose cowl was separated from the engine due to fracture of the structure approximately 3 inches forward of "A" flange. The nose bullet was separated and not found. The forward side cowls were generally present with heavy heat damage to the paint on the entire outside surfaces. This damage did not extend to the interior surfaces. There was denting, tearing , and major deformation in the lower area from approximately 5 to 7 o'clock. Three IGV's were missing from approximately the 6 o'clock position. Sixteen IGV's had TE damage. This consisted of metal foldover that averaged 1 inch in depth and included approximately 6 inches of the blade span. All except one of the C1 blades were in place. The remaining blade was fractured just above the platform. The C1 fan blades had LE tip curl and minor LE damage. Light rub observed on the case at the C1 position. The number 1 bearing was exposed and had an overall rust-colored appearance. There was no visible damage to the intact bearing but the condition of the races could not be determined without disassembly. The front compressor rear case had axial compression deformation evident on its lower half.

4.2 EXTERNALS AND ACCESSORIES

The gearbox and accessories were not found.

4.3 LOW PRESSURE COMPRESSOR

The front compressor rear case was mostly obscured by wreckage but the visible external areas showed no penetrations or flange separations. No inspection of the low pressure compressor (LPC) rotating members was made.

4.4 HIGH PRESSURE COMPRESSOR

The intermediate case which houses the high pressure compressor (HPC) was deformed and dented on the lower half. There were no penetrations observed on this case. No internal inspection was made of the HPC.

4.5 DIFFUSER/COMBUSTOR

The diffuser and combustion outer cases had damage that was generally limited to the lower part of the case extending from approximately 4:00 to 7:00 o'clock. This damage was limited to abrasion and scoring marks that were mostly oriented in the longitudinal direction. No inspection was made of the combustor interior.

4.6 HIGH PRESSURE TURBINE

The turbine nozzle case was deformed and dented. A 360-degree fracture was noted in the plane just aft of the 2nd stage vanes. The fractured nozzle case section remained attached to the rear pylon mount and some pylon structure that remained with the engine. The HPT blades were all fractured at approximately ½ to ¾ span. There was predominately TE damage to the remaining portions of the HPT blades.

4.7 LOW PRESSURE TURBINE AND TURBINE EXHAUST CASE

The turbine exhaust case (TEC) was fractured, badly crushed, and separated from the engine. The 2nd stage rotor had approximately half of the blades fractured at the platforms and the rest bent or fractured at mid-span or greater. Blade damage was limited to the TE areas. The 3rd and 4th stage rotors were separated from the engine and lying within approximately 30 feet. Many of the blades were missing and the remainder were bent opposite to the direction of rotation with only TE damage noted. Numerous complete LPT blades and blade roots were found near the third impact depression as identified in Figure 1. The 4th stage turbine outer airseal was in place within the separated aft section of the nozzle case and showed very little rub or impact damage.

4.8 THRUST REVERSER ASSEMBLIES

Portions of the right fan reverser cascade and door assembly was still attached to the engine in the stowed position. Extensive heat damage was noted to all members including melting of the sheet metal on the third cascade door from the top.

5.0 ENGINE NUMBER 4, S/N 644989

5.1 INLET/FAN

The engine was identified by the speed data plate that is located on the fire shield on the turbine case of the engine. The inlet cowl was separated from the engine due to fracture of the nose cowl structure approximately 3 inches forward of "A" flange. The nose cowl was severely damaged and fractured by impact and discolored by intense heat that burned the

exterior paint. Most of the material from the cowl was found within 25 feet of the front of the engine. The nose bullet was separated and not found. The forward engine side cowls were still attached to the engine while the aft side cowls were missing. The IGVs indicated TE damage similar to the other engines in that there was about 1 inch of blade foldover on at least six of the remaining vanes. Four vanes were completely missing. The C1 fan blades had some leading edge damage and were bent opposite to the direction of rotation. Rub marks on the case were light and appeared to be heavier on the lower half in the C1 plane of rotation. The number 1 bearing was visible and appeared intact with some discoloration that resembled the heat damage to the outer cowl surfaces.

5.2 EXTERNALS AND ACCESSORIES

The gearbox was missing from the engine core. Numerous pieces of gearbox case and gears were scattered along the approximate ground path of the engine beginning at the point of initial airplane impact.

5.3 LOW PRESSURE COMPRESSOR

The front compressor rear case was mostly obscured by wreckage but the visible external areas showed no penetrations or flange separations. No inspection of the low pressure compressor (LPC) rotating members was made.

5.4 HIGH PRESSURE COMPRESSOR

The intermediate case which houses the high pressure compressor (HPC) was complete with no evidence of penetration. The flanges all appeared undamaged. The rotating members and interior were not inspected

5.5 DIFFUSER/COMBUSTOR

The diffuser and combustion outer cases were generally intact. There was a circumferential tear in the diffuser case extending 360 degrees around the case and located approximately 5 inches aft of the "G" flange. There was a large radially inward oriented dent in the combustion chamber rear case at the 6 o'clock position. No inspection of the combustor interior was made.

5.6 HIGH PRESSURE TURBINE

The high pressure turbine blades could not be inspected due to the presence of the heavily deformed turbine exhaust case that was still attached. The turbine nozzle case was separated through approximately 270 degrees at "L" flange and this opening was the only visual access to the case interior.

5.7 LOW PRESSURE TURBINE AND TURBINE EXHAUST CASE

The turbine exhaust case was badly crushed and distorted. The primary direction of metal displacement was from the case 6 o'clock position to the 12 o'clock position. The "L" flange was separated except for approximately 90 degrees centered at the 12 o'clock position. The LPT rotors could not all be seen because of the crushing and debris. What could be seen of the 4th stage blades showed either fractures at the blade platform or bending opposite to the direction of rotation. Numerous vane airfoils were located on the ground in the vicinity of the final location of the engine and along the path that the engine followed from its initial impact point to its final resting location. All these vane airfoils had TE damage and negligible LE damage.

5.8 THRUST REVERSER ASSEMBLIES

No intact portions of the thrust reverser actuators were identified at the scene.

6.0 RELATED INFORMATION

No engine parameters were recorded on the flight data recorder (FDR) due to malfunctioning transducers. To obtain factual data on engine performance during the flight, the Safety Board's cockpit voice recorder (CVR) staff located the acoustic signatures of the engines as recorded on the recovered CVR tape. By plotting the frequencies of these signatures over the period of flight they were able to reproduce the engines' fan or N1 speed. The data shows that the fan speeds of all four engines accelerated normally and maintained between 96 and 101% until impact. Further details of this study are presented in the Specialist's Sound Spectrum Study, Cockpit Voice Recorder.

[redacted]

George W. Anderson
Powerplants Group Chairman

3/16/98

Attachments:

FIGURE	DESCRIPTION
1	Engine Wreckage Diagram
2	Pratt & Whitney JT3D-3B Engine Cross Section
3	Pratt & Whitney JT3D-3B Engine Flange and Case Identification
4	Damage Overview

PHOTOGRAPHS

PHOTO	DESCRIPTION
1	Aerial View of Engine Wreckage
2	Number 1 Engine Front View
3	Number 1 Engine Side View
4	Number 1 Engine Rear View
5	Number 2 Engine Front View
6	Number 2 Engine Side View
7	Number 2 Engine Rear View
8	Number 3 Engine Front View
9	Number 3 Engine Side View
10	Number 3 Engine Rear View
11	Number 4 Engine Front View
12	Number 4 Engine Side View
13	Number 4 Engine Rear View

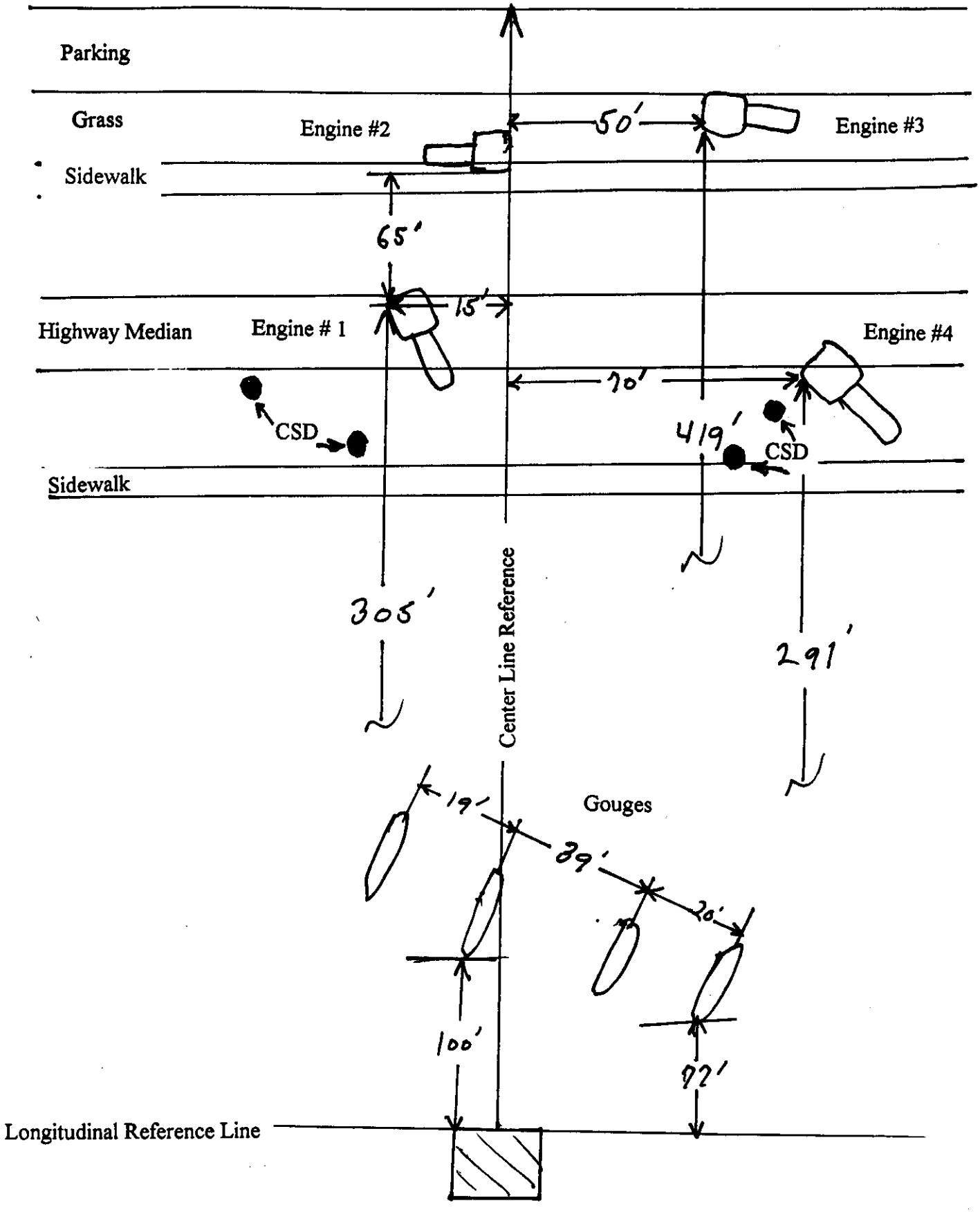

Figure 1. Engine Wreckage Diagram

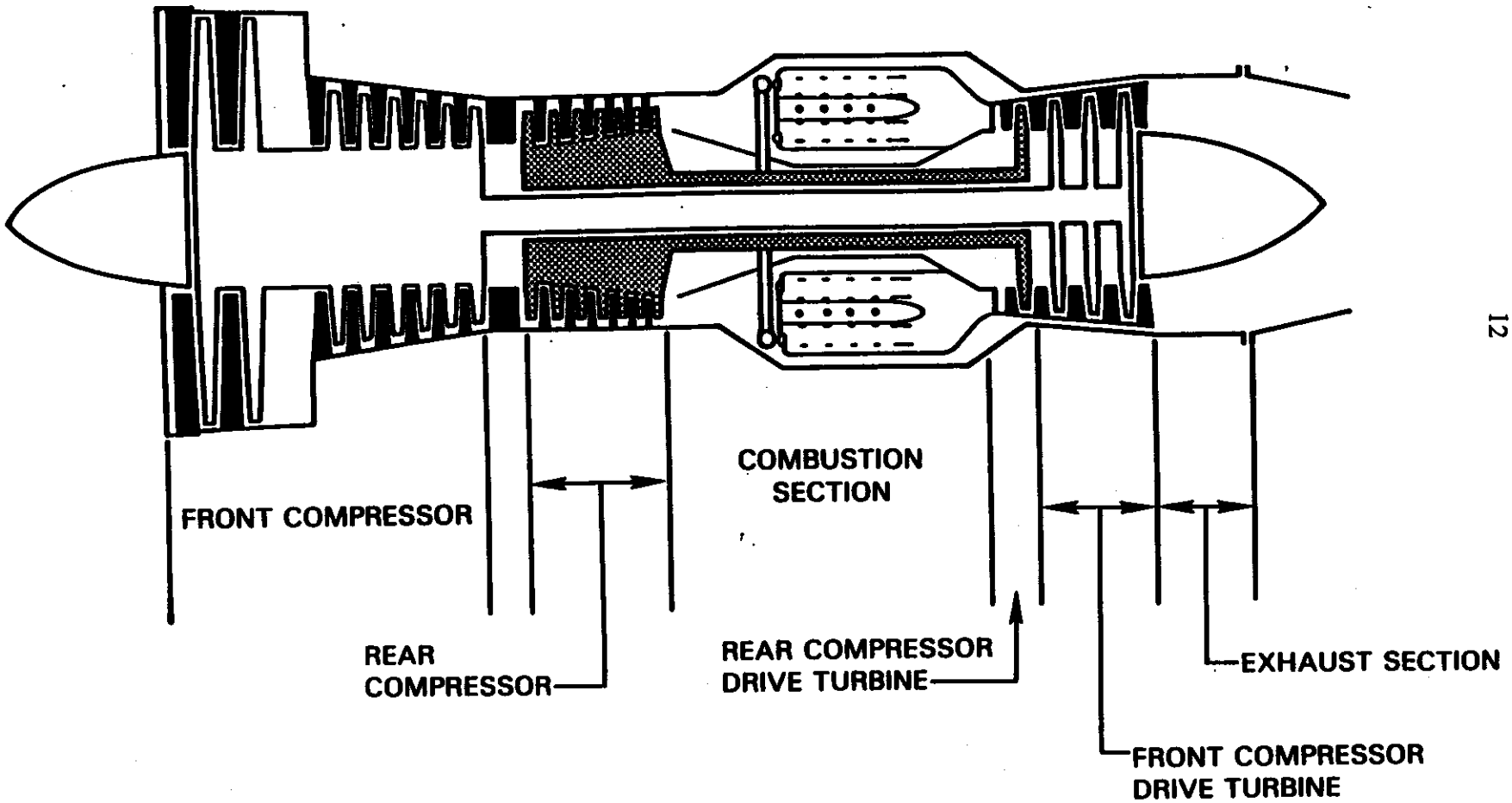

FIGURE 2. Pratt & Whitney JT3D-3B Engine Cross Section

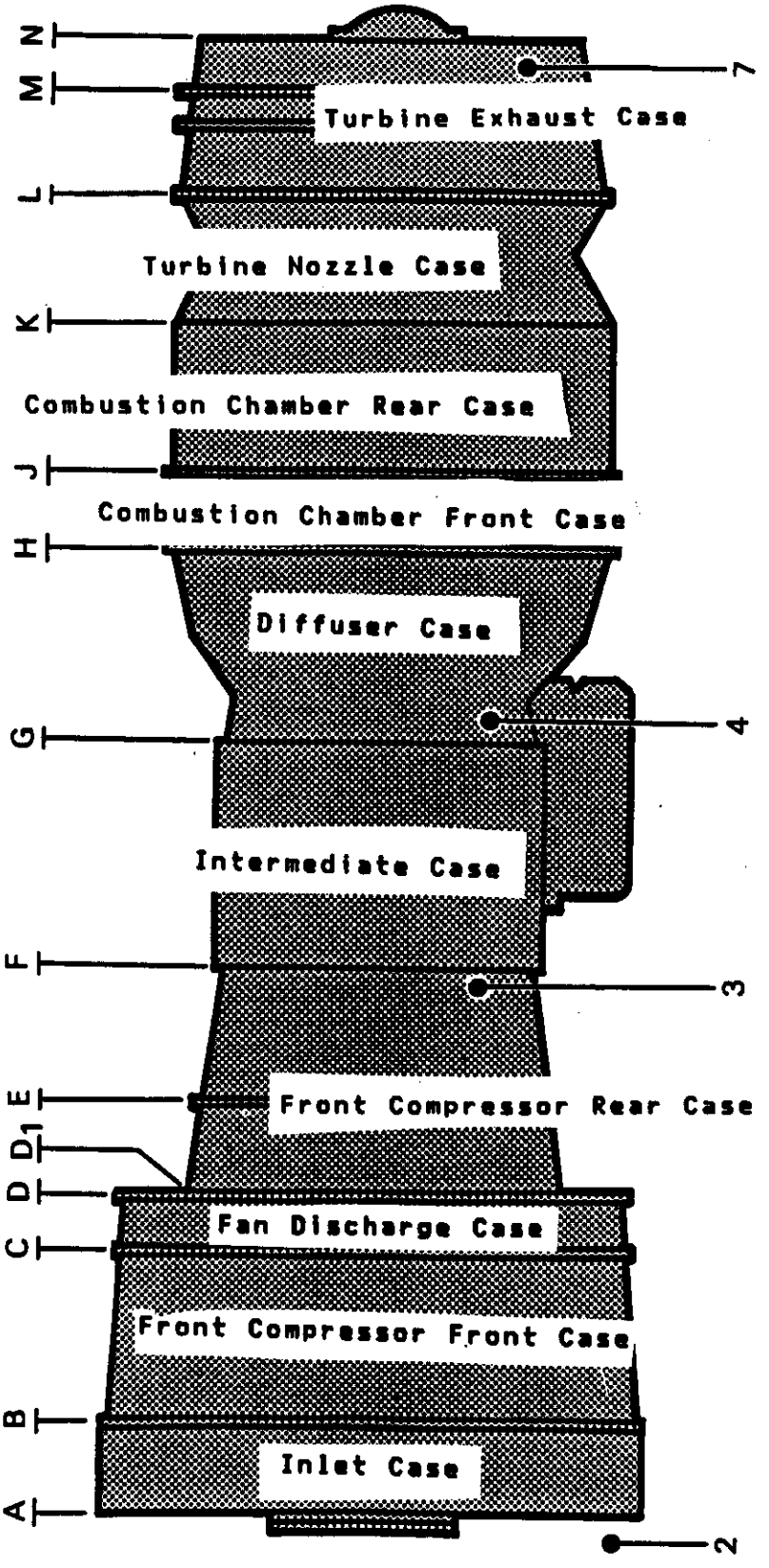

FIGURE 3 Pratt & Whitney JT3D-3B Engine Flange and Case Identification

Engine Section	Case Nomemclature	Flange ID	#1 Eng. Damage	#2 Eng. Damage	#3 Eng. Damage	#4 Eng. Damage
Front Compressor	Inlet Case	A-B	no penetration	no penetration	no penetration	no penetration
" "	Front Comp Front Case	B-C	no penetration	no penetration	no penetration	no penetration
" "	Rotating Components	n/a	moderate TE	moderate TE	moderate TE	moderate TE
Rear Compressor	Fan Discharge Case	C-D	no external	no external	no external	no external
" "	Front Comp Rear Case	D-F	no external	no external	no external	no external
" "	Intermediate Case	F-G	no external	no external	no external	no external
" "	Diffuster Case	G-H	360 deg. fracture	no external	no external	360 deg. fracture
" "	Rotating Components	n/a	not inspected	not inspected	not inspected	not inspected
Combustion Section	Comb. Chamber Front Case	H-J	not inspected	not inspected	not inspected	not inspected
" "	Comb. Chamber Rear Case	J-K	not inspected	not inspected	not inspected	not inspected
" "	Interior Condition	n/a	not inspected	not inspected	not inspected	not inspected
Rear Comp.Drive Turbine	Turbine Nozzle Case	K-L	fractured	fractured	fractured	fractured
(high pressure turbine)			& dented	& dented	& dented	& dented
" "						
" "	Rotating Components	n/a	heavy	heavy	heavy	heavy
Front Comp. Drive Turbin	Turbine Exhaust Case	L-N	fractured	fractured	fractured	fractured
(low pressure turbine)						
" "						
" "	Rotating Components	n/a	heavy	heavy	heavy	heavy
Exhaust Section	Exhaust Cases and Bullet		separated	separated	separated	compressed

FIGURE 4. Damage Overview