National Transportation Safety Board
Aviation Accident Final Report

Location:	Ely, NV	**Accident Number:**	LAX06LA092
Date & Time:	01/18/2006, 1330 PST	**Registration:**	N612CK
Aircraft:	Croman Corporation SH-3H	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	4 None
Flight Conducted Under:	Part 91: General Aviation - Positioning		

Analysis

While en route on a positioning flight, the restricted category helicopter lost power in both engines and then landed hard and rolled over during an autorotative forced landing on a road. Both pilots said that as they neared the area of the accident site the flight had to maneuver around areas of bad weather. The helicopter was at 80 knots and 200 feet above ground level (agl) following a road while maneuvering around weather when a loud bang was heard and both engines suddenly lost power. The flying pilot entered an autorotation and managed to get the helicopter onto the road. The landing was hard and the main rotor blades flexed downward and damaged the empennage, then the helicopter rolled to the right. The pilot said that just prior to the loud noise and the dual engine failure, the engine instrument indications were normal and the fuel gauges were reading around 1,500 pounds in each tank. The fuel system was configured for normal operation; the number 1 engine feeding from the forward tank and the number 2 engine feeding from the aft tank, with boost pumps on and the crossfeed valve closed. The engine and airframe deice/anti-ice systems were on and functioning, and no annunciator lights were illuminated concerning any of the systems elements. The helicopter's Federal Aviation Administration approved and issued Type Certificate Data Sheet states that flight into known icing conditions is prohibited and notes that "the helicopters approved under this type certificate are done so under the concept of limited exposure associated with escape from inadvertent ice encounters." The anti-ice/deice systems on the helicopter consist of a combination of electrically and bleed air heated elements protecting the windshield, the oil tank mounting ring, engine air intake ducts, engine inlet guide vanes, starter cover, and the front frame of each engine. In addition to the anti-ice systems, an engine inlet ice deflector shield can be installed in front of the engine inlets to prevent any accumulation of ice and snow that forms around the upper deck and mast area ahead of the engines from entering the engine inlets. According to company Director of Maintenance and the subsequent examination of the wreckage, the optional engine inlet ice/snow deflector shields were not installed. The pilot received three preflight weather briefings from two separate Automated Flight Service Stations (AFSS), with the first two from the same station and the third from a different one. In the first briefing, the pilot was told that a routing from Oregon down to southern California could expect widespread IFR conditions due to mountain obscurement, clouds, precipitation, icing, and turbulence. An hour later the pilot called the same AFSS, but spoke to a different briefer,

who told the pilot he had overheard the earlier briefing and then suggested the pilot consider a routing through northern Nevada to Utah, then south to Arizona. The specialist then stated that two stations east of the Cascade Mountain range had high scattered clouds with good visibility, and Winnemucca, Nevada, had current conditions of 8,500 broken. The pilot responded, "Oh, really." The specialist then said "it was...like clear below 12,000" all the way to Cedar City, Utah, and concluded with, "I think once you get by like Winnemucca or Elko (Nevada) things improve drastically." The pilot responded, "We may just try that." An hour and a half later the pilot called and reached a different AFSS facility and asked about the conditions on the northern Nevada routing. The specialist said that presently there were AIRMETS in effect over the route for moderate rime and mixed icing, moderate turbulence, mountain obscurement and general IFR conditions over the entire area. The specialist said that VFR flight was not recommended over that route and another two alternate routings the pilot inquired about, and he cautioned the pilot that icing conditions would be moderate rime and mixed icing in clouds and precipitation from the surface to 21,000 feet, especially in the Ely, Nevada, area. Analysis of the actual weather conditions disclosed that en route to the accident site, the helicopter probably encountered occasional snow showers with low ceilings and visibilities. The freezing level was at or near the surface and that in-flight icing was likely from the surface to 18,000 feet. The formation of airframe ice due to the freezing of melted snow was also possible. The airframe fuel and anti-icing systems were functionally tested and operated normally. The number 1 engine had inlet guide vane trailing edge and first stage compressor blade leading edge damage that was consistent with the ingestion of ice chunks. Detailed disassembly of the number 1 engine revealed no other damage, condition, or abnormality that would have precluded normal operation. The number 2 engine was not damaged and was installed in a test cell where it ran normally. The fuel system components from the number 1 engine where then installed on the number 2 and the test cell run repeated with identical results to the first test.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the loss of power in both engines due to the ingestion of ice and snow. Also causal was the pilot's preflight and in-flight decisions to fly into areas of known and forecast moderate icing conditions in contravention to the prohibitions contained in the helicopter's Federal Aviation Administration approved Type Certificate Data sheet. A factor in the accident was the failure of the company maintenance organization to install the optional ice/snow deflector shields in front of the engine inlets that are designed to prevent the ingestion of ice and snow. An additional factor was the inaccurate and inappropriate weather briefing provided by the second AFSS specialist.

Findings

Occurrence #1: IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation: CRUISE

Findings
1. WEATHER CONDITION - LOW CEILING
2. (C) WEATHER CONDITION - SNOW
3. (C) WEATHER CONDITION - ICING CONDITIONS
4. (C) PREFLIGHT PLANNING/PREPARATION - INADEQUATE - PILOT IN COMMAND
5. (C) IN-FLIGHT PLANNING/DECISION - INADEQUATE - PILOT IN COMMAND
6. (C) FLIGHT INTO KNOWN ADVERSE WEATHER - CONTINUED - PILOT IN COMMAND
7. (F) PREFLIGHT BRIEFING SERVICE - INCORRECT - ATC PERSONNEL(FSS)

Occurrence #2: LOSS OF ENGINE POWER(TOTAL) - NONMECHANICAL
Phase of Operation: CRUISE

Findings
8. 2 ENGINES
9. (C) COMPRESSOR ASSEMBLY - ICE INGESTION
10. (F) INDUCTION AIR CONTROL,AIR FILTER/SCREEN - NOT INSTALLED
11. (F) MAINTENANCE,INSTALLATION - NOT PERFORMED - COMPANY MAINTENANCE PERSONNEL

Occurrence #3: FORCED LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #4: ROLL OVER
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Factual Information

1.1 HISTORY OF FLIGHT

On January 18, 2006, at 1330 Pacific standard time, a Croman Corporation SH-3H helicopter (modified version of a military Sikorsky SH-3H), N612CK, lost power in both engines and rolled over during a hard forced autorotative touchdown on a road 28 miles northwest of Ely, Nevada. Croman Corporation was operating the helicopter under the provisions of 14 CFR Part 91 of the Federal Aviation Regulations on a positioning flight. The helicopter sustained substantial damage. The two commercial pilots and two additional crew members were not injured. Visual meteorological conditions prevailed and a company flight plan was filed. The flight departed Winnemucca, Nevada, at 1130, en route to Page, Arizona.

According to Federal Aviation Administration (FAA) records, an individual who identified himself as the pilot of N612CK called on the telephone and obtained three preflight weather briefings on January 18 at the times of 0628, 0730, and 0850. The first two calls were handled by the McMinnville, Oregon, Automated Flight Service Station (AFSS), and the last one by the Boise, Idaho, Automated Flight Service Station. Complete transcripts of these briefings were reviewed by National Transportation Safety Board investigators, and are contained in the Public Docket for this accident.

In the 0628 call, the pilot requested a visual flight rules (VFR) weather briefing from the Medford, Oregon, area to Bakersfield, California, with an ultimate destination of Abilene, Texas. During this call, the pilot also requested weather information for the Truckee and Reno, Nevada, areas. According to the transcript, the AFSS specialist described the general conditions as being influenced by a low pressure system off the Oregon coast and a trough in western Oregon and Northern California with associated atmospheric instability. The specialist stated that instrument flight rules (IFR) conditions, due to reduced visibilities, clouds, rain, and fog, existed from southern Oregon down through the central portions of California to just above Bakersfield. Mountain obscurement was also forecast along with AIRMET's for moderate turbulence and moderate rime or mixed icing below 18,000 feet. Cloud tops were generally described as at 25,000 feet. Isolated thunderstorms scattered throughout the area were also predicted. The specialist concluded with a statement that the route down through California to the Bakersfield area "does not look like a good way even for a helicopter to go today, at least until after noon." The pilot then inquired about the Truckee/Reno area and the general conditions east of the Sierra Nevada Mountains. The specialist provided the information, which included multiple cloud layers, reduced visibilities below 3 miles, and snow showers.

At 0730, the pilot telephoned again and requested another briefing for the same initial routing through Oregon and California to Bakersfield, with an ultimate destination of Albuquerque, New Mexico. The specialist said that he had a suggestion for the pilot to consider; if the pilot did not have to go through California for some reason that they should consider going through northern Nevada. The pilot replied that he thought northern Nevada's weather was "stinko" and that getting across the Sierra Nevada Mountains would be a big problem. The specialist then stated that two stations east of the Cascade Mountain range, Klamath Falls and Lakeview, Oregon, had high scattered clouds with good visibility, and Winnemucca had current conditions of 8,500 broken. The pilot responded, "Oh, really." The specialist then said that he had overheard the other specialist in the facility talking to the pilot earlier that morning and

that he had looked at conditions east of Winnemucca and "it was...like clear below 12,000" all the way to Cedar City, Utah. The pilot then asked about the conditions south of Cedar City toward the Farmington/Albuquerque areas and the specialist told him the conditions were clear below 12,000 feet and concluded with, "I think once you get by like Winnemucca or Elko (Nevada) things improve drastically." The pilot responded, "We may just try that."

In the 0850 telephone call (which was routed to another AFSS facility), the pilot asked for weather information for a flight eastbound from Klamath Falls, Oregon, to Cedar City, Utah, with stops in Winnemucca and Ely. The specialist told the pilot that presently there were AIRMETS in effect over the route for moderate icing, moderate turbulence, mountain obscurement and general IFR conditions over the entire area. The specialist said that VFR flight was not recommended over that route. The pilot then inquired about various alternative routings, including through southern Idaho. The specialist provided reports for the stations requested; the reports delineated varying conditions from visibilities less than a mile in snow to areas of multiple cloud layers with visibilities between 3 and 5 miles. The specialist said that icing conditions would be moderate rime and mixed icing in clouds and precipitation from the surface to 21,000 feet, especially in the Ely area. The pilot then concluded the telephone call.

According to a verbal and written statements from the crew, the flight was to position the helicopter to Texas for a firefighting contract. The flight departed Winnemucca about 1130 with the intention of going all the way to Page, but with the understanding that they might have to stop somewhere en route due to weather conditions. Aboard was the second pilot, who was the flying pilot and acting as pilot-in-command for this leg, and two other company employees, a mechanic, and a third pilot.

While en route the flight had to maneuver around areas of bad weather. Near the location of the accident there was a low ceiling and the helicopter was at 80 knots and 200 feet above ground level (agl) following a road while maneuvering around weather when a loud bang was heard and both engines suddenly lost power. The flying pilot entered an autorotation and managed to get the helicopter onto the road. The landing was hard and the main rotor blades flexed downward and damaged the empennage. A portion of the vertical stabilizer and the tail rotor gearbox were knocked off and the tail wheel separated. The helicopter then rolled to the right.

The pilot said that just prior to the loud noise and the dual engine failure, the engine instrument indications were normal. He believes that the fuel gauges were reading around 1,500 pounds in each tank. The fuel system was configured for normal operation; the number 1 engine feeding from the forward tank and the number 2 engine feeding from the aft tank, with boost pumps on and the crossfeed valve closed. The engine and airframe deice/anti-ice systems were on and functioning, and no annunciator lights were illuminated concerning any of the systems elements

1.2 PILOT INFORMATION

According to information supplied by Croman Corporation, both pilots were qualified to act as pilot-in-command in the SH-3/S61 helicopters operated by the company. The information contained in this section of the report was obtained from the company, the pilots, and from the FAA Airman and Medical Records databases. The left seat is the normal command pilot station in the Sikorsky S-61/SH-3 helicopter.

1.2.1 First Pilot

The pilot occupying the left seat held a commercial pilot certificate with a rotorcraft-helicopter rating that was last issued on June 21, 1993. The commercial certificate also contained type ratings for the MBB BV-107 and Sikorsky S-61 helicopters, both limited to VFR conditions only. The certificate was also endorsed for private privileges for single engine land airplanes. A second-class medical certificate was issued on July 21, 2005, without limitations. The pilot's total flight time was 20,000 hours, of which 19,800 were accumulated in helicopters. The pilot had accrued 8,000 hours in the Sikorsky S-61/SH-3. In the preceding 90 and 30 days prior to the accident the pilot had flown 60 and 10 hours, respectively. His most recent competency flight check in the S-61 was completed on June 30, 2005.

1.2.2 Second Pilot

The pilot occupying the right seat held a commercial pilot certificate with ratings for rotorcraft-helicopters, single and multiengine land airplanes, and instrument ratings for airplanes and helicopters, the most recent issuance of which was dated April 1, 2004. His certificate contained type ratings for the Sikorsky S-58, S-61, and S-64 helicopters, all limited to VFR conditions. He also held a Certified Flight Instructor certificate for helicopters. His most recent second-class medical certificate was issued on March 3, 2005, with the limitation that correcting lenses be worn. The pilot's total flight time was 20,000 hours, of which 19,500 were accumulated in helicopters. The pilot had accrued 15,000 hours in the Sikorsky S-61/SH-3. In the preceding 90 and 30 days prior to the accident the pilot had flown 35 and 10 hours, respectively. His most recent competency flight check in the S-61 was completed on June 28, 2005.

1.3 AIRCRAFT INFORMATION

1.3.1 General

The SH-3H and predecessor versions of this helicopter were originally manufactured by Sikorsky for the US Navy. A civilian version with a lengthened fuselage and other differences was manufactured by Sikorsky under the model designation S-61. The SH-3H is a 21,000-pound gross weight helicopter powered by two General Electric T58-GE-402 turbine engines. On June 2, 2004, the FAA issued Croman Corporation a Type Certificate Data Sheet (R00004SE) that authorizes Croman to convert surplus military SH-3H helicopters to a specific airworthiness configuration standard and obtain an FAA issued restricted category airworthiness certificate expressly for external load operations under 14 CFR 21.25 (b)(7). Flight operations limitations and maintenance requirements are those specified in the pertinent US Navy NAVAIR publications for the SH-3H.

1.3.2 Maintenance History

The helicopter airframe was serial number 149713, and had accumulated a total time in service of 14,305 hours. Review of the maintenance records disclosed that the last continuous airworthiness inspection event was completed on January 16, 2006, about 43 hours prior to the accident.

Engine serial number 281-323 was installed on the number one position and had accumulated a total time in service of 8,339 hours, with 606 hours accrued since the last major overhaul.

Engine serial number 281-447 was installed on the number two position and had accumulated a total time in service of 5,869 hours, with 504 hours accrued since the last major overhaul.

According to the statements of both pilots and the company maintenance information, there

were no unresolved maintenance discrepancies at the time of departure from Winnemucca.

1.3.3 Fueling

According to records from Winnemucca Air Service, 346 gallons of Jet A fuel was loaded into the helicopter's fuel tanks just prior to the flight's departure, which was recorded by the facility at 1155. The technician who performed the fueling stated that the 346 gallons added topped the fuel tanks. The pilot's stated that a total of 700 gallons was onboard at takeoff. According to the FAA Type Certificate Data Sheet for the helicopter, the maximum fuel system capacity is 848 gallons.

1.3.4 Anti-Ice/Deice Systems

The anti-ice/deice systems on the helicopter consist of a combination of electrically and bleed air heated elements protecting the windshield, the oil tank mounting ring, engine air intake ducts, engine inlet guide vanes, starter cover, and the front frame of each engine. The systems are pilot controlled and automatically regulated to prevent ice from forming. The system includes cockpit control switches for the systems and advisory and caution lights to alert pilots to the operational status of each component. A complete systems description is included in the public docket material for this accident report.

In addition to the above described anti-ice systems, an engine inlet ice deflector shield can be installed in front of the engine inlets to prevent any accumulation of ice and snow that forms around the upper deck and mast area ahead of the engines from entering the engine inlets. According to Croman Corporation Director of Maintenance and the subsequent examination of the wreckage, the engine inlet ice deflector shields were not installed.

The FAA approved and issued Type Certificate Data Sheet states that flight into known icing conditions is prohibited and notes that "the helicopters approved under this type certificate are done so under the concept of limited exposure associated with escape from inadvertent ice encounters."

1.3.5 Prior Accident History, SH-3/S-61

1.3.5.1 Fuel System Misconfiguration

According to information supplied by technical representatives from GE Aviation, Sikorsky, and the US Navy, a specific fuel system configuration can be detrimental to continued operation of the other engine following a failure or shutdown of one engine. This configuration would be for ALL aircraft fuel boost pumps to be OFF and the crossfeed valve to be OPEN.

On the SH-3H, the forward tank system supplies fuel to the No 1 engine and the aft tank system supplies fuel to the No 2 engine. Each tank has two boost pumps. With the crossfeed valve open, fuel from both the forward and aft tanks can be directed to one engine during single engine operation, or fuel from one tank can be directed to supply both engines. The crossfeed system does not transfer fuel between tanks.

During normal twin-engine cruise operation, the crossfeed valve would be CLOSED and fuel boost pumps will be ON as required. The Navy NATOPS Flight Manual states that, during normal operations, at least one boost pump shall be on in the forward and aft tanks. It also

states that use of all fuel boost pumps is mandatory when flying at pressure altitudes of 4,000 feet and above (also at >43°C OAT and <600 lbs of fuel in either tank). The flight manual goes on to state that fuel crossfeed may be utilized during normal operations to assist in fuel management, but with the crossfeed valve OPEN, both boost pumps must be ON in the crossfeeding tank and one boost pump must be ON in the non-crossfeeding tank. This is also true for single engine operation, when boost pumps must be ON.

During twin-engine operation with ALL boost pumps OFF and crossfeed OPEN, if one engine should shutdown, the operating engine would immediately try to suck fuel not only from the fuel tanks, but also from the "shutting down" engine - its fuel lines, fuel control, fuel pump, fuel filter, etc. Because the engines are roof mounted and above the fuel tanks, the other engine offers a greater pressure head than the tanks (with boost pumps off) and therefore, the "path of least resistance" for fuel being demanded by the running engine. Once all the fuel in these lines and engine fuel system has been consumed, the running engine may now start to suck air past the various seals in the shutdown engine fuel system components, causing it to also shutdown.

Both pilots provided oral and written statements at various times during the investigation, including submitting to oral interviews within hours of the accident. In all their statements, both pilots have consistently reported the fuel system configuration as normal for cruise with boost pumps on in each tank and the crossfeed valve closed.

1.3.5.2 Ice/Snow Ingestion Events

According to information provided by Sikorsky and GE, there are prior instances where an uncommanded engine shutdown has been attributed to snow and/or ice build-ups on the fuselage upper deck ahead of the engine inlets entering the engines. GE was asked for information on the amount of snow and/or ice ingestion the T58 engine can tolerate and continue to run; however, the company had no reliable data on the amount.

1.3.5.3 Input Freewheel Unit Slippage

The Canadian Transportation Safety Board (TSB) reported that there have been several accidents involving Sikorsky S61's where a one engine power loss and the slippage of the running engine's input freewheel unit have triggered an inadvertent shutdown of the operating engine. After the failure of one engine, the operating engine attempts to increase power to assume the operating load. If the input freewheel unit begins to slip, the operating engine goes into an overspeed condition and its fuel control unit shuts off the fuel flow to prevent further overspeed. Once the engine decelerates out of the over speed range, the fuel control unit then restores fuel flow; however, reignition may not always occur (the helicopter and engine is not equipped with an auto-ignition system) and the operating engine then loses power.

1.3.6 Height Velocity Operating Limitations

US Navy publication NAVAIR 01-230HLH-1 is the equivalent of civilian Rotorcraft Flight Manual and prescribes operating limitations. According to the operator's estimate of the fuel burn and the weight of the occupants, cargo, and baggage, the helicopter weighed about 16,000

pounds at the time of the accident. Review of the Height Velocity Diagram for a two engine failure condition at 17,000 pounds was accomplished. The plotted point on the chart for the data points of 200 feet agl and 80 knots is outside of the areas labeled "avoid," but inside the area labeled "cautionary operating area." On the vertical line for 80 knots, altitudes 240 feet and above are in the clear area.

1.4 METEOROLOGICAL INFORMATION

1.4.1 General

The closest official weather reporting station is the Ely airport, which is about 28 miles southeast of the accident site. At 1353, the station was reporting a 7-statute mile visibility in light snow showers with few clouds at 2,800 feet, a broken ceiling at 3,600 feet and overcast clouds at 4,400 feet; the temperature/dew point was zero and minus 3 degrees Celsius, respectively. A series of special observations were taken at 1414, 1424, 1428, 1441, and 1453 that showed deteriorating ceilings and visibilities down to 1/4-mile and 300 feet broken in heavy snow showers, with the temperature/dew point decreasing to minus 2 and minus 3 degrees Celsius, respectively.

A Safety Board staff meteorologist prepared a factual report of the actual and forecast weather conditions along the route of flight. The complete factual report is contained in the public docket for this accident. Pertinent portions of that report were extracted for inclusion in this report.

1.4.2 Surface Weather Observations

The surface weather observations for Winnemucca (WMC), elevation 4,297 feet, were obtained for the listed times, which are expressed as coordinated universal time (Zulu, PST + 8).

1956Z: Winds 160 degrees at 10 knots; visibility 10 miles; few clouds at 2,600 feet, ceiling 3,100 feet broken, 4,700 feet overcast; temperature 2 degrees C; dew point -2 degrees C; altimeter setting 29.85 inches of Hg.

2009Z: Winds 140 degrees at 8 knots; visibility 2 ½ miles; light snow, mist; ceiling 2,800 feet broken, 3,300 feet broken, 4,700 feet overcast; temperature 1 degree C; dew point -1 degree C; altimeter setting 29.85 inches of Hg.; snow began 1959Z.

According to the flight crew, N612CK departed WMC about 2000Z.

The surface weather observations for Ely (ELY), elevation 6,252 feet, were also obtained. The accident location is about 39.4758 degrees north latitude and 115.3679 degrees west longitude. The accident location is about 28 nautical miles west-northwest of Ely.

2053Z: Winds 010 degrees at 6 knots; visibility 10 miles; scattered clouds at 4,800 feet, ceiling 6,000 feet overcast; temperature 1 degree C; dew point -4 degrees C; altimeter setting 29.81 inches of Hg.

2153Z: Winds 350 degrees at 5 knots; visibility 7 miles; light snow; few clouds at 2,800 feet, ceiling 3,600 feet broken, 4,400 feet overcast; temperature 0 degrees C; dew point -3 degrees C; altimeter setting 29.80 inches of Hg.; snow began 2151Z; trace (< 0.01 inch) of precipitation recorded between 2053Z and 2153Z.

1.4.3 Upper Air Data

Data for the approximate accident location for January 18, 2006, at 2100Z, was obtained from

the North American Mesoscale Model (NAM12). The following abbreviations are used in the table.

PRESS = Pressure in millibars

HGT = Height in meters

TEMP = Temperature in degrees C

DEW PT = Dew Point Temperature in degrees C

WND DIR =. Wind Direction degrees true

WND SPD = Wind speed in meters per second

PRESS	HGT(MSL)	TEMP	DEW PT	WND DIR	WND SPD
HPA	Meters	C	C	DEG	M/S
790.	2053.	-1.4	-3.1	229.3	3.3
775.	2202.	-3.1	-5.3	237.9	2.9
750.	2461.	-5.1	-8.1	252.5	6.2
725.	2727.	-7.4	-10.0	261.8	8.2
700.	2999.	-9.4	-12.0	270.6	11.4
650.	3568.	-13.6	-15.8	262.5	18.7
600.	4171.	-18.2	-20.9	259.2	22.9
550.	4817.	-21.7	-29.2	256.2	26.0
500.	5513.	-25.9	-37.1	253.3	29.6

Relative Humidity in %

HGT	RH
2053.	84.3
2202.	84.9
2461.	79.9
2727.	82.1
2999.	82.0
3568.	84.0
4171.	79.9
4817.	51.7
5513.	35.8

1.4.4 Weather Radar Data

The Elko, Nevada (LRX) Doppler Weather Radar images were viewed for times of 2100Z to 2130Z. Weak weather radar echoes are seen in the accident area and along the route from WMC to the accident site.

1.4.5 Satellite Data

Geostationary Operational Environmental Satellite (GOES)-10 infrared image data were reviewed at a 4-kilometer resolution for a time of 2130Z. At the accident location the radiative temperature was about 238 degrees K (-35 degrees C). Using NAM upper air data this temperature results in a cloud top near 23,000 feet.

1.4.6 Current Icing Potential Product

The Current Icing Potential (CIP) forecast consists of a likelihood field ranging from 0 (no icing) to 1 (certain icing). For a time of 2200Z at 9,000 feet at the location of the accident, the CIP number was 0.4.

1.4.6 In-Flight Weather Advisories

The following in-flight weather advisories were issued at, and valid for, the times indicated and encompassed the area of the accident.

AIRMET Zulu Update 3 for icing issued January 18, 2006, at 1445Z and valid until January 18, 2006, at 2100Z (SLCZ WA 181445). Occasional moderate rime / mixed icing in cloud and in precipitation between 8,000 feet and FL210.

AIRMET Zulu Update 4 for icing issued January 18, 2006, at 2045Z and valid until January 19, 2006, at 0300Z (SLCZ WA 182045). Occasional moderate rime / mixed icing in cloud and in precipitation between 8,000 feet and FL210.

AIRMET Tango Update 3 for turbulence issued January 18, 2006, at 1445Z and valid until January 18, 2006, at 2100Z (SLCT WA 181445). Occasional moderate turbulence below FL180 due to strong low level winds over rough terrain.

AIRMET Tango Update 4 for turbulence issued January 18, 2006, at 2045Z and valid until January 19, 2006, at 0300Z (SLCT WA 182045). Occasional moderate turbulence below FL180 due to strong low level winds over rough terrain.

The route from WMC to the accident site was contained in the area encompassed by the turbulence AIRMETs.

AIRMET Sierra Update 2 for IFR and mountain obscuration issued January 18, 2006, at 1445Z and valid until January 18, 2006, at 2100Z (SLCS WA 181445). Occasional ceiling below 1,000 feet / visibility below 3 miles in precipitation / mist / fog.

AIRMET Tango Update 3 for turbulence issued January 18, 2006, at 1445Z and valid until January 18, 2006, at 2100Z (SLCT WA 181445). Occasional moderate turbulence below FL180 due to strong low level winds over rough terrain.

AIRMET Tango Update 4 for turbulence issued January 18, 2006, at 2045Z and valid until January 19, 2006, at 0300Z (SLCT WA 182045). Occasional moderate turbulence below FL180 due to strong low level winds over rough terrain.

The route from WMC to the accident site was contained in the area encompassed by the turbulence AIRMETs.

AIRMET Sierra Update 2 for IFR and mountain obscuration issued January 18, 2006, at 1445Z and valid until January 18, 2006, at 2100Z (SLCS WA 181445).

Occasional ceiling below 1,000 feet / visibility below 3 miles in precipitation / mist / fog.

Mountains occasional obscured by clouds / precipitation / mist / fog.

AIRMET Sierra Update 3 for IFR and mountain obscuration issued January 18, 2006, at 2045Z and valid until January 19, 2006, at 0300Z (SLCS WA 182045).

Occasional ceiling below 1,000 feet / visibility below 3 miles in precipitation / mist / fog. Mountains occasional obscured by clouds / precipitation / mist / fog.

The route from WMC to the accident site was encompassed by the mountain obscuration AIRMETs. The IFR AIRMETS encompassed the route from WMC to about 20 to 25 nautical miles north of the accident site.

1.5 TESTS AND RESEARCH

1.5.1 Airframe Examination

On January 31, 2006, an FAA airworthiness inspector from the Portland, Oregon, Flight Standards District Office conducted an examination of the recovered helicopter and it's components at the Croman facility in Medford, Oregon. The aircraft was a SH3H, serial number 149713. It was hangared in the Croman building. The engines, main rotor assembly, and main rotor transmission had been removed and the vertical stabilizer had been chopped off by the main rotors during the impact sequence.

Croman mechanics assisted the inspector. The fuel tanks were sumped and the forward and aft fuel system filters were removed for examination. Some minor water and debris were found in the fuel tanks. The main airframe fuel pumps were operationally checked and appeared to function normally. Fuel was pumped from the forward and aft fuel tanks up to the engine deck, satisfactorily. The fuel lines were capped at the engine deck and the forward and aft fuel systems were pressurized. No leaks were found. The full airframe fuel system appeared to function normally.

The engine anti-ice system was checked. The engines were removed previously and not available so the anti-ice components mounted on the engine could not be checked. It was found that AC and DC electrical power was available to the engine anti-ice control box. The anti-ice control box was functionally tested and functioned normally. An electrical continuity check was preformed on the wire harness that provides electricity to the engine mounted anti-ice components. All circuits had continuity.

The chip detector and filter was removed from the main rotor transmission. The chip detector was clean and the filter did not show any evidence of transmission failure. The sprag clutch cover was removed from the main rotor transmission to gain access to the sprag clutch gear assemblies and helical gear. A visual inspection of these gears was accomplished, no defects found.

The engine related anti-ice components in the Bellmouth assemblies were examined and tested, with no anomalies found.

1.5.2 Engine Teardowns

The engines were visually examined by the FAA inspector on January 26, 2005. The engines were in the back of a pickup truck owned by the company that previously overhauled the engines, AcroHelipro, Richmond, British Columbia, Canada. The engines were en route to

AcroHelipro for complete disassembly and internal examination.

The No. 1 engine, General Electric model T58-402, serial number 281-323, had damaged fist stage stator blades and first stage compressor rotor blades. The trailing edges on the first stage stators were bent forward. The leading edges of the first stage compressor rotor were damaged. No external engine damage was found. There was no compressor or external engine damage found on the No. 2 engine, General Electric model T58-402, serial number 281-447.

Both engines were then transported to AcroHelipro (Richmond, BC) for further investigation, which took place on January 31 and February 1, 2006, under the auspices of a TSB investigator. Engine disassembly was conducted by AcroHelipro technicians familiar with the T58 engine.

1.5.2.1 Left Engine (No. 1); T58-GE-402; Serial Number 281-323:

This engine had accumulated 8,389 hours time since new (TSN) at the time of the accident. It also had 605.8 hours time since overhaul (TSO). It was installed in the accident helicopter on March 22, 2005, with a TSO of 556.4 hours. It had therefore accumulated about 50 hours since installation, with the only service record "write-up" during this period being replacement of outboard engine mount due to worn out isolators, about 1 hour after installation.

There was no evidence of any external, fire, or casing damage to this engine.

This engine was disassembled at Acro for further investigation. One stage 1 compressor blade had severe leading edge (LE) tip "curl" covering about 3/4 of its span, together with a small tear in the LE. This compressor blade had, in effect, been "straightened-out" such that its LE tip was about 0.25 inches proud of the LE plane of all other stage 1 blades. The adjacent blade also had a small amount of tip curl and tear damage towards its tip, consistent with the severely damaged blade contacting it.

All 38 inlet guide vanes (IGV) had trailing edge (TE) "curl-over" damage covering about 3/4 of their span, in the direction of rotation of the stage 1 compressor blades. This damage was consistent with them all being contacted by the single proud stage 1 compressor blade during rotation. Looking into the compressor from the front, the IGV with the heaviest TE damage was at about the 6:30 position. This TE damage continued to be heavy round to about 3:00 position (counterclockwise), and then lessened round at 12:00, thru 9:00 positions, and was least at about 7:00. Consistent with this heavy IGV TE damage from 6:30 to 3:00, all vespel bushings were missing from the associated IGV lever arms from 6:30 to 3:00.

This was the only damage or distress observed to this 10 stage axial compressor and stator vanes. All stage 1 compressor blades were non-destructively tested (MPI) with only the above damaged blade showing evidence of a small crack.

The variable stator system on this engine was rigged two full turns open (-2.2 degrees of IGV vane angle). The stator vane actuator rod was observed to be partially extended at 1.05 inches. A "normally" shutdown engine would have this actuator rod fully retracted (ie. 0 inches) and the IGV's fully closed. Croman indicated that this rod extension likely occurred after the accident when the IGV's were opened to inspect the compressor for damage.

The one-stage power turbine rotor and two-stage gas generator rotors (wheels and blades) looked to be in good condition, as did their associated nozzles. Accurate measurements by Acro confirmed that there was no bore growth in any of the rotors. All exposed bearings looked to be in good condition. The power turbine rotated freely. The core (compressor and gas

generator) could not be rotated due to the damaged stage 1 compressor blade "hanging-up" on the IGV's. With the IGV's fully rotated closed and out of the way of this stage 1 blade, the compressor also rotated freely. The combustor and other internal engine components also looked to be in good condition.

The GE technical representative noted that the damage to the stage one compressor blade and the inlet guide vanes was consistent with other known ice ingestion events.

All lube system filters and chip plugs were removed and inspected, with only typical in-service amounts of debris being observed.

Proper functioning of this engine's anti-ice valve was confirmed by AcroHelipro bench testing.

The engine was equipped with a Hamilton Sundstrand fuel control: P/N 787226-1; S/N 52621.

1.5.2.2 Right Engine (#2); T58-GE-402; Serial Number 281-447:

This engine had accumulated 5,869 hours time since new (TSN) at the time of the accident. It also had 504.1 hours time since overhaul (TSO). It was installed in the accident helicopter on March 22, 2005, with a TSO of 454.7 hours. It had therefore accumulated about 50 hours since installation, with no service record "write-ups" during this period.

There was no evidence of any external, fire or casing damage to this engine. Looking into the front of the compressor with the IGV's wide open, there was no evidence of any damage.

The variable stator system on this engine was rigged two full turns open (-2.2 degrees of IGV vane angle). The stator vane actuator rod was observed to be partially extended at 1.4 inches. A "normally" shutdown engine would have this actuator rod fully retracted (ie. 0 inches) and the IGV's fully closed. Croman indicated that this rod extension likely occurred after the accident when the IGV's were opened to inspect the compressor for damage.

Both the power turbine and the core (compressor and gas generator) rotated freely.

All lube system filters and chip plugs were removed and inspected, with only typical in-service amounts of debris being found.

Proper functioning of this engine's anti-ice valve was confirmed by AcroHelipro bench testing.

Hamilton Sundstrand fuel control: P/N 744322-2; S/N 69421M.

The investigation team decided that this No. 2 engine would not be disassembled, but instead perform an "as-received" test cell run, providing all visual checks revealed no evidence of any potential damage. The team also agreed that, following a successful test cell run of engine No. 2, certain fuel system components from engine No. 1 would then be "slaved" on to engine No. 2 for test cell checkout. These components included the fuel control, fuel pump, pilot valve, flexible drive shaft and Nf tach generator.

1.5.3 No. 2 Engine Test Cell Run

Engine No. 2 (s/n 281-447) was installed on the test cell stand at the Croman facility. All filters and chip plugs were cleaned before the run. The engine was first motored to check for any unusual noises. The stator system was opened and the engine motored again. The stator system closed normally.

The engine started normally and the idle speed was within normal limits. Vibration readings

were taken at the front frame, gas generator and power turbine with the engine at idle. All readings were within limits. After all preliminary checks the engine was taken to 100 percent and vibration levels were checked again. All readings were within limits.

A scheduling check showed that the stator system position versus gas generator speed was at the top of the envelope. A performance run showed no deterioration of power in comparison to the test cell run completed at the last overhaul 504 hours prior. The fuel system performed normally when the throttle was rapidly cut back to idle and rapidly burst open. The only abnormality noted was a slight leak from the stator vane actuator drain. The chip plugs and filters were inspected and nothing unusual was observed..

The fuel system components were removed and the fuel pump, fuel control, pilot valve, flexible drive shaft, and Nf tach generator from the No. 1 engine (s/n 281-323) were installed. The test described above was repeated, with identical results.

1.5.4 Input Freewheel Units

The No. 1 and No. 2 sprag clutch gear assemblies in the input freewheel units were removed and disassembled. The sprag clutch rollers, cage, and related parts were inspected. No defects were found on these parts. Roller and ball bearing assemblies that were visible by looking in to the main rotor transmission with the sprag clutch cover removed were inspected. No defects were found.

The units were taken to a metallurgical laboratory for examination of the rollers under high magnification. According to the report, no evidence consistent with slippage of the input freewheel units was found. The complete laboratory report is contained in the public docket for this accident.

Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	57, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2	**Last FAA Medical Exam:**	03/01/2005
Occupational Pilot:		**Last Flight Review or Equivalent:**	06/01/2005
Flight Time:	20000 hours (Total, all aircraft), 15000 hours (Total, this make and model), 18000 hours (Pilot In Command, all aircraft), 35 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	62, Male
Airplane Rating(s):	Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2	**Last FAA Medical Exam:**	07/01/2005
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	20000 hours (Total, all aircraft), 8000 hours (Total, this make and model), 19000 hours (Pilot In Command, all aircraft), 60 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Croman Corporation	**Registration:**	N612CK
Model/Series:	SH-3H	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Restricted	**Serial Number:**	149713
Landing Gear Type:	Tailwheel	**Seats:**	5
Date/Type of Last Inspection:	01/01/2006, Continuous Airworthiness	**Certified Max Gross Wt.:**	21000 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Shaft
Airframe Total Time:	14305 Hours at time of accident	**Engine Manufacturer:**	General Electric
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	T58-GE-402
Registered Owner:	Croman Corporation	**Rated Power:**	1500 hp
Operator:	Croman Corporation	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	JYEL

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	KELY, 6259 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	1353	**Direction from Accident Site:**	95°
Lowest Cloud Condition:	Few / 2800 ft agl	**Visibility**	7 Miles
Lowest Ceiling:	Broken / 3600 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	350°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.8 inches Hg	**Temperature/Dew Point:**	0°C / -4°C
Precipitation and Obscuration:	Light - Showers - Snow		
Departure Point:	Winnemucca, NV (WMC)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Page, AZ (PGA)	**Type of Clearance:**	None
Departure Time:	1130 PST	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 None	**Latitude, Longitude:**	39.472222, -115.367500

Administrative Information

Investigator In Charge (IIC):	Jeff Rich	**Report Date:**	02/26/2007
Additional Participating Persons:	Bill Kunder; Federal Aviation Administration; Reno, NV David Gridley; GE Aviation; Lynn, MA Keith Harper; Sikorsky Aircraft; Stratford, CT Brian Beattie; Croman Corporation; White City, OR		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		