When the Engine Goes...

NTSB study probes general aviation engine-failure causes, points finger at pilots as well as their powerplants

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■■ Engine failure. Fearful words for any pilot. Horrible events in the air come to mind—a disintegrating crankshaft, deteriorating valves, broken throttle linkage, or shorted magnetos. Chunks of engine blowing out the exhaust ports.

But no. More often than not the root cause of an engine failure is not a malfunction of the engine, but rather a malfunction of the pilot.

These findings and a load of other facts on engine-failure accidents can be gleaned from 211 statistic-filled pages recently released by the National Transportation Safety Board (NTSB). (The study, *Accidents Involving Engine Failure/Malfunction, U.S. General Aviation, 1965–1969,* is available on request from the Publications Branch, NTSB, Washington, D.C. 20591.)

During the five-year period covered by the study, 4,310 out of 22,355 nonairline accidents were attributed by the Safety Board to engine failure, defined for the purpose of the study as "engine stoppage, power interruption, or power loss for any reason."

Cause—The Pilot. The study found that in almost 52 percent of the engine-failure cases, the pilot was "a probable cause/related factor." Basically what the report tells us is that the oldest cause in the book—pilot error—did not give up its place as the No. 1 accident-producing factor, even in a study relating to malfunctions of a piece of machinery.

It seems, interpreting from the report, that pilots have an amazingly large repertoire of methods for making engines stop at some time before their planes pull up at the hangar—unfortunately, usually in the air.

Almost one-fourth of the engine-out accidents resulted from "inadequate preflight preparation or planning," the NTSB report says. The pilot's alleged inadequacies resulted in airborne surprises such as fuel exhaustion (563 accidents), water in the fuel (182 accidents), and fuel starvation (120 accidents). "Fuel starvation" differs from "fuel exhaustion," the report notes, in that starvation occurs "when ample fuel is aboard the aircraft but for some reason the flow of fuel to the engine is interrupted."

The second most popular method which pilots used to make a perfectly good powerplant go bad was "mismanagement of fuel," blamed in more than 14 percent of the malfunctions. Pilots guilty of mismanagement, explains the NTSB study, were inattentive to the fuel supply, lacked familiarity with the aircraft, miscalculated fuel consumption, or positioned the fuel selector between fuel tanks.

Another method favored almost as much as fuel mismanagement was "improper operation of powerplant and powerplant controls." Most of these cases involved a pilot caught with his pants down while his carburetor was icing up. In some cases, although a pilot may have pulled carb heat, it was too little or too late.

Next in line among pilot-caused engine malfunctions (but not nearly as popular among pilots as the preceding three methods) was "improper in-flight decisions or planning." According to the study, 127 accidents from engine failure were due to bad decisions. These causes related to others mentioned, and usually were the precursor of fuel exhaustion.

The final cause for pilot-related engine failure found in the study was a situation in which the pilot became lost or disoriented. In most of the 101 engine failures in this category, a pilot, after becoming lost, continued to fly until his tanks were dry, subsequently encountering a cow pasture or trees.

"Increased emphasis to overcome these errors," suggests the study, "along with increased awareness of fuel starvation and fuel exhaustion, could reduce the occurrence of engine-failure accidents significantly for all aircraft."

Cause—The Powerplant. The Safety Board's report on engine failures confirms the fact that airplane engines are still machines—imperfect, subject to stress and wear, with malfunctioning sometimes a by-product.

In over 44 percent of engine-failure accidents, the NTSB cited the powerplant and its parts as either a cause or a related factor. The most common powerplant deficiencies found by the study were:

POWERPLANT INVOLVEMENT	NO. OF ACCIDENTS
Valve assemblies	130
Carburetor	102
Master and connecting rods	86
Cylinder assembly	72
Piston, piston rings	70
Magnetos	64
Crankshaft	57
Spark plug	53

In most of these cases, the part malfunction was due to material failure and fatigue fractures. Inadequate maintenance and inspection (a cause cited in almost 10 percent of the engine-failure crashes) often contributed to powerplant malfunction. This was notably the case in carburetor, plug, and magneto incidents.

Included in the NTSB study is a list of engine makes and models that had "significantly higher-than-expected involvement in individual powerplant cause/factor citations." Included were:

- Avco/Lycoming O-235: fuel system—vents, drains, tank caps
- Avco/Lycoming O-290: exhaust system—mufflers
- Avco/Lycoming O-320: engine structure—valve assemblies; lubricating system—lines, hoses, fittings
- Avco/Lycoming IO-360: engine structure—master and connecting rods
- Avco/Lycoming O-540: fuel system—vents, drains, tank caps; fuel system—tanks; exhaust system—mufflers
- Continental A-65: engine controls—throttle power lever assemblies
- Continental C-75 and C-85: engine controls—throttle power lever assemblies
- Continental E-225: fuel system—pumps
- Continental E-470: fuel system—carburetor
- Continental IO-470: engine structure—cylinder assemblies, master and connecting rods, crankshaft; fuel system—lines and fittings
- Continental IO-520: engine structure—piston, piston rings, crankshaft
- Franklin 64A and 6AG4: engine structure—valve assemblies; ignition system—magnetos
- Pratt & Whitney military R-985: engine structure—cylinder assembly, master and connecting rods, blower impeller assembly.

Despite the fact that some engines seem to have higher malfunction rates, the Safety Board points out that its analysis is "not intended to be an evaluation of the overall safety of a specific aircraft or powerplant, or as a criticism of any manufacturer." Determination of the importance of the findings and suggestions for remedial solutions "will require additional engineering, operational and design study," the NTSB report continues.

The study mentions, too, that several of the engines considered are old, and in some cases out of production. Owners and operators of older planes are told to be wary of the problems older engines showed. And maintenance people "should be certain that they comply with the most recent manufacturer's service bulletins and the FAA's airworthiness directives when repairing older engines."

Engine-Failure Accidents. An engine failure in itself is a pretty harmless affair. A little sputter, a gag, a spurt, some coughing, and then silence—none of these ever hurt anyone. But when that silence is followed by loud ripping, crashing, and shattering noises, then a pilot's concern may turn to mild terror. Or worse.

Of the 4,310 accidents due to engine failure during the five years covered in the NTSB study, 312 resulted in fatalities. A total of 639 people died in the engine-out incidents, while another 837 were seriously injured.

The most serious, though not the most common, events following engine failure in the accidents studied by NTSB were spins, spirals, and stalls. When a spin occurred, 94 percent of the resulting accidents caused a fatal or serious injury. For spirals and stalls, the respective rates were 70 and 61 percent.

Most commonly, the forced landing following an engine failure results in a collapsed landing gear, a crunching experience which occurred (with very few fatalities) in 896 of the 4,310 crashes analyzed. The second most common accident, a duel between airframe and trees, turned out to be the biggest killer. Although only 26 percent of those encounters resulted in fatal or serious injuries, the very large number of such collisions (595) brought in the highest casualty toll.

Touching on the ever-present debate over the relative safety of a single-engine plane versus a multi-engine aircraft, the study finds (as might be expected) that multis crashed less frequently than singles when experiencing engine failure—in fact, about half as frequently. For every 100,000 hours flown in a single, 4.6 accidents due to engine failure were reported. The rate for the multis was 2.3 crashes per 100,000 hours. But, obviously, that spare engine is not the panacea for all engine-out situations.

Despite the apparent margin of safety surrounding the multi-engine plane, where engine-out failures are concerned, the NTSB statistics show twins to be markedly more prone to fatal results in a crash. No reasons for the higher twin fatality rate are given, but the numbers show 22.9 percent of multi-engine accidents as fatal, compared with a 5.4-percent fatality rate for single-engine plane crashes.

Concluding from its findings, NTSB suggests that "a pilot who experiences an engine failure in his aircraft and is required to initiate a precautionary or forced landing should do everything possible to avoid a stall spin, stall spiral, stall, or uncontrolled collision with ground/water, because these accidents result in the highest percentage of deaths and serious injuries."

"Our goal," explained an NTSB staffer who worked on the report, "was not to make recommendations, but to put the information out. We wanted to raise questions and stimulate thinking. Then others can come up with recommendations."

One recommendation is obvious. When was the last time *you* went over your engine-out procedures? □

Cause/Factor Table**

Accidents Involving Engine Failure or Malfunction As A First Accident Type
Fixed-Wing Aircraft
U. S. General Aviation
1965–1969

(Causes displayed relate to first accident type only)

Involves 4,310 total accidents
Involves 312 fatal accidents

Broad Cause/Factor	Fatal Accidents			Nonfatal Accidents			All Accidents		
	Cause	Factor	Total*	Cause	Factor	Total*	Cause	Factor	Total*
Pilot	163	14	166	2060	72	2067	2223	86	2233
Personnel	38	6	44	398	32	429	436	38	473
Airframe	1		1	2		2	3		3
Landing gear				1	1	2	1	1	2
Powerplant	142	3	144	1716	70	1779	1858	73	1923
Systems		1	1	18	1	19	18	2	20
Instruments/equipment and accessories	1		1	5	5	10	6	5	11
Airports/airways/facilities				1	1	2	1	1	2
Weather	13	28	38	145	176	318	158	204	356
Terrain					1	1		1	1
Miscellaneous	10		10	114	8	122	124	8	132
Undetermined	4		4	3		3	7		7

The figures opposite each causal category represent the number of accidents in which that particular causal category was assigned.

* If an accident includes both a cause and related factor in the same causal category, the accident is represented once under the total for that category.

**Source: NTSB Special Report No. NTSB-AAS-72-10.