National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: September 8, 1998
In reply refer to: A-98-84 through -86

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On January 12, 1997, about 1026 Hawaiian standard time, a McDonnell Douglas Helicopter Systems (MDHS)[1] 369D helicopter, N7012G, powered by one Allison 250-C20B turboshaft engine, lost engine power about 150 feet above ground level (agl) shortly after takeoff from a helipad near Kamuela, Hawaii. The pilot initiated an autorotation, but the helicopter landed hard in an open field, resulting in the main rotor blades severing the tailboom. The helicopter was substantially damaged; however, the pilot was not injured. No flight plan was filed, and visual meteorological conditions prevailed at the time of the accident. The flight was operated under Title 14 Code of Federal Regulations Part 91 as a personal flight.

The MDHS 369 series (formerly Hughes 369 series) has one two-cell fuel tank. The airframe fuel system has a fuel tank boost pump to provide positive-pressure fuel delivery to the engine for starting. The engine-driven fuel pump provides high-pressure fuel to the fuel control unit (FCU), which meters fuel to the fuel nozzle. The fuel nozzle is a two-stage single-barrel fuel delivery device providing fuel to the engine for starting and fuel spray for continuous operation. The Allison 250 series engine has three fuel straining devices to prevent contaminants in the fuel from reaching the engine. The fuel pump has a two-stage filter with a bypass and pressure sensor to activate a warning light in the cockpit if the fuel flow through the filter is obstructed (impending bypass). The FCU has an inlet fuel screen with a bypass feature with no associated warning indication. The fuel nozzle has a fuel screen with neither a bypass feature nor an associated warning indicator.

During the investigation of the Kamuela, Hawaii, accident, Safety Board investigators found that the fuel nozzle screen was contaminated with foreign material, including sodium chloride (salt). Contamination was also found in the fuel pump filter and FCU screen of the engine fuel system.

[1] The MDHS commercial helicopter division was recently acquired by Boeing Aircraft Company.

The maintenance records indicated that the helicopter had been inspected in accordance with the manufacturer's recommended 100/300-hour inspection procedures about 21 flight hours before the accident. The inspection procedures did not include inspecting the fuel nozzle screen nor the FCU screen, but did include replacement of the engine fuel pump filter. The engine manufacturer's inspection guidelines recommend that the fuel nozzle screen be inspected only when the engine fuel filter bypass light illuminates and/or the engine fuel pump filter is found to be contaminated. The maintenance records did not indicate a contaminated fuel filter during the 100/300-hour inspection nor had there been any reports of an illuminated fuel filter bypass light. The fuel nozzle has an overhaul time limit of 2,500 flight hours with no requirement for regularly scheduled interim inspections. The accident nozzle had accumulated about 317 flight hours since overhaul. The engine had been operated in a salt water environment, and its maintenance records showed that it had been subject to regular wash procedures (see enclosed Brief of Accident File No. 654).

The Safety Board is aware of three similar accidents involving fuel nozzle screen contamination of Allison 250 series engines. On November 16, 1996, near Forks, Washington, a Hughes 369D helicopter, registration N5225C, lost engine power during an external load operation. The helicopter received substantial damage when it collided with trees during its autorotational descent. The investigation revealed contamination throughout the helicopter's fuel system. The fuel filters were contaminated and in the bypass mode, and the fuel nozzle screen was found partially blocked by contaminants. The fuel contaminants were traced to the operator's in-ground storage tanks (see enclosed Brief of Accident File No. 1569).

On April 14, 1996, near Yerington, Nevada, a Hughes 369D helicopter, registration N519BH, lost engine power during cruise flight at 200 to 300 feet agl. The subsequent engine-out emergency landing resulted in substantial damage to the helicopter. The helicopter had an annual inspection 6 months before the accident. The last compressor wash was 2 months before the flight, and the helicopter had been flown 8 hours since the compressor wash. Examination of the FCU inlet screen and the fuel pump fuel filter did not reveal contaminants; however, the engine flamed out during the initial postaccident engine test run and experienced consistent engine power degradation in all tests. Inspection of the engine fuel nozzle after the test runs revealed a partially blocked screen (see enclosed Brief of Accident No. 689).

On April 18, 1994, a Hughes 369D helicopter, registration N1103N, lost engine power during a sightseeing flight near Hanapepe, Hawaii. While maneuvering, the engine suddenly lost power, and, after an autorotation, the helicopter landed hard on rocky terrain. Examination of the engine fuel system revealed that the fuel nozzle screen was obstructed by contaminants, including salt. The helicopter was operated in a marine environment with substantial operations over the ocean. The maintenance procedures used by the company included daily engine compressor rinses (see enclosed Brief of Accident No. 1416).

In addition to the above-mentioned accidents, investigators found a Federal Aviation Administration (FAA) maintenance periodical, Advisory Circular No. 43.16, titled "General

Aviation Airworthiness Alerts," which described an incident that involved an Allison 250-C20 engine installed in a Hughes 369D helicopter. During flight, the engine reportedly lost power without warning; however, the pilot performed a successful autorotational landing. The investigation revealed a severely restricted fuel nozzle screen. The fuel nozzle's historical flight hours and the contaminants blocking the screen were not reported.

The Safety Board's staff also found that numerous malfunction or defect reports of partially clogged Allison 250 engine fuel nozzles have been submitted by mechanics. These fuel nozzles are not removed based on a schedule provided by the manufacturer, but based on deteriorating engine performance or the mechanic's personal experience. Because these measures have not proved adequate, corrective action is needed to address the engine power losses that have been caused by contamination of Allison 250 series fuel nozzle screens. The Safety Board believes that the FAA should direct all operators of helicopters powered by Allison 250 series engines to conduct a one-time inspection of all the engine fuel nozzle screens to ensure that they are intact, unobstructed, and functional. After the one-time inspection, the Safety Board believes that the FAA should determine appropriate inspection intervals for helicopters powered by Allison 250 series turboshaft engines and then require that periodic inspections be accomplished on those engine fuel nozzle screens to prevent the accumulation of contaminants that could alter the fuel delivery, engine performance, and ultimately clog the fuel nozzle screen and cause engine power loss.

The Safety Board notes that of those occurrences known to the Board, all of the MDHS 369 helicopters involved in fuel nozzle screen anomalies have not had an airframe-mounted fuel filter installed, which is optional on MDHS 369 series and some other makes of helicopters. Although the airframe-mounted fuel filter does not capture smaller particles than the fuel pump filter, the airframe-mounted filter does afford greater surface area filtration. Also, the fuel nozzles installed on Allison 250 series engines do not have a fail-safe design (bypass feature), even though a failure or obstruction of the nozzle results in complete loss of engine power. Therefore, the Safety Board believes that the FAA should determine if the optional airframe-mounted fuel filter on helicopters powered by Allison 250 series engines provides substantial improvement in the removal of fuel system contaminants, and, if so, require airframe-mounted fuel filters on those helicopters that do not already have them installed.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Direct all operators of helicopters powered by Allison 250 series engines to conduct a one-time inspection of all the engine fuel nozzle screens to ensure that they are intact, unobstructed, and functional. (A-98-84)
>
> Determine appropriate inspection intervals for helicopters powered by Allison 250 series turboshaft engines and then require that periodic inspections be accomplished on those engine fuel nozzle screens to prevent the accumulation of contaminants that could alter the fuel

delivery, engine performance, and ultimately clog the fuel nozzle screen and cause engine power loss. (A-98-85)

Determine if the optional airframe-mounted fuel filter on helicopters powered by Allison 250 series engines provides substantial improvement in the removal of fuel system contaminants, and, if so, require airframe-mounted fuel filters on those helicopters that do not already have them installed. (A-98-86)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

Enclosures

LAX94FA197
FILE NO. 1416 04/18/94 HANAPEPE,HI AIRCRAFT REG. NO. N1103N TIME (LOCAL) - 13:14 HST

Occurrence# 1 LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation HOVER

Findings
1. - FUEL SYSTEM,NOZZLE - FOREIGN MATERIAL/SUBSTANCE
2. - FUEL SYSTEM,STRAINER - BLOCKED(PARTIAL)
3. - MAINTENANCE,SERVICE BULLETINS - INADEQUATE - MANUFACTURER
4. - PROCEDURE INADEQUATE - MANUFACTURER
5. - INSUFFICIENT STANDARDS/REQUIREMENTS - MANUFACTURER

Occurrence# 2 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Occurrence# 3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
6. - TERRAIN CONDITION - ROUGH/UNEVEN

The National Transportation Safety Board determines that the probable cause(s) of this accident was: INADEQUATE TURBINE ENGINE COMPRESSOR CLEANING PROCEDURES BASED ON INFORMATION IN THE MANUFACTURER'S SERVICE LETTER, AND LOSS OF ENGINE POWER DUE TO BLOCKAGE OF THE FUEL NOZZLE STRAINER WITH FOREIGN MATERIAL (SODIUM). FACTORS RELATED TO THE ACCIDENT WERE: THE LACK OF A SPECIFIED SERVICE REQUIRMENT FOR INSPECTION OF THE FUEL STRAINER, AND TERRAIN CONDITIONS IN THE EMERGENCY LANDING AREA.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 04/07/1995

LAX94FA197
FILE NO. 1416 04/18/94 HANAPEPE,HI AIRCRAFT REG. NO. N1103N TIME (LOCAL) - 13:14 HST

MAKE/MODEL - HUGHES 369D
ENGINE MAKE/MODEL - ALLISON 250-C20B
AIRCRAFT DAMAGE - Destroyed
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	1	0
PASS	1	3	0

OPERATING CERTIFICATES - On-demand air taxi
- Rotorcraft-external load operator
TYPE OF FLIGHT OPERATION - SIGHTSEEING
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0015.000 SM
WIND DIR/SPEED - 040 /018 KTS
TEMPERATURE (F) - 77
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 32

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
None

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 3100
LAST 90 DAYS - 40
TOTAL MAKE/MODEL - 2200
TOTAL INSTRUMENT TIME - 110

THE PILOT REPORTED THAT WHILE MANEUVERING NEAR A WATERFALL ON A SIGHT-SEEING FLIGHT, THE HUGHES 369D SUSTAINED A LOSS OF ENGINE POWER, DESCENDED, AND LANDED HARD ON ROUGH/ROCKY TERRAIN. AN EXAM OF THE ENGINE REVEALED THE FUEL NOZZLE STRAINER WAS CONTAMINATED AND BLOCKED WITH SODIUM, AND IT WAS PARTIALLY COLLAPSED. TESTS OF THE NOZZLE REVEALED THAT FLOW RATES WERE BELOW THE MANUFACTURER'S SPECIFICATIONS. THE HELICOPTER WAS BEING OPERATED EXCLUSIVELY IN A MARINE ENVIRONMENT AND THE OPERATOR PERFORMED COMPRESSOR WASH PROCEDURES ON A DAILY BASIS. IN A SERVICE LETTER, THE ENGINE MANUFACTURER PRESCRIBED TURBINE ENGINE COMPRESSOR WASH PROCEDURES WHICH RESULTED IN IMMERSION OF THE FUEL NOZZLE IN CONTAMINATED WASH WATER. THERE WAS EVIDENCE OF SUBSEQUENT INFILTRATION OF WASH WATER INTO THE FUEL NOZZLE STRAINER. THE FUEL NOZZLE STRAINER HAD A LIFE LIMIT OF 2500 HOURS, BUT ACCORDING TO THE MANUFACTURER, IT WAS NOT SUBJECT TO ANY PRIOR ROUTINE INSPECTION REQUIREMENT.

LAX97LA088
FILE NO. 654 01/12/97 KAMUELA,HI AIRCRAFT REG. NO. N7012G TIME (LOCAL) - 10:26 HST

Occurrence# 1 LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation TAKEOFF - INITIAL CLIMB

Findings
1. - FUEL SYSTEM - CONTAMINATION
2. - FUEL SYSTEM,NOZZLE - BLOCKED(PARTIAL)
3. - PROCEDURE INADEQUATE - MANUFACTURER
4. - INSUFFICIENT STANDARDS/RQRMNTS,MANUFACTURER - MANUFACTURER
5. - FLUID,FUEL - OBSTRUCTED
6. - TURBOSHAFT ENGINE - OUTPUT LOW

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY LANDING AFTER TAKEOFF

Occurrence# 3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
7. - TERRAIN CONDITION - GROUND
8. - AUTOROTATION - IMPROPER - PILOT-IN-COMMAND
9. - ROTOR RPM - NOT MAINTAINED - PILOT-IN-COMMAND

The National Transportation Safety Board determines that the probable cause(s) of this accident was:
fuel system contamination resulting in a partial loss of power, and the failure of the pilot to maintain adequate rotor rpm to cushion the autorotative landing and prevent main rotor blade contact with the tailboom. Factors were the inadequacy of manufacturer's maintenance inspection procedures for aircraft operated in a marine environment.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 02/02/1998

LAX97LA088
FILE NO. 654 01/12/97 KAMUELA,HI AIRCRAFT REG. NO. N7012G TIME (LOCAL) - 10:26 HST

MAKE/MODEL - McDonnell Douglas 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	1
PASS	0	0	0

OPERATING CERTIFICATES - On-demand air taxi
- Rotorcraft-external load operator
TYPE OF FLIGHT OPERATION - Positioning
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Weather observation facility

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0010.000 SM
WIND DIR/SPEED - 340 /008 KTS
TEMPERATURE (F) - 77
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 37

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
Helicopter

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 9400
LAST 90 DAYS - Unk/Nr
TOTAL MAKE/MODEL - Unk/Nr
TOTAL INSTRUMENT TIME - Unk/Nr

The helicopter was being operated in a marine environment. The pilot reported he lost engine power during the initial takeoff climb and autorotated to an open field. The helicopter landed hard and the main rotor blades severed the tailboom. Examination of the engine fuel filter, the fuel control unit (FCU) screen, and the fuel nozzle screen revealed contamination in the fuel system. The helicopter had been inspected in accordance with the manufacturer's 100/300 hour inspection about 21.2 flight hours before the accident. There were no reports of the engine fuel filter bypassing or the fuel filter caution light illuminating. The manufacturer's inspection program does not require the inspection of the fuel screens at the 100 or 300 hour intervals. The airframe manufacturer's maintenance manual does indicate that a conditional inspection be performed after the fuel filter caution light has illuminated. Review of the conditional inspection procedures revealed the FCU screen is to be removed and cleaned; however, there is no requirement for the removal and cleaning of the nozzle screen, which is downstream of the FCU screen, before the part's 2,500 hour overhaul cycle.

LAX96LA168
FILE NO. 689 04/14/96 YERINGTON,NV AIRCRAFT REG. NO. N519BH TIME (LOCAL) - 11:55 PDT

Occurrence# 1 LOSS OF ENGINE POWER(PARTIAL) - NON-MECHANICAL
Phase of Operation CRUISE - NORMAL

Findings
1. - FUEL SYSTEM,NOZZLE - CONTAMINATION
2. - COMPRESSOR ASSEMBLY,BLADE - DIRTY(FOGGY)

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY DESCENT/LANDING

Findings
3. - AUTOROTATION - PERFORMED - PILOT-IN-COMMAND

Occurrence# 3 ROLL OVER
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings
4. - FLARE - MISJUDGED - PILOT-IN-COMMAND
5. - TERRAIN CONDITION - OPEN FIELD
6. - TERRAIN CONDITION - SOFT

The National Transportation Safety Board determines that the probable cause(s) of this accident was: the partial loss of engine power and the pilot's misjudged flare during an autorotation landing in soft dirt with excessive forward speed. The power loss resulted from flight operations in an environment which debris contaminated the engine's nozzle port and compressor assembly.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 12/16/1996

LAX96LA168
FILE NO. 689 04/14/96 YERINGTON,NV AIRCRAFT REG. NO. N519BH TIME (LOCAL) - 11:55 PDT

MAKE/MODEL - Hughes 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	0	1
PASS	0	0	2

OPERATING CERTIFICATES - None
TYPE OF FLIGHT OPERATION - Personal
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 91

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Pilot

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - None
VISIBILITY - 0050.000 SM
WIND DIR/SPEED - 315 /005 KTS
TEMPERATURE (F) - 70
OBSTR TO VISION - None
PRECIPITATION - None

PILOT-IN-COMMAND AGE - 68

CERTIFICATES/RATINGS
Private
Single-engine land, Multiengine land
Helicopter, Free balloon, Glider
INSTRUMENT RATINGS
None

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 6348
LAST 90 DAYS - 8
TOTAL MAKE/MODEL - 176
TOTAL INSTRUMENT TIME - Unk/Nr

The pilot experienced a total loss of engine power while cruising between 200 and 300 feet above ground level and at an airspeed of 100 knots. The pilot reported that the engine noise resembled the same whining as if it were in a shut down mode. The pilot entered an autorotation and landed in an open field approximately 0.5 miles from his airstrip. The accident site examination revealed that the helicopter had touched down with forward speed and made depressions in the soft ground over a distance of 25 to 30 feet. The helicopter rolled onto its side and a main rotor blade severed the tail boom. Tail rotor blade and drive shaft components separated from the helicopter and were found 200 feet from the main wreckage. The last annual inspection was performed 6 months prior to the accident flight and the aircraft had flown 16.9 hours. Also, the last compressor wash was performed about 2 months prior to the flight and had flown 8 hours since then. The postaccident engine examination revealed accumulated nozzle port debris and dirty compressor blades and vanes. The engine flamed out during its first test run and, during subsequent tests, it produced power 7.8 percent below specifications.

SEA97LA032
FILE NO. 1569 11/16/96 FORKS,WA AIRCRAFT REG. NO. N5225C TIME (LOCAL) - 15:00 PST

Occurrence# 1 LOSS OF ENGINE POWER(TOTAL) - NON-MECHANICAL
Phase of Operation MANEUVERING

Findings
1. - FLUID,FUEL - CONTAMINATION,OTHER THAN WATER
2. - MAINTENANCE,SERVICE OF AIRCRAFT - IMPROPER

Occurrence# 2 FORCED LANDING
Phase of Operation EMERGENCY DESCENT/LANDING

Findings
3. - AUTOROTATION - PERFORMED - PILOT-IN-COMMAND

Occurrence# 3 IN-FLIGHT COLLISION WITH OBJECT
Phase of Operation EMERGENCY LANDING

Findings
4. - TERRAIN CONDITION - NONE SUITABLE
5. - OBJECT - TREE(S)

The National Transportation Safety Board determines that the probable cause(s) of this accident was: fuel contamination, which resulted in loss of engine power. Factors relating to the accident included: improper servicing of the helicopter, and a lack of suitable terrain for an emergency landing due to the proximity of trees.

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

Adopted 08/21/1997

SEA97LA032
FILE NO. 1569 11/16/96 FORKS,WA AIRCRAFT REG. NO. N5225C TIME (LOCAL) - 15:00 PST

MAKE/MODEL - Hughes 369D
ENGINE MAKE/MODEL - Allison 250-C20B
AIRCRAFT DAMAGE - Substantial
NUMBER OF ENGINES - 1

	FATAL	SERIOUS	MINOR/NONE
CREW	0	1	0
PASS	0	0	0

OPERATING CERTIFICATES - Rotorcraft-external load operator
TYPE OF FLIGHT OPERATION - Other work use
REGULATION FLIGHT CONDUCTED UNDER - 14 CFR 133

LAST DEPARTURE POINT - Same as Accident
DESTINATION - Local

AIRPORT PROXIMITY - Off airport/airstrip

CONDITION OF LIGHT - Daylight

WEATHER INFO SOURCE- Pilot

BASIC WEATHER - Visual (VMC)
LOWEST CEILING - 2000 FT Broken
VISIBILITY - 0003.000 SM
WIND DIR/SPEED - 225 /005 KTS
TEMPERATURE (F) - 40
OBSTR TO VISION - None
PRECIPITATION - Unk/Nr

PILOT-IN-COMMAND AGE - 50

CERTIFICATES/RATINGS
Commercial
Helicopter
INSTRUMENT RATINGS
Helicopter

FLIGHT TIME (Hours)

TOTAL ALL AIRCRAFT - 18610
LAST 90 DAYS - Unk/Nr
TOTAL MAKE/MODEL - 5825
TOTAL INSTRUMENT TIME - Unk/Nr

The helicopter lost engine power during an external load/logging operation, then it sustained substantial damage when it collided with trees during an emergency landing. Investigation revealed that fuel contamination disrupted the flow of fuel from the engine fuel nozzle(s). Test samples from the fuel supplier, storage tank, and the helicopter's fuel filter were provided by the operator to an independent laboratory. Testing showed that the fuel supplier's sample was free of contamination, but contamination was found in samples from the storage tank and the helicopter fuel filter.