U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: GOVERNMENT AIRCRAFT OPERATIONS	**Date:** 4/19/95 **Initiated by:** AFS-220	**AC No:** 00-1.1 **Change:**	

1. PURPOSE. The purpose of this advisory circular (AC) is to provide guidance on whether particular government aircraft operations are public aircraft operations or civil aircraft operations under the new statutory definition of "public aircraft." This AC contains the Federal Aviation Administration's (FAA) intended application of key terms in the new statutory definition. For operations that have lost public aircraft status under the new law, this AC provides information on bringing those operations into compliance with FAA safety regulations for civil aircraft. It also provides information on applying for an exemption. This AC provides acceptable, but not exclusive, means of complying with the law. Agencies which conduct public aircraft operations are encouraged to comply with the Federal Aviation Regulations (FAR), even when they are not required to do so. They and the flying public will benefit from their voluntary adherence to the enhanced safety standards set out in the regulations. The FAA will continue to provide assistance to public agencies which seek to voluntarily comply with the regulatory requirements.

2. REFERENCE. 49 U.S.C. § 40102(A)(37).

3. RELATED MATERIAL.

a. AC 00-2.8, Advisory Circular Checklist, lists documents that provide guidance on many of the processes required to be followed in the certification and operation of civil aircraft.

b. AC 00-44FF, Status of Federal Aviation Regulations, provides the current public status of the Federal Aviation Regulations (FAR), prices, and order forms.

c. AC 20-132, Public Aircraft, provides guidance that public aircraft status under the Federal Aviation Act does not permit operations outside the territorial limits of the United States without a valid airworthiness certificate.

d. AC 120-12A, Private Carriage Versus Common Carriage of Persons or Property, furnishes general guidelines for determining whether transportation operations by air constitute private or common carriage.

e. AC-120-49, Certification of Air Carriers, provides information and guidance on the certification process for air carriers under FAR Parts 121 and 135.

f. Guide to Federal Aviation Administration Publications provides guidance on identifying and obtaining FAA and other aviation-related publications issued by the Federal government.

Note: Copies of the above documents may be obtained from the Department of Transportation, M-45.3, General Services Section, Washington, DC 20590.

[redacted]

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CHAPTER 1. DETERMINING WHETHER OPERATIONS ARE PUBLIC OR CIVIL.

1. PUBLIC AIRCRAFT DEFINITION.

a. Background. In recent years, there has been an increasing interest in matters involving operations of public aircraft, which are generally exempt from compliance with the Federal Aviation Regulations.

(1) One area of interest is related to government agencies' receipt of reimbursement for their operation of government-owned aircraft. Prior to the enactment of the Public Law 103-411, the Independent Safety Board Act Amendments of 1994, "public aircraft" was defined to exclude "any government-owned aircraft engaged in carrying persons or property for commercial purposes." (P.L. 100-223, 1987). The FAA's long-standing interpretation has been that, where there is a receipt of compensation, such an operation is "for commercial purposes" and that such an operation therefore is not a public aircraft operation. This interpretation has been applied to intergovernmental arrangements wherein one government agency receives compensation for providing aircraft services to another government agency. Such services may be provided for firefighting, search and rescue or other governmental functions. Many government operators objected to the FAA's interpretation, claiming that such an interpretation impeded their governmental missions. They urged that it was impractical or impossible to obtain the services commercially, and that it was too costly to conduct their operations under the Federal Aviation Regulations as civil aircraft.

(2) On October 9, 1994, Congress passed the Independent Safety Board Act Amendments, Pub. L. 103-411, which changed the definition of the term "public aircraft." The law was signed by President Clinton on October 25, 1994.

(3) On January 26, 1995, the proposed advisory circular on Government Aircraft Operations was published in the Federal Register. 60 Fed. Reg. 5237. The proposed advisory circular set forth the FAA's understanding of the terms set forth in the new statute and the agency's intended application of those terms. The proposed advisory circular requested comments from affected parties on the positions taken by the FAA.

(4) Between January 26 and the current date, the FAA received and considered numerous comments from federal, state, and local governmental organizations as well as from representatives of private aircraft operators. Additionally, the FAA received an opinion of the Office of Legal Counsel,

United States Department of Justice. That opinion, dated March 31, 1995, addresses whether the transport of prisoners on government aircraft falls within the statutory definition of "public aircraft." The opinion advised that the position taken by the FAA in the proposed advisory circular regarding the transport of prisoners was unnecessarily restrictive. It discusses generally the terms used in that section of the statute which relate to the transporting of passengers in government-owned aircraft and advises that those terms would more appropriately be given a slightly broader interpretation than that in the proposed advisory circular. The FAA has modified its position to accord with the legal direction received.

b. Legislative History. The general purpose of the new law, as reflected in the legislative history, is to extend FAA regulatory oversight to some government aircraft operations. In part, Congress determined that government-owned aircraft, which operate for commercial purposes or engage in transport of passengers, should be subject to the regulations applicable to civil aircraft. The new law (with certain exceptions) preserved as public aircraft operations, those relating to the performance of certain governmental functions and, further, allowed public agencies to receive reimbursement from other public agencies for some operations conducted in response to significant and imminent threats. The FAA was also authorized to grant exemptions for operations whose status had changed as a result of the new law.

c. Statutory Text. The new definition of public aircraft enacted by Congress is as follows:

"(1) an aircraft--

(i) used only for the United States Government; or

(ii) owned and operated (except for commercial purposes) or exclusively leased for at least 90 continuous days by a government (except the United States Government), including a State, the District of Columbia, or a territory or possession of the United States, or political subdivision of that government; but

(2) does not include a government-owned aircraft--

(i) transporting property for commercial purposes; or

(ii) transporting passengers other than--

(A) transporting (for other than commercial purposes) crewmembers or other persons aboard the aircraft whose presence is required to perform, or is associated with the performance of, a governmental function such as firefighting, search and rescue, law enforcement, aeronautical research, or biological or geological resource management; or

(B) transporting (for other than commercial purposes) persons aboard the aircraft if the aircraft is operated by the Armed Forces or an intelligence agency of the United States.

(3) An aircraft described in the preceding sentence shall, notwithstanding any limitation relating to use of the aircraft for commercial purposes, be considered to be a public aircraft for the purposes of this part without regard to whether the aircraft is operated by a unit of government on behalf of another unit of government, pursuant to a cost reimbursement agreement between such units of government, if the unit of government on whose behalf the operation is conducted certifies to the Administrator of the Federal Aviation Administration that the operation was necessary to respond to a significant and imminent threat to life or property (including natural resources) and that no service by a private operator was reasonably available to meet the threat." 49 U.S.C. 40102 (a)(37).

d. Operational Nature of Definition. The status of an aircraft as "public aircraft" or "civil aircraft" depends on its use in government service and the type of operation that the aircraft is conducting at the time. Rather than speaking of particular aircraft as public aircraft or civil aircraft, it is more precise to speak of particular operations as public or civil in nature. Example: An aircraft owned by a state government is used in the morning for a search and rescue mission. During the search and rescue operation, the aircraft is a public aircraft. Later that same day, however, the aircraft is used to fly the governor of the state from one meeting to another. At that time, the aircraft loses its public aircraft status and must be operated as a civil aircraft.

e. Effective Date. The effective date of the new statute is April 23, 1995.

2. MEANING OF KEY STATUTORY TERMS. The FAA interprets various words, phrases, and clauses in the statutory definition (in their order of appearance in the statute) as follows:

a. "For Commercial Purposes." The FAA has consistently taken the position that this term means "for compensation or hire". The test historically applied to determine whether an operation is for "compensation or hire" is whether the operator receives direct or indirect payment for the operation. It is not necessary that a flight be conducted for profit to constitute an operation for "compensation or hire," the term may be applicable even where there is no intent or ability to make a profit from the flight. Even where there is only cost-reimbursement from a unit of one government to a unit of another for the operation of an aircraft, such reimbursement constitutes "compensation." Accordingly, operations conducted pursuant to cost-reimbursement arrangements between units of government are considered to be "for commercial purposes." The new statute provides a limited exception allowing for public aircraft status where the unit of government on whose behalf the operation is conducted certifies that the operation was necessary to respond to a significant and imminent threat to life or property and that no service by a private operator was reasonably available to meet the threat. By providing this limited exception, Congress clearly recognized that operations conducted pursuant to cost-reimbursement agreements are to be considered "for commercial purposes." Generally, a transfer of funds by one element of government to another element within that same government will not be treated as compensation. Operations conducted pursuant to those arrangements are not considered "for commercial purposes" where the reimbursement is essentially an accounting of transactions within the same unit of government.

(1) One state agency reimburses another agency of the same state for conducting operations on its behalf using a state-owned aircraft. If the two agencies share a common treasury, the operation is not "for commercial purposes" within the meaning of the statute.

(2) A federal agency reimburses a state agency for conducting aircraft operations on the former's behalf using state-owned aircraft. Such an operation is considered to be "for commercial purposes." Generally, this operation would be a civil aircraft operation, unless the federal agency certified that the operation was necessary to respond to a significant and imminent threat to life or property (including natural resources) and that no service by a private operator was reasonably available to meet the threat. In that case, the operation would be considered a public aircraft operation.

b. "Whose Presence is Required to Perform." This phrase means that the person is aboard the aircraft for the purpose of performing a task or duty directly related to an ongoing governmental function of the sort enumerated in the statute. It indicates that the person's presence is essential to the performance of that function.

(1) Examples:

(i) Firefighters who are being transported for the purpose of engaging in a current firefighting activity are considered persons whose presence is essential for the performance of that activity. The transport of firefighters directly to a firefront by aircraft as part of a mission for which the use of an aircraft is necessary would constitute an accepted activity. Similarly, the transport of firefighters to a base camp by aircraft where they are to be dispersed to the firefront may be viewed in the same manner.

(ii) Officials who are conducting law enforcement operations while in an aircraft would be considered as being required for the performance of that governmental function. Thus, the carriage of law enforcement personnel performing aerial surveillance would be considered as necessary to perform the law enforcement function. So too, might officials who are being transported for the purpose of engaging in a law enforcement activity. For example, the carriage of officers to the scene of a public disturbance for the purpose of performing riot control duty on the ground would also be included if the effectiveness of riot control would be compromised by inability to use the aircraft. The movement of law enforcement personnel for administrative purposes would not be considered necessary for the performance of an excepted government function.

(iii) Persons engaging in search and rescue operations from an aircraft would be considered necessary for the performance of the governmental function. Also included would be persons who are being carried to a remote search area from which they would conduct ground search and rescue operations, provided that the use of the aircraft is necessary for the performance of that mission.

(iv) Persons on board aircraft conducting aeronautical research who are engaged in the airborne gathering of data or information are necessary for performance of the governmental function.

(v) Persons on board an aircraft that is engaged in biological and geological resource management would be included, so long as they perform biological and geological resource management-related duties on the aircraft. Also included would be persons carried to a location from which they would engage in an ongoing operation or mission.

c. "<u>Associated with the Performance of</u>." This clause operates to include persons who, while not directly engaged in performing the governmental function, are present on the aircraft in connection with that function.

(1) Examples:

(i) An official who accompanies firefighters to a fire to oversee or assess the success of the operation and/or the need to commit further resources to the fire fight would be associated with the performance of the governmental function.

(ii) A ground crew that accompanies a weather research aircraft to the theater of operations for the purpose of maintaining the aircraft and equipment would be associated with the performance of the governmental function.

(iii) Prisoners who are being transported aboard an aircraft are associated with the performance of a law enforcement function.

(iv) Persons who are rescued during a search and rescue operation are associated with that function. Also included are members of a ground rescue party which assists in the search and rescue operation.

d. "<u>Governmental Function Such As...</u>" The term "such as," when used in the clause "a governmental function such as firefighting, search and rescue, law enforcement, aeronautical research, or biological or geological resource management" indicates that the listed functions are not exhaustive and that the exception may apply to other governmental functions as well. However, the exception is limited to those other governmental functions that are comparable to and consistent with the listed functions. The unifying characteristic shared by the governmental functions listed in the statute is that they each involve the carriage of persons as part of a mission for which the use of an aircraft is necessary. Thus, it is not sufficient to merely show that the passengers are being transported to perform one of the functions listed in the statute; the use of the aircraft must be necessary for the performance of the mission. The aircraft would be necessary for the performance of a mission if the inability to use the aircraft would compromise the effectiveness of that mission.

(1) <u>Examples</u>:

(i) The use of an aircraft for administrative travel, such as to attend meetings or make speeches, would not be considered necessary for the performance of a listed or comparable governmental mission. Such an operation would not qualify for the exception.

(ii) Training flights would be included if the persons on board are being trained on the aircraft to perform one of the functions listed in the statute. Flights to transport persons to receive ground training would not be included.

(2) "Firefighting." This term includes the dispensing of water or fire retardants on a fire. It also includes the transport of firefighters and equipment to a fire or to a base camp from which they would be dispersed to conduct the firefighting activities.

(3) "Search and Rescue." This term is commonly used to mean operations conducted to locate and rescue persons who are lost, injured, and/or exposed to some degree of danger or harm. Generally, the use of an aircraft is indispensable to the search effort or is the only feasible means of recovering the victim. Persons rescued would be considered "associated with" the activity.

(4) "Law Enforcement." Operations requiring the use of an aircraft, such as aerial surveillance, fugitive apprehension, and riot control would be included. Also included would be other situations where the use of an aircraft is essential for the performance of an ongoing law enforcement mission. For instance, deployment of SWAT teams to the theater of operations by aircraft would be included when the use of an aircraft is essential for the successful performance of the mission.

(5) "Aeronautical Research." This term would include flights to measure the performance of aircraft or aeronautical components. It would also include atmospheric research, meteorological observation and airborne astronomy.

(6) "Biological and Geological Resource Management." This term would include operations which require the use of an aircraft for the successful performance of the mission. For example, counting wildlife from an aircraft would be included.

(7) "Other Governmental Functions - Examples:"

(i) Medical evacuation. While this term is not considered synonymous with "search and rescue," it may be an included governmental function, depending on the particular circumstances of the operation. Again, the use of an aircraft must be essential to the successful performance of the mission. It is unlikely that the use of an aircraft would be essential for a medical evacuation operation in an urban area where other means of transportation are routinely available.

(ii) Aerial Survey. Operations conducted to assure compliance with state or local laws or codes are included if the inability to use an aircraft would compromise the effectiveness of the mission. Examples:

(A) The identification of environmental polluters would be included if the use of an aircraft was necessary to locate the offenders.

(B) Aerial patrol of nuclear test sites to deter or locate trespassers would be included.

e. "Cost-Reimbursement Agreement." This term means any agreement, oral or written, providing for reimbursement of all or part of the costs of an aircraft operation. Any charge or payment in excess of the cost of the operation would not constitute a cost-reimbursement agreement.

f. "Unit of Government." This term means a government body. Generally, the singular characteristic of a unit of government in this context is its common treasury. Reimbursement for flight operations between two elements of the same unit of government would not be considered an operation for "compensation or hire." However, the receipt of reimbursement for a flight operation from an element of one unit of government to an element of a separate unit of government would constitute an operation "for commercial purposes." Such operation would be considered a civil aircraft operation, except when the government unit, which receives the benefit of the operation, certifies that there is a significant and immediate threat to life or property and that no private operator is reasonably available.

g. "Certifies." The certification that there is a significant and immediate threat to life or property and that no private operator is reasonably available should be made by the unit of government on whose behalf the operation is conducted. Without the certification, the unit of government who receives reimbursement for conducting the operation will be assumed to have conducted the operation "for commercial purposes." Such an operation will be considered a civil aircraft operation and may require compliance with FAR Part 121, 125, 133, 135, or 137.

(1) The certification should include: the date of the operation, a description of the flight operation conducted, a description of the significant or immediate threat, and an

explanation of why it was determined that no service by a private operator was reasonably available.

(2) The certification is the responsibility of the unit of government which provides the flight operations. It is suggested that the certification be completed contemporaneously with the operation and be retained by the unit of government which operated the aircraft.

h. "Significant and Imminent Threat." This term refers to a situation where the public agency responsible for responding to a threat has determined that serious injury or death, or significant damage to property (including natural resources) is present. The agency must also determine that the use of an aircraft is necessary to respond to the threat.

i. "No Service by a Private Operator was Reasonably Available." This term means that the public agency responsible for responding to a threat has reasonably determined that, at the time of the response, no private operator was available and capable of responding to the threat in a timely manner.

CHAPTER 2. BRINGING OPERATIONS INTO COMPLIANCE.

3. BASIC TYPES OF CIVIL AIRCRAFT OPERATIONS. The government operator should contact the nearest FAA Flight Standards district office (FSDO) for assistance and guidance in bringing its operations into compliance with the FAR. For operations requiring certification, the FSDO manager will assign an FAA aviation safety inspector to assist the government operator during the certification process. Initial inquiries about certification or requests for applications should be in writing or by personal visit to the FSDO.

a. FAR Part 91.

(1) FAR Part 91 prescribes the general flight rules for all aircraft operations within the United States, including the waters within 3 nautical miles of the U.S. coast. U.S.-registered civil aircraft are required to comply with FAR Part 91. When over the high seas, they must comply with Annex 2 (Rules of the Air) to the Convention on International Civil Aviation.

(2) FAR Part 91 prohibits a pilot from operating a civil aircraft unless it is in an airworthy condition. The pilot in command (PIC) is responsible for determining whether the aircraft is in condition for safe flight. The PIC is required to terminate the flight when unairworthy mechanical, electrical, or structural conditions occur. In addition, the PIC may not operate the aircraft without complying with the operating limitations specified in the approved Airplane or Rotorcraft Flight Manual, markings, and placards, or as otherwise prescribed by the certificating authority of the country of registry.

(3) Under FAR Part 91, the PIC of an aircraft is directly responsible for, and is the final authority as to the operation of that aircraft. In case of an inflight emergency, the PIC is authorized to deviate from any rule in FAR Part 91 to the extent necessary to meet the emergency. However, any PIC who deviates from a rule in FAR Part 91 is required, upon the request of the Administrator, to send a written report of that deviation to the Administrator.

b. FAR Part 125. If an operator uses an airplane with a seating configuration for 20 or more passenger seats or a maximum payload capacity of 6,000 pounds or more, and is not engaged in "common carriage," then FAR Part 125 applies. A person is considered to be engaged in "common carriage" when "holding out" to the general public or to a segment of the public as willing to furnish transportation within the limits of its facilities to any person who wants it. Examples of holding out are as follows: advertising through telephone yellow pages, billboards, television, radio, and individual ticketing. FAR Section 125.11(b) prohibits FAR Part 125 certificate holders from conducting any operation which results directly or indirectly from holding out to the general public. Further information regarding common carriage vs. private carriage can be found in AC 120-12. If the operator is engaged in "common carriage," then FAR Part 121 or 135 applies rather than FAR Part 125.

c. FAR Part 121 or 135. When a government-owned aircraft is operated "for commercial purposes" (see paragraph 2(a) above), the requirements contained in either FAR Part 121 or 135, depending on the type of operation, must be met. Generally, FAR Part 121 applies to domestic, flag, and supplemental air carriers and commercial operators of large aircraft, while FAR Part 135 applies to air taxi operators and commercial operators. An operator should consult Special Federal Aviation Regulation (SFAR) No. 38-2 as well as the applicability provisions of each part (FAR Sections 121.1 and 135.1) to determine whether it is FAR Part 121 or 135 that applies to a particular operation. The FSDO will provide an applicant for a FAR Part 121 or 135 certificate with a videotape on certification and a copy of AC 120-49, Certification of Air Carriers. Once the videotape and the AC have been reviewed, the applicant will complete FAA Form 8400-6, Preapplication Statement of Intent, and the FSDO manager will assign a Certification Team to assist the applicant through each phase of the certification process.

d. FAR Part 133. FAR Part 133, Rotorcraft External-Load Operations, prescribes the airworthiness certification requirements for rotorcraft, and the operating and certification rules governing the operation of rotorcraft conducting external-load operations in the United States by any person. The certification rules do not apply to a Federal, state, or local government conducting operations with a government-owned aircraft unless it is operating as a civil aircraft due to receipt of compensation. Federal, state, or local governments must; however, comply with all of the other rules contained in FAR Part 133, even when operating a public aircraft.

(1) FAR Part 133 requires that a person must obtain a Rotorcraft External-Load Operator Certificate issued by the FAA before any rotorcraft external-load operations in the United States are begun. This certificate is valid for 24-calendar months unless it is surrendered, suspended, or revoked prior to the expiration date shown on the certificate.

(2) Rotorcraft used in external-load operations must have been type certificated and must continue to meet the requirements of FAR Part 27 or 29 or of FAR Section 21.25. Rotorcraft must also comply with the airworthiness requirements contained in Subpart D of FAR Part 133 and must have a valid standard or restricted category airworthiness certificate. At the present time, only rotorcraft of U.S. registry are eligible for external-load operations.

(3) Pilots conducting rotorcraft external-load operations must have at least a current commercial pilot certificate with a rating appropriate to the rotorcraft being used, and a Second Class Medical Certificate.

e. FAR Part 137. FAR Part 137, Agricultural Aircraft Operations, prescribes the rules which govern the certification and operation of agricultural aircraft operated in the United States, and the issuance of either a private or commercial agricultural aircraft operator certificate for those operations. In a public emergency, a person who conducts agricultural aircraft operations may, where necessary, deviate from any operating rule contained in FAR Part 137 for relief and welfare activities approved by an agency of the United States or of a state or local government. However, each person who deviates from a rule shall complete a report of the aircraft operation involved within 10 days, including a description of the operation and the reasons for it, to the nearest FAA FSDO.

(1) As defined in FAR Part 137, an agricultural aircraft operation means the operation of an aircraft for the purpose of:

(i) dispensing any economic poison;

(ii) dispensing any other substance intended for plant nourishment, soil treatment, propagation of plant life, or pest control; or

(iii) engaging in dispensing activities directly affecting agriculture, horticulture, or forest preservation. It does not include the dispensing of live insects. Forest firefighting is considered to be an agricultural aircraft operation.

(2) FAR Part 137 requires that a person must obtain an Agricultural Aircraft Operator Certificate issued by the FAA before any agricultural aircraft operations in the United States are begun. A rotorcraft may conduct agricultural aircraft operations with external dispensing equipment in place without a rotorcraft external-load operator certificate. However, an

operator with a rotorcraft external-load operator certificate may conduct agricultural aircraft operations if it disperses only water on forest fires by rotorcraft external-load means without an agricultural aircraft operator certificate. A Federal, state, or local government conducting agricultural aircraft operations is not required to obtain an Agricultural Aircraft Operator Certificate. They must; however, comply with all of the other rules contained in FAR Part 137.

(3) Aircraft used in agricultural aircraft operations must be certificated and airworthy, and equipped for agricultural operation. They must be equipped with a suitable and properly installed shoulder harness for use by each pilot.

(4) Operators conducting agricultural aircraft operations must have the services of one person who has at least a current U.S. commercial pilot certificate and who is properly rated for the aircraft to be used.

4. <u>PILOT CERTIFICATION</u>.

a. <u>Generally</u>. All civil aircraft are required to be operated by pilots certificated under FAR Part 61, Certification: Pilots And Flight Instructors. FAR Part 61 prescribes the requirements for issuing pilot certificates and ratings, the conditions under which those certificates and ratings are necessary, and the privileges and limitations of those certificates and ratings.

b. <u>Domestic Aircraft</u>. Pilots operating civil aircraft of U.S. registry are required to have in their personal possession a current pilot certificate issued to them under FAR Part 61. U.S.-registered aircraft may be operated in a foreign country with a pilot license issued by that country.

c. <u>Foreign Aircraft</u>. Foreign aircraft may be operated in the U.S. by pilots who have in their personal possession current pilot certificates issued under FAR Part 61 or a pilot license issued to them or validated for them by the country in which the aircraft is registered.

d. <u>Medical Certificate</u>. Pilots operating U.S.-registered civil aircraft are required to have in their personal possession an appropriate current medical certificate issued to them under FAR Part 67, Medical Standards and Certification. FAR Part 67 prescribes the medical standards for issuing medical certificates. A Third Class Medical Certificate is required for Private Pilot certification. A Second Class Medical Certificate is required for Commercial Pilot certification. A First Class Medical Certificate is required for Airline Transport Pilot Certification.

e. Instrument Rating. Pilots operating civil aircraft under instrument flight rules or in weather conditions less than the minimums prescribed for Visual Flight Rules are required to hold an Instrument Rating or an Airline Transport Pilot Certificate appropriate for the aircraft flown.

5. AIRCRAFT CERTIFICATION.

a. Generally. Government aircraft operations that are no longer eligible for public aircraft status must now meet the civil airworthiness standards for certification of aircraft. This includes the aircraft's engines and propellers as well as the aircraft as a whole. A civil aircraft must have a current airworthiness certificate to operate in the National Airspace System. Additionally, all civil aircraft must meet the following requirements:

(1) The aircraft must have an effective U.S. registration certificate on board during all operations as required by FAR Section 91.203.

(2) An appropriate and current airworthiness certificate must be displayed in accordance with FAR Section 91.203(c). An airworthiness certificate is effective as long as the maintenance, preventative maintenance, and alterations are performed in accordance with FAR Parts 21, 43, and 91, as appropriate, and the aircraft is registered in the United States.

(3) The aircraft must have been inspected in accordance with FAR Section 91.409 within the preceding 12-calendar months.

(i) If the government agency plans to use a progressive inspection program, it must submit a written request to the FAA. The request must be sent to the FSDO having jurisdiction over the area in which the applicant is located and the applicant must be able to meet the requirements identified in FAR Section 91.409(d).

(ii) Large airplanes, turbojet multiengine airplanes, turbopropeller-powered multiengine airplanes, and turbine-powered rotorcraft must have a program approved that meets the requirements of FAR Section 91.409(e).

(4) All maintenance and required inspections must have been completed by a person authorized under FAR Sections 43.3 and 43.7. Additionally, the maintenance and inspections performed must be recorded in accordance with FAR Sections 43.9 and 43.11. FAR Part 43 prescribes the rules governing the maintenance, preventative maintenance, rebuilding, and alteration of civil U.S.-registered aircraft.

(5) Any alterations to the aircraft must have been accomplished and returned to service by an appropriately certified and authorized person under FAR Part 43.

(6) Aircraft operations for compensation or hire must be performed in accordance with the appropriate Air Operations Certificate, e.g., FAR Part 125, 135, etc.

b. Type Certification. Prior to airworthiness certification, the type design must be certificated by the FAA. Section 603(c) of the Federal Aviation Act of 1958 makes a type certificate a prerequisite for issuance of airworthiness certificates. Each government operator who wishes to determine the eligibility of its aircraft for civil operations must contact the responsible geographic Aircraft Certification Office (ACO) for assistance in seeking either:

(1) design approval for aircraft that have been type certificated in the past; or

(2) type certification approval of aircraft that have been operated in the past under public aircraft status without a type certificate.

c. Aircraft Previously Type Certificated. If the aircraft was originally built to an FAA type certificate, the Aircraft Certification Office will review the type certificate data and make a comparison with the aircraft's current design and condition.

(1) The applicant should provide the FAA Aircraft Certification Office with the technical information to assist in the following:

(i) a review of type design for any engineering changes or modifications;

(ii) a review of replacement parts and technical data on the replacement parts;

(iii) a review of applicable Airworthiness Directives (AD);

(iv) a review of previous operating regimes;

(v) if needed, application of later regulatory amendments or special conditions for any changes found necessary to establish current airworthiness standards for safe design.

(2) The applicant must provide accurate records of any changes from the approved type design that are necessary to establish the current design. The applicant should update all maintenance manuals as necessary. If there has been a substantial change in the type design, e.g., in the configuration, power, power limitations, speed limitations, or weight that have proven so extensive that a substantially complete investigation of compliance with the applicable regulations is required, the owner will be required to apply for a new type certificate.

d. <u>Aircraft with No Prior Certification</u>. It may be difficult to obtain type certification of aircraft that have no history of civil certification. However, if a government operator wishes to apply for type certification, it should file an application for a type certificate on FAA Form 8110.12. The applicant must submit the application and all type design data for the aircraft, including the aircraft's engines and propellers, to the Aircraft Certification Office in its geographic area for approval. The application form must be accompanied by a three-view drawing and available basic data so that a preliminary regulatory certification basis may be established. The applicable airworthiness certification regulations, i.e., FAR Part 23, 25, 27, 29, 33, 35, etc., will be those that are in effect on the date of application for the certificate, unless otherwise noted in the regulations. The applicant must submit the type design, test reports, and computations necessary to show that the product to be certificated meets the applicable airworthiness, aircraft noise, fuel venting, and exhaust emission requirements of the FAR. Upon examining the data and test reports, participating in testing, and inspecting the prototype aircraft, the Administrator must be able to find that the type design in fact complies with the above-mentioned regulations.

e. <u>Airworthiness Certification</u>. An operator of an aircraft that has been operated in public aircraft status cannot obtain a standard airworthiness certificate or return the aircraft to civil operations without showing that the aircraft meets all the criteria for that airworthiness certificate as prescribed by the regulations. Making that showing may be difficult when the aircraft has not been maintained, altered, or inspected in accordance with the FAR. In order to receive a standard airworthiness certificate, the operator should show that the aircraft has been maintained according to the manufacturer's instructions, and that any modifications to the aircraft either were removed or approved by the FAA. Before a standard airworthiness certificate can be issued, the applicant must show that:

(1) The aircraft conforms to its approved type design and is in condition for safe operation.

(2) Any alterations were accomplished in accordance with an approved supplemental type certificate (STC) or other FAA approved data, such as a field approval as reflected by the issuance of an FAA Form 337, Major Repair or Alteration.

(3) All applicable AD's have been complied with.

(4) If altered while in another category, the aircraft continues to meet, or has been returned to, its approved type design configuration and is in a condition for safe operation.

f. <u>Procedures for Obtaining Certificate</u>. Applicants interested in obtaining an airworthiness certificate must follow the following procedures.

(1) Applicants are required to submit a properly executed Application for Airworthiness, FAA Form 8130-6, and any other documents called for in FAR Parts 21 and 45 for certification. An applicant may obtain an FAA Form 8130-6, "Application for Airworthiness" from the local Manufacturing Inspection district office (MIDO) or FSDO. The applicant must have completed and signed the appropriate sections prior to submitting it to the FAA.

(2) The applicant is required to make available for inspection and review the aircraft, aircraft records, and any other data necessary to establish conformity to its type design.

(3) The applicant must properly register the aircraft in accordance with FAR Part 47, Aircraft Registration.

(4) The applicant is also required to show that the aircraft complies with the noise standards of FAR Sections 21.93(b), 21.183(e), Part 36, or Part 91, as appropriate. This may be demonstrated through the use of data. Also, the applicant is required to show that the aircraft's fuel venting and exhaust emission systems comply with the requirements of FAR Part 34. In addition, the applicant must show the

aircraft meets the applicable passenger emergency exit requirements of FAR Section 21.183(f) and SFAR No. 41.

(5) During the course of the certification process, the FAA will review records and documentation to the extent necessary to establish that:

(i) All of the required records and documentation are provided for the aircraft; i.e., an up-to-date approved flight manual, a current weight and balance report, equipment list, maintenance records, FAA-accepted Instructions for Continued Airworthiness (ICAW) and/or FAA-acceptance maintenance manual(s) (MM), and any other manuals required by FAR Sections 21.31, 21.50, 23.1529, 25.1529, 27.1529, 29.1529, 33.4, and 35.4. These documents must be in the English language.

(ii) The applicant should ensure that the appropriate markings are present in accordance with FAR Part 45. The applicant should make available the Type Certificate Data Sheets (TCDS), aircraft specification, or aircraft listing that is applicable.

(iii) The inspection records and technical data should reflect that the aircraft conforms to the type design, and all required inspections, including those provided for in FAR Section 21.183(d)(2), which provides for a 100-hour inspection, as described in FAR Section 43.15 and Appendix D. The applicant must also show that the tests the aircraft has been subjected to have been satisfactorily completed, the records completed, and reflect no unapproved design changes.

(iv) The aircraft has been flight tested, if required. If it has not been flight tested, the FAA may issue a special airworthiness certificate as provided for in FAR Sections 21.35 and 21.191(b). The flight test must be recorded in the aircraft records in accordance with FAR Section 91.417(a)(2)(i) as time in service as defined in FAR Part 1. Aircraft assembled by a person other than the manufacturer (e.g., a dealer or distributor) must have been assembled and, when applicable, flight tested in accordance with the manufacturer's FAA-approved procedures.

(v) Large airplanes, turbojet, or turbopropeller multiengined airplanes must comply with the inspection program requirements of Subpart C of FAR Part 91 or other FAR referenced therein. A supplemental structural inspection program is also required for certain large transport category airplanes. Reference AC 91-56, Supplemental Structural Inspection Program for Large Transport Category Airplanes.

(6) Inspection of the aircraft. Aircraft submitted by the applicant for inspection will be inspected for the following:

(i) The nationality and registration marks and identification plate should be displayed and marked in accordance with FAR Part 45. The information presented should agree with the application for airworthiness certification.

(ii) All equipment, both required and optional, should be properly installed and listed in the aircraft equipment list.

(iii) Instruments and placards should be located in the appropriate places, installed, and properly marked in the English language.

(iv) All applicable AD's must have been complied with and appropriately recorded.

(v) The aircraft should conform to its approved U.S. type certificate and should be in a condition for safe operation.

(vi) All aircraft systems should have been satisfactorily checked for proper operation. The operation of the engine(s) and propeller(s) should be checked in accordance with the aircraft manufacturer's instructions.

CHAPTER 3. APPLYING FOR AN EXEMPTION.

6. ADMINISTRATOR'S EXEMPTION AUTHORITY.

a. In General. The FAA Administrator has the authority to grant exemptions, provided certain requirements are met, to units of government for operations that do not have public aircraft status. The Independent Safety Board Act Amendments of 1994, Pub. L. 103-411, provide, in pertinent part:

(1) AUTHORITY TO GRANT STATUTORY EXEMPTIONS.

(i) IN GENERAL. The Administrator of the Federal Aviation Administration may grant an exemption to any unit of Federal, State, or local government from any requirement of part A of subtitle VII of title 49, United States Code, that would otherwise be applicable to current or future aircraft of such unit of government as a result of the amendment made by subsection (a) of this section (the revised "public aircraft" definition).

Note: The above provision authorizes exemptions from the United States Code--specifically, the Federal Aviation Act of 1958, as amended and recodified--rather than from the regulations. The above provision authorizes such exemptions only for operations whose status has changed as a result of the revised definition of public aircraft. This authorization does not apply to operations conducted for commercial purposes, in as much as they were considered civil aircraft operations under both the original and revised definitions.

b. Statutory Requirements. The statute provides as follows:

(1) The Administrator may grant an exemption [to a unit of government] ... only if--

(i) the Administrator finds that granting the exemption is necessary to prevent an undue economic burden on the unit of government and

(ii) the Administrator certifies that the aviation safety program of the unit of government is effective and appropriate to ensure safe operations of the type of aircraft operated by the unit of government.

Independent Safety Board Act Amendments of 1994, Section (b)(2), Pub. L. 103-411 (emphasis added).

c. Delegation of Authority. In the interest of administrative efficiency, the Administrator's authority to grant exemptions to units of government has been delegated to the Director, Flight Standards Service, and the Director, Aircraft Certification Service. FAR Section 11.25(b)(6).

7. KEY STATUTORY TERMS.

a. "The Administrator Finds ... and ... Certifies." This language indicates that the Administrator, or his or her delegate, is to make an independent determination as to whether the statutory requirements for granting an exemption have been met. This is in contrast to an earlier portion of the statute in which the unit of government rather than the Administrator makes the required certifications (that the operation was necessary to respond to a significant and imminent threat, and that no private operator was reasonably available to meet the threat).

b. "Undue Economic Burden." One finding that the Administrator or his or her delegate must make before granting an exemption is that the exemption is necessary to prevent an undue economic burden on the unit of government. "Undue economic burden" means that it would cost substantially more to comply with FAA regulations than with "an aviation safety program that is effective and appropriate to ensure safe operations of the type of aircraft operated by the unit of government" under the statute's exemption provision. To show "substantial additional costs," a petitioner for exemption should submit information that will allow the FAA to compare the cost of operating in compliance with Part A of Subtitle VII of Title 49 of the United States Code with comparable costs if an exemption were granted.

c. "Aviation Safety Program." The Administrator or the Administrator's delegate may not grant an exemption to a unit of government without certifying that the aviation safety program of the unit of government is "effective and appropriate to ensure safe operations of the type of aircraft operated by the unit of government." As a result, in the petition for an exemption, the petitioner must show to the Administrator's satisfaction that the petitioner's aviation safety program is effective and appropriate to ensure safe operations of the type of aircraft operated by the petitioner. Example: A unit of government applies for an exemption on an aircraft whose wings were modified to carry external pods for various surveillance activities. In its proposed aviation safety program, the unit of government would need to identify how the continued airworthiness of the modification will be accomplished. At minimum, the following may be required: a special structural inspection at the wing attach points, additional training for pilots operating the aircraft during pod installations, and flight manual changes to reflect any new operating limitations that may be necessary due to the modifications.

d. Aircraft with No Previous FAA Type Certification. It may be difficult for units of government to show that, for aircraft having no previous FAA type certification, e.g., military surplus aircraft, they have "an aviation safety program that is effective and appropriate to ensure safe operations of the type of aircraft operated by the unit of government." In order to make the "effective and appropriate aviation safety program" finding, the FAA must be assured that the safety of the aircraft in question is comparable to that provided by the FAR. Aircraft that have no history of civil certification often present significant "unknowns" when it comes to such critical safety matters as life-limited parts and aircraft design. Thus, such aircraft often do not have the basis on which to build an aviation safety program that is effective and appropriate to ensure safe operations. A unit of government developing a proposal for an aviation safety program may find the information below helpful:

(1) Generally. Subpart E of FAR Part 91 prescribes the rules governing the maintenance, preventative maintenance, and alterations of U.S.-registered aircraft civil aircraft operating within and outside the United States. FAR Section 91.403 states that the owner or operator of an aircraft is primarily responsible for maintaining that aircraft in an airworthy condition, including compliance with FAR Part 39. FAR Part 39 describes the requirements for compliance to AD's issued by the FAA.

(2) Inspection Programs. Operators of large aircraft, turbojet multiengine airplanes, or turbopropeller powered multiengine airplanes, should select and use one of the four inspection program options outlined in FAR Sections 91.409(e) and (f).

(i) For one of the four inspection program options, that identified in FAR Section 91.409(f)(4), the inspection program submitted should be compared with the manufacturer's recommended program. Where there is no manufacturer's program, a time-tested program should be utilized. The program developed must provide a level of safety equivalent to or greater than that provided by the other inspection options identified in FAR Section 91.409(f).

(ii) For the other three inspection options outlined in FAR Sections 91.409(e) and (f), the basis for the development of the inspection program or the instructions for continued airworthiness, including the detail of the parts and areas of the airplane to be inspected, is the manufacturer's recommendations. In the case of surplus military aircraft, the manufacturers provide this basic information to the specific military service that has contracted for the airplane. The military service then develops a reliability-centered maintenance program to meet its needs and environment which are often comparable to the continuous airworthiness maintenance programs developed by air carriers.

(iii) In many cases, manufacturers may be unwilling or unable to provide instructions for continued airworthiness for operation of the airplane in other than a military environment. Therefore, in keeping with existing policy as provided by the FAA, the only reasonable basis that for detailing the inspection criteria for the aircraft to be inspected, as required by FAR Section 91.409(g)(1), is the scope and detail developed by the applicable military service.

(iv) In addition to the "field" level inspection requirements set forth in the military maintenance program, the "depot" level inspection requirements should also be included in any inspection program approved under FAR Section 91.409(f)(4). The military "field" level maintenance is roughly equivalent to the civil terminology that air carriers use to describe "A, B or C" checks. The military "depot" level maintenance is comparable to the "heavy C or D" checks used by air carriers. Some air carriers may use a numerical description verses the alphabetical identifier for inspection checks.

(v) The inspection frequency and program structure established by the military may not be appropriate for use in a civilian environment. Therefore, inspection frequency and program structure may require adjustment to meet the government operator's requirement. However, facts and sound judgment must form the basis for any inspection frequency adjustment beyond that which has been established for use by the military.

(vi) An alternate means of compliance for individual specific inspection requirements, in lieu of that which is called for in the military "field" or "depot" level programs, may be approved following evaluation of the applicant's inspection process instructions.

(vii) Revisions to an operator's existing approved inspection program can be requested by the Administrator in accordance with FAR Section 91.415.

(3) Persons Conducting Inspections and Maintenance. The program proposed by the petitioner should include procedures to insure that inspections and maintenance tasks are performed by persons authorized by FAR Sections 43.5 and 43.7.

(4) Modifications and Repairs. The program must identify all major modifications and repairs accomplished since the aircraft was put into service. Additionally, all further modifications and major repairs will need to be approved in the same format as required for civil aircraft under the regulations.

8. PETITION FOR EXEMPTION.

a. Procedure. FAR Section 11.25--contains the procedures to be followed by a unit of government seeking any kind of exemption. The petition for exemption should be submitted in duplicate to the Rules Docket (AGC-10), Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591. Under FAR Part 11, petitions for exemption are published in the Federal Register for notice and comment period.

b. Contents. The petition for statutory exemption must set forth the text or substance of the statute from which the exemption is sought. (As noted above, Congress authorized exemptions from the *statute*--the Federal Aviation Act of 1958, as amended and recodified--rather than from the *regulations*). The petition for exemption must contain any information, views, or analysis available to the petitioner to show that the statutory requirements for granting an exemption have been met--i.e.:

(1) that the exemption is necessary to prevent an undue economic burden on the unit of government; and

(2) that the aviation safety program of the unit of government is effective and appropriate to ensure safe operations of the type of aircraft operated by the unit of government. Individuals drafting a petition for exemption on behalf of a unit of government should familiarize themselves with FAR Part 11.

U.S. Department
of Transportation
**Federal Aviation
Administration**

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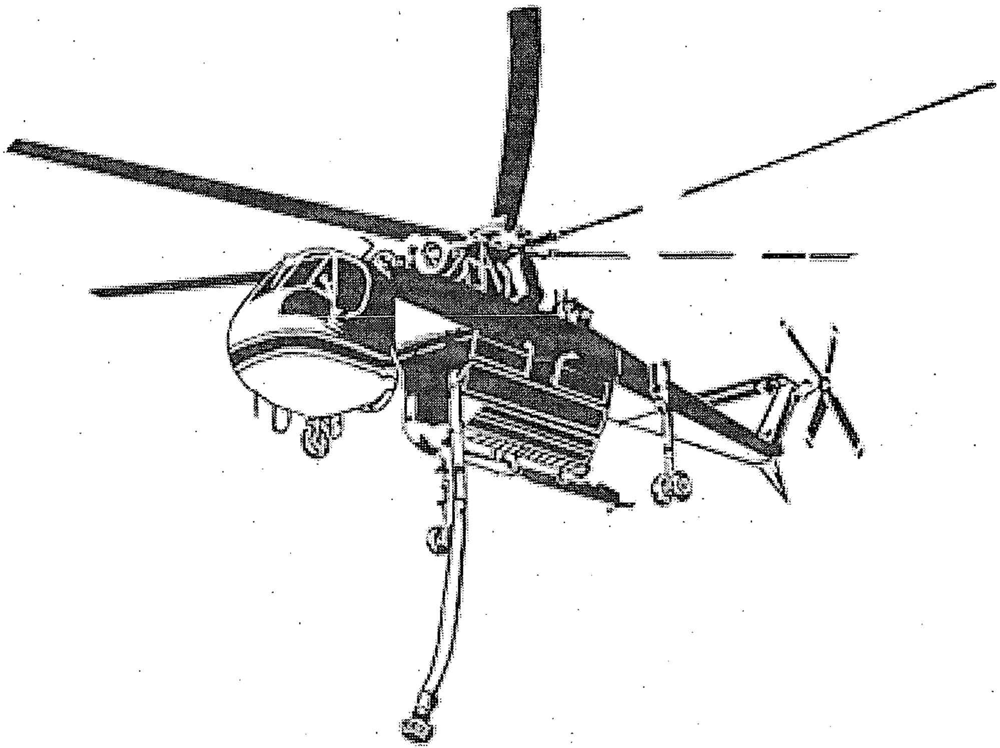

Interagency Helicopter Operations Guide

NFES 1885

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CHAPTER 15: HELIBASE AND HELISPOT MANAGEMENT AND OPERATIONS.

I. Introduction.

To achieve the maximum degree of safety and efficiency in helispot and helibase operations, personnel must be able to anticipate current and future needs, plan effectively to meet those needs, supervise and monitor the operation, and take timely corrective action in response to problems encountered.

Most of the preceding sections of the Interagency Helicopter Operations Guide discuss specific methods, procedures, and tasks which, if performed safely and effectively, will contribute to the success of helibase and helispot operations.

Helibase complexity can range from a simple, single-helicopter operation to a complex multiple-helicopter one, with as many as 10-20 aircraft working from an airport or large field. Helispot complexity can range from a location with limited use to a location servicing considerable personnel and/or cargo transport missions.

IMPORTANT NOTE: The questions are often asked, "When does an unimproved landing site become a helispot, and when does a helispot become a helibase?"

An unimproved landing site becomes a helispot when it will be utilized on a recurring basis for the purposes of transporting personnel and/or cargo to or from the site. It should then be managed, improved to the extent necessary, and supplied with the equipment outlined in Chapter 8.

To determine when a helispot should be managed as a helibase, use the following criteria:

For incidents, a landing site should have required helibase management and controls implemented (helibase positions filled, completion of checklists and mandatory forms, etc.) when two or more helicopters are assigned to or based at the location for more than one day. Prudent management and safety concerns should naturally dictate that when several helicopters arrive at a helibase on the first day, helibase management procedures and requirements should be initiated.

For projects, a landing site should have required helibase management and controls implemented when two or more helicopters are assigned to that location, regardless of the length of the project.

These criteria are for the purpose of determining when a higher level of management and control should be exercised, and are separate from the physical attributes that define a helibase (for example, road access, etc.)

The 8:1 slope limit measured from the edge of the safety circle, may be used as a guideline for obstruction removal when the terrain is relatively flat and level.

EXAMPLE: Approximately 8' Elevation Rise x 100' Length = 8:1 Slope

Chart 8-1: Specifications For Planning And Constructing Helispots[3]

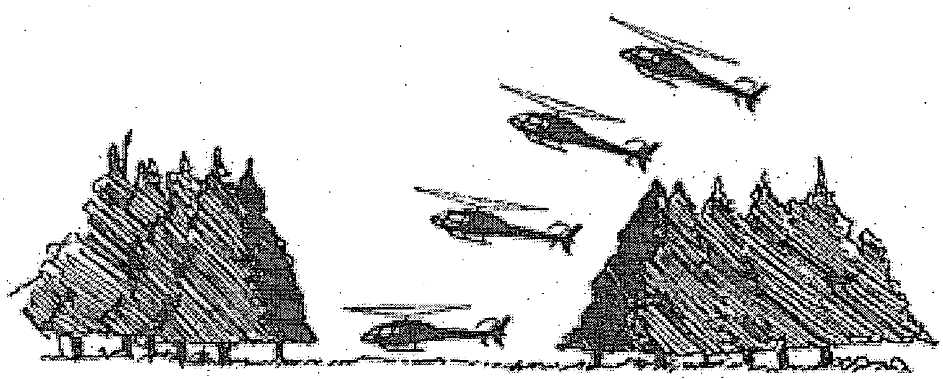
Type	1	2	3
Touchdown Pad Dimension	30' x 30'	20' x 20'	15' x 15'
Safety Circle Diameter	110'	90'	75'

4. Approach-Departure Path. (See Exhibits 8-1 and 8-2.) Site selection should provide for approaches and departures in several directions. If the site is not located on a ridge top, an approach-departure path aligned with the prevailing wind should be constructed. If possible, avoid one-way helispots, although these landing sites are not inherently unsafe provided correct piloting techniques are followed.

   a. Wind Direction. Always attempt to locate landing areas so that takeoffs and landings may be made into the prevailing winds.

   b. Almost-Vertical (Full Performance) Approaches and Takeoffs. (See Exhibit 8-6.) Almost-vertical approaches and departures are not inherently unsafe, but should be avoided if possible, especially on an extended-use basis. Remember that most small helicopters must be at approximately 400' AGL at zero airspeed to execute a safe autorotation in the event of engine failure.

Exhibit 8-6: Full Performance Takeoff/Landing



   c. Minimum Width. An adequate minimum width for an approach-departure path is the diameter of the safety circle. Construction starts at the edge of the safety circle and extends in the takeoff direction far enough to permit normal no-wind takeoffs for the expected density altitudes. Safety is increased if the paths can be widened as they leave the circle.

[3] See Chart 6-1 in Chapter 6 for performance and seating specifications for Types 1-3 helicopters.

1. **Hand Construction.** Hand construction methods are best since there is less ground disturbance than that created by mechanized construction. There are measures which can be implemented during construction of a helibase or helispot that will lessen the workload during rehabilitation, and help ensure that the objective of restoration to as close to a natural state as possible is achieved. These include:

   - Cut trees or snags close to the ground, leaving stump heights of 0-3 inches. (It is recognized that this may not always be possible during initial construction; follow up flush cutting will be necessary.)

   - If possible, and only if it can be performed safely, fell trees or other vegetation so that some cut trees and snags will be in a crisscrossed or natural appearing arrangement.

   - Buck up only what is necessary to achieve a safe operation in and around the touchdown pad and in the approach-departure path(s). Excessive bucked-up pieces are unnatural. They also increase the workload of camouflaging cutfaces during helispot rehabilitation.

   - Limb only what is necessary to achieve a safe operation in and around the touchdown pad and in the approach-departure path(s). If possible, breaking of limbs is preferred to sawing. Excessive limbing results in additional, smooth-cut spots along the boles. It also creates an increased amount of limbs to either dispose of in the timbered area or to arrange in a fashion that resembles a natural ecosystem floor.

2. **Mechanized Construction.** Basic requirements are the same as those for hand construction. If large rocks are dislodged, they should be removed and placed in an area where they appear to be natural. Hand work is frequently necessary to cut the fringe of brush left by bulldozers. Dozer-constructed landing areas generally have soil that is disturbed, requiring dust abatement procedures. Unless absolutely necessary, mechanized construction or improvement is to be avoided.

C. General Locations For Helispots and Unimproved Landing Site.

1. **Ridge tops.** (See Exhibit 8-1.) An exposed knob on a ridge offers the best location, especially if approach/departure is available from all or several directions. Consider the following:

   - Minimum approach/departure path should be no less than the required safety circle.

   - Avoid cutting timber keyhole helispots visible from scenic roads, towns, scenic rivers etc.

   - Clear brush and trees below the level of the landing area. Jumbled brush and limbs tend to dissipate the ground-effect cushion, resulting in an abrupt transition to out-of-ground-effect flight.

1. **Accommodation for Different Helicopter Types (Sizes).** All permanent facilities should, at a minimum, be built to accommodate one Type 2 (medium) helicopter.

2. **Planning and Construction Specifications.** The planning and construction of permanent helibases shall be according to agency-specific and/or FAA policy and specifications, as well as applicable local, state, and federal regulations.

> NOTE: Agency guidance usually incorporates FAA standards. It is local and state policy and procedures that are usually of concern.

B. Temporary Helibases and Helispots.
Helibase or helispot construction, especially in wilderness or similar sensitive areas, can cause a double impact -- the impact of an abrupt or an unnatural-appearing opening in a vegetation-covered landscape, and the impact resulting from cut-faces of stumps and boles of trees or shrubs.

> IMPORTANT NOTE: Remember that safety shall not be compromised. The area should not be considered as a landing site if it cannot be built to safe standards, or negative environmental impacts cannot be mitigated. Minimum Impact Suppression Technique (MIST) guidelines may be established and should be reviewed prior to wilderness or sensitive area construction.

The following issues should be addressed and actions performed during the planning stage for helibases and helispots.

1. **Initial Planning Actions at an Incident or Project.** Project helibases and helispots can be adequately planned well in advance of the project start. Incident helibases and helispots, on the other hand, are established and become operational in a very short time frame. The rapidity of incident response does not, however, relieve the Helibase or Helispot Manager from performing basic planning actions.

   - Upon arrival, the Helibase Manager should gather intelligence by obtaining maps from the dispatch office, talking to local inhabitants, flying a reconnaissance, etc.

   - Check with the local Resource Advisor to ensure that the sites for the helibase(s) and helispots are acceptable from an environmental standpoint. Factors to consider include but are not limited to:

     - Impact of construction and aerial activity on threatened and endangered species or on wilderness or similar values;

     - Hazardous materials (fuel) handling.

   - The Helibase Manager should reference Appendix H, Helibase Manager's Reminders List, Section I (Helibase Site Selection and Layout) and Section II (Helispot Site Selection and Layout) for factors to consider. These sections include one-time items for both the Helibase Manager and Helispot Manager

E. Fire Extinguisher.
A fire extinguisher meeting the requirements of the procurement document shall be installed in the helicopter.

VI. Crash-Rescue Equipment for Helicopter Landing Sites.

The following requirements apply to helicopter landing sites on incidents or projects. Consult Appendix K for ordering information. Chapter 12 contains additional crash-rescue information and discussion.

A. Requirements for Fire Extinguishers, Evacuation Kits, and Crash-Rescue Kits at Helicopter Landing Sites.

Personnel must be trained and briefed in the use of crash-rescue equipment. Chart 9-7 specifies required numbers and types for helibases (for Helispot requirements, see Chart 9-2). There is no extinguisher requirement for an unimproved landing site unless the site is used on a recurring basis.

Chart 9-7: Extinguisher, Crash-Rescue, and Evacuation Kit Requirements for Helibases

No. Of Helicopters	Number And Type Extinguishers	No. Of Crash-rescue Kits	No. Of Evacuation Kits
1-4	1 20-pound 40-B:C Extinguisher per landing pad	1	1
5-10	1 20-pound 40-B:C Extinguisher per landing pad	2	2
11 +	1 20-pound 40-B:C Extinguisher per landing pad	1 Kit per every 5 helicopters	1 Kit per every 5 helicopters

D.7 Tables:

Table 1 -SkyConnect data (Page 1)

registration	longitude	latitude	speed	heading	altitude	fix	PDOP	HDOP	UTC	local	usageType	source
N612AZ	-123.2748	40.78867	87	53	3294	3D	1	1	2008-08-05 21:39:08.000	2008-08-05 14:39:08.000	0	SkyConnect
N612AZ	-123.2262	40.81933	80	42	5453	3D	1	1	2008-08-05 21:41:19.000	2008-08-05 14:41:19.000	0	SkyConnect
N612AZ	-123.217	40.8475	29	25	4039	3D	2	1	2008-08-05 21:43:25.000	2008-08-05 14:43:25.000	0	SkyConnect
N612AZ	-123.233	40.81617	103	209	5207	3D	1	1	2008-08-05 21:45:38.000	2008-08-05 14:45:38.000	0	SkyConnect
N612AZ	-123.3002	40.774	103	230	1706	3D	2	1	2008-08-05 21:47:44.000	2008-08-05 14:47:44.000	0	SkyConnect
N612AZ	-123.3227	40.776	4	51	1132	3D	3	2	2008-08-05 21:49:52.000	2008-08-05 14:49:52.000	0	SkyConnect
N612AZ	-123.3003	40.7745	68	63	2195	3D	1	1	2008-08-05 21:51:58.000	2008-08-05 14:51:58.000	0	SkyConnect
N612AZ	-123.253	40.79867	80	74	4190	3D	1	1	2008-08-05 21:54:04.000	2008-08-05 14:54:04.000	0	SkyConnect
N612AZ	-123.2145	40.83133	35	16	5564	3D	1	1	2008-08-05 21:56:17.000	2008-08-05 14:56:17.000	0	SkyConnect
N612AZ	-123.2223	40.85083	64	194	4423	3D	2	1	2008-08-05 21:58:23.000	2008-08-05 14:58:23.000	0	SkyConnect
N612AZ	-123.175	40.81883	101	109	5449	3D	1	1	2008-08-05 22:00:29.000	2008-08-05 15:00:29.000	0	SkyConnect
N612AZ	-123.0955	40.802	115	108	4869	3D	1	1	2008-08-05 22:02:37.000	2008-08-05 15:02:37.000	0	SkyConnect
N612AZ	-123.0245	40.77983	107	103	4856	3D	1	1	2008-08-05 22:04:48.000	2008-08-05 15:04:48.000	0	SkyConnect
N612AZ	-122.9465	40.78133	109	69	4511	3D	1	1	2008-08-05 22:06:54.000	2008-08-05 15:06:54.000	0	SkyConnect
N612AZ	-122.8693	40.78817	101	87	3668	3D	1	1	2008-08-05 22:09:00.000	2008-08-05 15:09:00.000	0	SkyConnect
N612AZ	-122.8088	40.7885	39	127	3501	3D	1	1	2008-08-05 22:11:09.000	2008-08-05 15:11:09.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	58	3278	3D	1	1	2008-08-05 22:13:02.000	2008-08-05 15:13:02.000	0	SkyConnect
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N612AZ	-122.8043	40.787	0	0	3278	3D	2	1	2008-08-06 00:00:08.000	2008-08-05 17:00:08.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	0	3271	3D	2	1	2008-08-06 00:02:14.000	2008-08-05 17:02:14.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	0	3284	3D	2	1	2008-08-06 00:04:20.000	2008-08-05 17:04:20.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	0	3274	3D	1	1	2008-08-06 00:06:27.000	2008-08-05 17:06:27.000	0	SkyConnect
N612AZ	-122.7973	40.78467	80	131	3323	3D	2	1	2008-08-06 00:08:08.000	2008-08-05 17:08:08.000	0	SkyConnect
N612AZ	-122.865	40.77234	119	279	3940	3D	2	1	2008-08-06 00:10:17.000	2008-08-05 17:10:17.000	0	SkyConnect
N612AZ	-122.9548	40.78267	115	273	5259	3D	2	1	2008-08-06 00:12:25.000	2008-08-05 17:12:25.000	0	SkyConnect
N612AZ	-123.047	40.8	122	299	5673	3D	2	1	2008-08-06 00:14:35.000	2008-08-05 17:14:35.000	0	SkyConnect
N612AZ	-123.1248	40.84133	117	309	5020	3D	2	1	2008-08-06 00:16:43.000	2008-08-05 17:16:43.000	0	SkyConnect
N612AZ	-123.1945	40.8815	111	305	6637	3D	2	1	2008-08-06 00:18:51.000	2008-08-05 17:18:51.000	0	SkyConnect
N612AZ	-123.254	40.909	87	77	6227	3D	2	1	2008-08-06 00:21:03.000	2008-08-05 17:21:03.000	0	SkyConnect
N612AZ	-123.2493	40.91667	78	337	6266	3D	2	1	2008-08-06 00:23:12.000	2008-08-05 17:23:12.000	0	SkyConnect
N612AZ	-123.2548	40.915	2	155	6158	3D	2	1	2008-08-06 00:25:24.000	2008-08-05 17:25:24.000	0	SkyConnect
N612AZ	-123.2213	40.85833	97	168	6138	3D	1	1	2008-08-06 00:27:39.000	2008-08-05 17:27:39.000	0	SkyConnect
N612AZ	-123.2117	40.82767	111	179	5551	3D	1	1	2008-08-06 00:29:49.000	2008-08-05 17:29:49.000	0	SkyConnect
N612AZ	-123.2245	40.76667	101	201	2949	3D	2	1	2008-08-06 00:31:55.000	2008-08-05 17:31:55.000	0	SkyConnect
registration	longitude	latitude	speed	heading	altitude	fix	PDOP	HDOP	UTC	local	usageType	source
N612AZ	-123.2417	40.70667	93	196	3757	3D	2	1	2008-08-06 00:34:19.000	2008-08-05 17:34:19.000	0	SkyConnect
N612AZ	-123.2692	40.66283	87	355	4767	3D	2	1	2008-08-06 00:36:25.000	2008-08-05 17:36:25.000	0	SkyConnect
N612AZ	-123.2492	40.71367	109	1	3829	3D	2	1	2008-08-06 00:38:31.000	2008-08-05 17:38:31.000	0	SkyConnect
N612AZ	-123.2615	40.7375	72	302	2037	3D	2	1	2008-08-06 00:40:37.000	2008-08-05 17:40:37.000	0	SkyConnect
N612AZ	-123.2663	40.73367	8	129	2057	3D	2	1	2008-08-06 00:42:47.000	2008-08-05 17:42:47.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	6	1585	3D	2	1	2008-08-06 00:44:53.000	2008-08-05 17:44:53.000	0	SkyConnect
N612AZ	-123.2607	40.733	0	6	1581	3D	2	1	2008-08-06 00:45:31.000	2008-08-05 17:45:31.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	6	1578	3D	2	1	2008-08-06 00:47:41.000	2008-08-05 17:47:41.000	0	SkyConnect
N612AZ	-123.2607	40.733	0	6	1585	3D	2	1	2008-08-06 00:49:51.000	2008-08-05 17:49:51.000	0	SkyConnect
N612AZ	-123.2637	40.736	70	319	1683	3D	2	1	2008-08-06 00:51:57.000	2008-08-05 17:51:57.000	0	SkyConnect
N612AZ	-123.2658	40.73817	87	319	1713	3D	1	1	2008-08-06 00:52:04.000	2008-08-05 17:52:04.000	0	SkyConnect
N612AZ	-123.2965	40.79417	111	334	3576	3D	2	1	2008-08-06 00:54:10.000	2008-08-05 17:54:10.000	0	SkyConnect
N612AZ	-123.2937	40.85783	117	17	5410	3D	2	1	2008-08-06 00:56:16.000	2008-08-05 17:56:16.000	0	SkyConnect
N612AZ	-123.265	40.91117	80	55	6256	3D	2	1	2008-08-06 00:58:28.000	2008-08-05 17:58:28.000	0	SkyConnect
N612AZ	-123.2498	40.912	58	117	6069	3D	2	1	2008-08-06 01:00:34.000	2008-08-05 18:00:34.000	0	SkyConnect
N612AZ	-123.2548	40.9165	37	180	6129	3D	2	1	2008-08-06 01:02:40.000	2008-08-05 18:02:40.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	65	5942	3D	2	1	2008-08-06 01:04:17.000	2008-08-05 18:04:17.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	65	5961	3D	2	1	2008-08-06 01:06:25.000	2008-08-05 18:06:25.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	65	5974	3D	2	1	2008-08-06 01:08:31.000	2008-08-05 18:08:31.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	65	5935	3D	2	1	2008-08-06 01:10:41.000	2008-08-05 18:10:41.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	65	5948	3D	2	1	2008-08-06 01:12:49.000	2008-08-05 18:12:49.000	0	SkyConnect
N612AZ	-123.2522	40.91383	10	185	5991	3D	2	1	2008-08-06 01:14:55.000	2008-08-05 18:14:55.000	0	SkyConnect
N612AZ	-123.2445	40.91217	86	85	6129	3D	2	1	2008-08-06 01:15:25.000	2008-08-05 18:15:25.000	0	SkyConnect
N612AZ	-123.2742	40.8945	107	260	6256	3D	2	1	2008-08-06 01:17:38.000	2008-08-05 18:17:38.000	0	SkyConnect
N612AZ	-123.3262	40.84983	117	192	5246	3D	2	1	2008-08-06 01:19:44.000	2008-08-05 18:19:44.000	0	SkyConnect
N612AZ	-123.294	40.78	122	151	2818	3D	2	1	2008-08-06 01:21:50.000	2008-08-05 18:21:50.000	0	SkyConnect
N612AZ	-123.2577	40.73267	37	262	1742	3D	3	1	2008-08-06 01:23:56.000	2008-08-05 18:23:56.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	308	1565	3D	3	1	2008-08-06 01:25:18.000	2008-08-05 18:25:18.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	308	1562	3D	3	1	2008-08-06 01:27:26.000	2008-08-05 18:27:26.000	0	SkyConnect
N612AZ	-123.2662	40.73817	91	318	1722	3D	3	1	2008-08-06 01:29:32.000	2008-08-05 18:29:32.000	0	SkyConnect
N612AZ	-123.2957	40.79716	121	337	3556	3D	3	1	2008-08-06 01:31:43.000	2008-08-05 18:31:43.000	0	SkyConnect
N612AZ	-123.2847	40.86717	121	22	5308	3D	3	1	2008-08-06 01:33:54.000	2008-08-05 18:33:54.000	0	SkyConnect
N612AZ	-123.2533	40.915	29	135	6053	3D	3	1	2008-08-06 01:36:03.000	2008-08-05 18:36:03.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	58	5948	3D	3	1	2008-08-06 01:37:13.000	2008-08-05 18:37:13.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	58	5951	3D	3	1	2008-08-06 01:39:22.000	2008-08-05 18:39:22.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	58	5978	3D	3	2	2008-08-06 01:41:36.000	2008-08-05 18:41:36.000	0	SkyConnect
N612AZ	-123.2518	40.90633	119	182	5627	3D	3	1	2008-08-06 01:43:11.000	2008-08-05 18:43:11.000	0	SkyConnect

Table 1, SkyConnect data (Page 2)

registration	longitude	latitude	speed	heading	altitude	fix	PDOP	HDOP	UTC	local	usageType	source
N612AZ	-123.281	40.83283	132	203	3734	3D	3	1	2008-08-06 01:45:24.000	2008-08-05 18:45:24.000	0	SkyConnect
N612AZ	-123.2813	40.7605	122	152	2411	3D	3	1	2008-08-06 01:47:33.000	2008-08-05 18:47:33.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	325	1585	3D	3	1	2008-08-06 01:49:42.000	2008-08-05 18:49:42.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	325	1588	3D	3	1	2008-08-06 01:50:08.000	2008-08-05 18:50:08.000	0	SkyConnect
N612AZ	-123.2607	40.73317	0	325	1565	3D	3	1	2008-08-06 01:52:18.000	2008-08-05 18:52:18.000	0	SkyConnect
N612AZ	-123.254	40.736	103	86	1739	3D	3	1	2008-08-06 01:54:23.000	2008-08-05 18:54:23.000	0	SkyConnect
N612AZ	-123.1622	40.756	134	69	3337	3D	2	1	2008-08-06 01:56:31.000	2008-08-05 18:56:31.000	0	SkyConnect
N612AZ	-123.069	40.77133	117	84	3802	3D	2	1	2008-08-06 01:58:38.000	2008-08-05 18:58:38.000	0	SkyConnect
N612AZ	-122.9773	40.7785	121	81	4764	3D	2	1	2008-08-06 02:00:47.000	2008-08-05 19:00:47.000	0	SkyConnect
N612AZ	-122.8828	40.78567	121	84	3773	3D	2	1	2008-08-06 02:02:53.000	2008-08-05 19:02:53.000	0	SkyConnect
N612AZ	-122.8053	40.78717	29	121	3356	3D	2	1	2008-08-06 02:05:00.000	2008-08-05 19:05:00.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	98	3274	3D	2	1	2008-08-06 02:06:11.000	2008-08-05 19:06:11.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	98	3274	3D	2	1	2008-08-06 02:08:17.000	2008-08-05 19:08:17.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	98	3278	3D	2	1	2008-08-06 02:10:23.000	2008-08-05 19:10:23.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	98	3284	3D	3	1	2008-08-06 02:12:36.000	2008-08-05 19:12:36.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	98	3287	3D	2	1	2008-08-06 02:14:42.000	2008-08-05 19:14:42.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	0	3294	3D	3	1	2008-08-06 02:19:04.000	2008-08-05 19:19:04.000	0	SkyConnect
N612AZ	-122.8043	40.787	0	0	3284	3D	3	2	2008-08-06 02:21:14.000	2008-08-05 19:21:14.000	0	SkyConnect
N612AZ	-122.804	40.78183	76	213	3524	3D	2	1	2008-08-06 02:23:20.000	2008-08-05 19:23:20.000	0	SkyConnect
N612AZ	-122.9578	40.809	115	297	6148	3D	2	1	2008-08-06 02:26:59.000	2008-08-05 19:26:59.000	0	SkyConnect
N612AZ	-123.0508	40.84167	134	292	5469	3D	1	1	2008-08-06 02:29:11.000	2008-08-05 19:29:11.000	0	SkyConnect
N612AZ	-123.142	40.87717	119	289	4423	3D	2	1	2008-08-06 02:31:20.000	2008-08-05 19:31:20.000	0	SkyConnect
N612AZ	-123.2233	40.901	122	322	6302	3D	2	1	2008-08-06 02:33:26.000	2008-08-05 19:33:26.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	138	5945	3D	2	1	2008-08-06 02:35:32.000	2008-08-05 19:35:32.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	138	5961	3D	2	1	2008-08-06 02:36:04.000	2008-08-05 19:36:04.000	0	SkyConnect
N612AZ	-123.2522	40.91417	0	138	5955	3D	2	1	2008-08-06 02:39:17.000	2008-08-05 19:39:17.000	0	SkyConnect
N612AZ	-123.2517	40.913	0	236	5928	3D	3	2	2008-08-06 02:41:25.000	2008-08-05 19:41:25.000	0	SkyConnect

Table 2 Speed Position Analysis and Comparison on 3-D Cam Servo:

	Columbia (Depth, Engine RPM, N_G)	**Hamilton Sundstrand** (Depth, Engine RPM, N_G)
FCU 1	Measurement depth[35]: = 0.725" N_G servo displacement: = 0.322" 2600 rpm--62% N_G	Measurement depth: 0.718 Depth at bottom: 0.960' Difference: 0.242" 2700 rpm = about 64% N_G
FCU 2	Measurement depth: = 0.900" N_G servo displacement: = 0.147 1900 rpm – 45% N_G	Measurement depth: 0.896 Depth at bottom: 0.958' Difference: 0.62" 1950 rpm = about 46% N_G (sub idle)
Delta	0.175"	0.178"

Note: According to a Hamilton Sundstrand representative, the position of the cam is not an indication of the final engine speed. Cam rest position can vary greatly.

[35] The measurement depth from the FCU housing to the 3-D Cam face (0.725 and 0.900 inches) is compared to a Columbia datum reference of 1.047 inches. The delta (0.322 and 0.147 inches) is the N_G servo displacement. Hamilton Sundstrand Overhaul Manual SEI-185, Figure 3-5, Gas Generator (N_G) Servo Calibration Curve, was then used to convert this displacement into a corresponding N_G -Control rpm.

...TER SERVICES, INC

828 Brookside Blvd.
Grants Pass, OR 97526
Bus: 800-344-7930
Fax: 541-955-9205

...WER CHECK	S/N	PRESS. ALT.	OAT	TQ	Ng	T5
...GINE						
...GINE						

DISCREPANCY	MAINTENANCE ACTION	RII / C
ITEM 1	MECHANIC SIGNATURE & NO.	DATE
SIGNATURE / DATE	INSPECTORS SIGNATURE & NO.	DATE
ITEM 2	MECHANIC SIGNATURE & NO.	RII / C / DATE
SIGNATURE / DATE	INSPECTORS SIGNATURE & NO.	DATE
ITEM 3	MECHANIC SIGNATURE & NO.	RII / C / DATE
SIGNATURE / DATE	INSPECTORS SIGNATURE & NO.	DATE
ITEM 4	MECHANIC SIGNATURE & NO.	
...URE / DATE	INSPECTORS SIGNATURE & NO.	

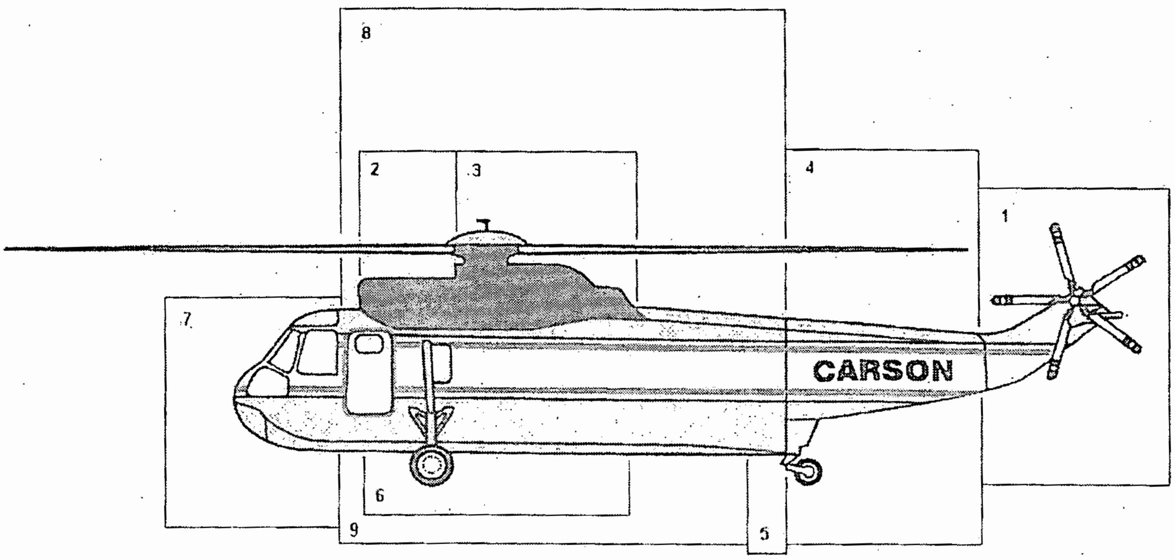
I certify that this aircraft has been inspected in accordance with a Carson Helicopter Services, Inc. Inspection Program, 135.411(a)(2), and that a PHASE 4 Par 1 Inspection has been accomplished and is approved for return to service. Next inspection due at Aircraft Total Time: 35414.7

	A/C T.T.	A.D.'s -- S.B.'s - ICA's	REMARKS	SIGNATURE AND CERT #
PERIOD ...ASE	A/C T.T.	AD 68-20-08 para B	Daily (see AD)	
		AD 78-12-05 para 4	Daily (see AD)	
		SB61B10-18	10hr (see SB)	
DUE		15 HR SAFETY INSP.	SEE INSP. PROG.	
		... Compressor Wash	I/A/W CT58 M.M.	
			SEE INSP. PROG.	

CARSON HELICOPTER SERVICES, INC.
CONTINUOUS AIRWORTHINESS INSPECTION PROGRAM
SIKORSKY S-61 MODEL AIRCRAFT

SIGN OFF FORM

PHASE IV
ZONE 7



ZONE	AREA
1	Pylon / Stabilizer
2	Power Plant
3	Rotor / Transmission
4	Tail Cone
5	Landing Gear
6	Fuel Cell Installation
7	Cockpit / Electronics
8	Cabin
9	Hull

A/C Reg. N 612AZ A/C T.T. 35384.7 Revision No. ________

SIGNATURE [redacted] CERT # IA AP [redacted] INITIALS TJO

SIGNATURE ________ CERT # ________ INITIALS ________

SIGNATURE ________ CERT # ________ INITIALS ________

CARSON HELICOPTER SERVICES, INC.
CONTINUOUS AIRWORTHINESS INSPECTION PROGRAM
SIKORSKY S-61 MODEL HELICOPTER

PHASE IV

ZONE 7
COCKPIT/ELECTRONICS

ATA 100 CHAP. NO.	ITEM	MECHANICS INITIALS	EVERY PERIOD	EVERY 2ND PERIOD	EVERY 8TH PERIOD	SPECIAL	FREQUENCY
31	INSTRUMENTS (CONT)						
	11. Fuel Quantity Indicator (2)	TJO	I		F		11. Calibration test at applicable inspection period.
	12. Fuel Pressure Indicator (2)	TJO	I				
	13. Engine oil Temp. Indicator (2)	TJO	I				
	14. Engine Oil Pressure Indicator (2)	TJO	I				
	15. Primary Hydraulic Pressure Indicator	TJO	I				
	16. Compass Power Failure Indicator	TJO	I				
	17. MGB Oil Temperature Indicator	TJO	I				
	18. Auxiliary Hydraulic Pressure Indicator	TJO	I				
	19. Master Warning Light	TJO N/A	I				
	20. Console Assembly	TJO	I				
	21. Master Warning Panel	TJO	I				
	22. #1 Auxiliary Warning Panel	TJO	I				
	23. #2 Auxiliary Warning Panel	TJO	I				
	24. Wiring and Connectors	TJO	I				
	25. Landing Gear Indicator	TJO	I				
	26. Free-Air Thermometer	TJO	I				
32	LANDING GEAR						
	1. Tailwheel Lock Control Handle	TJO	I				
	2. Cable	TJO	I				
	3. Pulleys and Brackets	TJO	I				
	4. Master Brake Cylinder (4)	TJO					
	5. Parking Brake Valve	TJO	F				
	6. Lines, Fittings, and Check Valves	TJO	I				
	7. Control Unit	N/A TJO	I				
	8. Landing Gear Relay(2)	N/A	I				
	9. Pump Motor Relay	N/A	I				
	10. Emergency Release Control Installation	N/A	I				

AIRCRAFT PERFORMANCE EVALUATION REPORT

Project:
PERFORMANCE EVALUATION TEST FLIGHT
VIH Cougar Helicopters SK-61 N // N 261F
Reno Stead Airport, Reno, NV 03 November 09

Prepared For:
CARSON HELICOPTERS, INC.
828 BROOKSIDE BLVD
GRANTS PASS, OR 97523

Prepared by:
Whipple Aviation Services, LLC
111 W. Main Street
Dayton, WA 99328
Tel: [redacted]
Cell: [redacted]

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Appendices (continued)

WHIPPLE AVIATION SERVICES, LLC
111 West Main St., Dayton, WA 99328
Tel.: [redacted] Fax: (509) 382-2380
Cell: [redacted]

Aviation Evaluation Report

Date: 03 November 09

Project

Name		Location
CARSON HELICOPTERS, INC. Performance Evaluation Test Flight		Reno Stead Airport Reno, NV
Average Pressure Altitude	Average D.A.	Average Centigrade Temperature
6,600 ft	8,550 ft	19 C

Aviation Contractor

Name	Home Office Address
VIH Cougar Helicopters Boise Air Terminal – Gowen Field	4700 West Aeronca Street Boise, ID 83705
Phone Number	Fax Number / E-mail
(208) 336-6651	(208) 336-6658 // larry.lippert@vih.com
President / General Manager	Vice President of Operations / Chief Pilot
Larry Kelly	Larry Kelly

Pilot(s)

Pilot Name	Total Helicopter Flight Time	Licenses Held	Total SK-61 Flt. Time
Jim Stone	22,000 hrs	CMOT/FAA ATP-Hel	8,500 hrs
Co-Pilot Name	Total Helicopter Flight Time	Licenses Held	Total SK-61 Flt Time
Tyler Hupp	5,500 hrs	CMOT/FAA ATP-Hel	1,000 hrs

Aircraft

Aircraft Make & Model	Optional Equipment	Aircraft Tail Number
SK-61 N	Fixed Landing Gear, Composite M/R Blades	N 261 F
Total Time On Air Frame	Total Time on Engines (TTSMOH)	Aircraft Empty Weight
26,191.7 hrs	#1 Eng = 285.9 hrs// #2 Eng = 415.5 hrs	12,198.2 lbs

GENERAL SYNOPSIS

The purpose of this flight test was to evaluate and document the flight performance capability of a Sikorsky S-61N helicopter equipped and configured like N612AZ under conditions similar to those experienced by N612AZ during the accident takeoff from Helispot 44 on the Iron Complex Fire on 5 August 08. If the flight conditions could not be replicated due to weather issues, any adjustments were made toward the more critical side of the flight envelope.

TEST FLIGHT PREPARATIONS

To set the stage for this project there were a number of issues that needed to be addressed in order to ensure accuracy in assessing the capabilities of an SK-61N set up similar to N612AZ. These issues are addressed below.

SK-61 N (# N261F) AIRCRAFT EQUIPMENT

Aircraft was equipped with the new (performance enhancing) Carson composite main rotor blades.

Aircraft was equipped with a new load cell for the cargo hook on 09 September 2009, aircraft total time 26,121.5 hrs, work order/Journey Log page # 00915. Load cell was calibrated successfully after installation.

Aircraft was equipped with "L model" fixed landing gear.

Aircraft was equipped with an adjustable load, 700-US gallon "Fast" water bucket with 200-foot long-line.

(See Appendices 3, 4, & 5)

WEIGHT & BALANCE

Aircraft N261F was defueled, emptied of contents, and rolled into the Tac-Air hangar at Reno-Stead airport for weighing.

Neptune Revere aircraft scales, serial # 5356A, last calibrated 9-28-09, were used to establish the current weight of the aircraft.

A calibrated level was used to ensure the aircraft was level (fore and aft and laterally) at each weighing.

Aircraft was weighed utilizing the three jack points (Left Main, Right Main & Aft), four different times following the procedure specified in the Carson Helicopters maintenance manual. Each scale (Red, Blue & Yellow) was moved one position clock-wise to a different jack-point for each different weighing. Load distribution devices were utilized between the jack lift points and the scale load cells.

The Carson Helicopters General Maintenance Manual recognized procedures and formulas were used to compute and average the individual weighing values to arrive at an aircraft weight of 12,198.3 lbs.

Equipped weight of both pilots was computed to be 385 lbs.

(See Appendices 2 & 6)

FUELING ISSUES

Aircraft was refueled after weighing from an airport FBO fuel truck with 469 gallons of Jet A (3189.2 lbs.).

MAINTENANCE ISSUES

D.A.R. David Swan did the necessary preparation and paperwork to certify the aircraft in the EXPERIMENTAL CATEGORY prior to the performance test flights.

Total time since major overhaul (TTSMOH) for the General Electric CT-58-140 turbine engines installed on N 261F were as follows: No. 1 engine = 285.9 hrs. // No. 2 engine = 415.5 hrs.

Aircraft was flown and both engine topping limits were adjusted to match the engine topping values of N612AZ as recorded on 8/4/08. These engine topping values were as follows: No. 1 engine = 101.8 Ng/ 708C T5 // No. 2 engine = 101.5 Ng / 709C T5.

PILOT ISSUES

The pilots for this project were experienced long-line pilots who were familiar with flying an SK-61 helicopter at high gross weight, relatively high density altitude, at little or no airspeed without "over-controlling" the aircraft. Over-controlling the aircraft in these conditions could hinder the aircraft's ability to operate efficiently and, thereby, compromise the ability to assess the true capabilities of the aircraft accurately. The left seat "flying pilot" was Tyler Hupp. The right seat "pilot not flying" was Jim Stone.

SAFETY ISSUES

Prior to starting the aircraft, the Command Pilot gave a thorough aircraft briefing to all aircraft occupants.

WEATHER INFORMATION ISSUES

The aircraft had three calibrated OAT gauges. Reno Stead AWOS was reporting 71F and, after converting to Centigrade, we found that two of the three OAT gauges were exactly accurate. Those two OAT gauges were the only ones used for DA computations.

There were 4 GPS units in the aircraft and the "0" ground speed indication on the Garmin 530 GPS was chosen to verify we were not moving over the ground while in our 400-foot AGL testing hovers.

The aircraft airspeed indicator and the "glassy calm" lake were used to cross-reference the wind speed/direction while in the testing hovers. During the entire testing period, the lake surface remained "glassy calm" which was desirable for flight-testing purposes.

PERFORMANCE FLIGHT TESTS

N261F was flown 1.5 hours (divided into two separate flights) to accomplish the desired testing. The first flight was used to adjust the engine topping values and to do a preliminary flight test to familiarize the pilots with the desired flight procedures and to confirm that they were comfortable with the helicopter's performance during the flight procedures before boarding the remaining flight evaluators. The second flight consisted of eight separate hover performance test maneuvers.

The area around Frenchman Lake was chosen to conduct the testing. The lake was an excellent indicator of wind direction and speed and a convenient source for filling the water bucket to adjust the aircraft weight, and the terrain surrounding the lake was very similar to the terrain surrounding Helispot 44 on the Iron Complex Fire.

FLIGHT NO. 1

After departing Reno Stead airport at 1510 hours, the engine topping adjustments were made in flight while the aircraft was enroute to the testing area over Frenchman Lake, elevation 5,588 MSL (mean sea level). As documented in the on-board technical observer's notes, the first performance testing/safety flight started at a stabilized OGE (out of ground effect) hover, 200 feet over Frenchman Lake while the lake surface was indicating glassy-calm wind conditions.

The aircraft had 2,800 lbs. of fuel, the two pilots' combined weight of 385 lbs., and the combined weight for one technical observer and one aircraft mechanic of 520 lbs. on board. With the aircraft weight of 12,198 lbs., the total aircraft weight was 15,903 lbs. Since the desired testing gross weight was 19,100 lbs., the "Fast" water bucket (on a 200-foot long-line attached to the load-cell equipped cargo hook) was lowered into the lake to fill the bucket. The bucket was then lifted vertically out of the water weighing approximately 4,300 lbs., measured on the load cell. At this point, the water level was adjusted by releasing some of the water until the bucket load of water weighed 3,200 lbs., giving the aircraft a total gross weight of 19,103 lbs.

Utilizing normal pilot inputs and techniques, a normal takeoff and climb was then initiated to climb from approximately 5,800 ft. MSL up the ridge line to the desired pressure altitude of 6,700 feet. The aircraft was then stabilized in a 400-foot OGE hover and the OAT (outside air temperature) was reconfirmed to be 19C. To figure the operating density altitude, the right seat three-pointer sensitive altimeter was adjusted so that it indicated 29.92 in the Kollsman window ensuring that the altimeter would indicate when the aircraft was at 6,700 ft. pressure altitude. The 6,700 ft. pressure altitude was corrected for the 19C OAT, utilizing both an electronic density altitude computer as well as a Jeppesen CSG-1A "Slide Graphic" ("whiz-wheel") flight computer, both of which computed a density altitude of 8,673 ft.

The aircraft was able to maintain 103% NR with 94% Tq while holding a stabilized OGE hover, at a density altitude of 8,673 ft, with little or no wind - all while weighing 19,103 lbs.

At this point, the collective pitch control was slowly and intentionally pulled UP to the control's TOP PHYSICAL STOP in order to bleed the NR down as far as it would go. Engine instruments indicated both engine topping limits were reached during this collective pull at: 101.8 Ng (compressor speed) / 710C T5 (turbine temperature) for the #1 engine and 101.5 Ng / 715C for the #2 engine. With the collective control at the top physical stop, the torques went up to 95% Tq #1 engine and 96% Tq #2 engine. The NR (main rotor RPM) decayed down to 94% NR and stabilized there, not going any lower. (NR Precautionary Range = 100% to 91% NR) The IVSI (instantaneous vertical speed indicator) was indicating a slight vertical rate-of-climb of up to 200 FPM (foot-per-minute).

While in the 200-FPM stabilized climb, the following power-train values were noted: 94% NR; 95% Tq #1 engine, 96% Tq #2 engine; 710C T5 #1 engine, 715C T5 #2 engine; 101.8% Ng #1 engine, 101.5 Ng #2 engine. To complete the test, the collective was then pushed down 1 inch which resulted in a 2% decrease in engine torque and the NR increasing to 100% NR in 2 seconds.

Only normal pilot inputs and techniques were used during the test.

The aircraft then flew back to Reno-Stead airport, off-loaded the aircraft mechanic and loaded three more technical observers. With the passenger change (new passenger weight of 860 lbs.) and, considering the fuel burn from the first flight, the aircraft weight was re-calculated to be 15,743 lbs.

FLIGHT NO. 2

The second flight was used to accomplish eight separate hover performance tests that were similar to the hover performance test maneuver done on the first safety flight. The first five tests were to be done at the desired test weight of 18,500 lbs GW (gross weight). These tests were all done at slightly different GWs due to the weight of the fuel being burned during the tests; therefore, the aircraft's GW was slightly higher than 18,500 lbs. at the beginning of the five tests and slightly lower at the end. With the aircraft weighing 15,743 lbs. before picking up water, 2,757 lbs. of water in the bucket was needed to bring the aircraft GW up to the desired testing weight of 18,500 lbs.

With the 15,743-lb. aircraft back over Frenchman Lake in a 200-foot stabilized hover, the water bucket was lowered into the lake to fill it. The water bucket was then lifted vertically out of the water weighing approximately 4,000 lbs. The water level was then intentionally adjusted down to 2,900 lbs. giving a gross aircraft weight of 18,643 lbs. for the first of the next five tests.

Utilizing normal pilot inputs and techniques, a normal takeoff and climb was initiated to climb the ridge line to the desired pressure altitude of 6,550 feet. The aircraft was then stabilized in a 400-foot OGE hover and the OAT was reconfirmed to be 19C. To figure the operating density altitude, the right seat three-pointer sensitive altimeter was still adjusted so that it indicated 29.92 in the Kollsman window ensuring that the altimeter would indicate when the aircraft was at 6,550 ft. pressure altitude. The 6,550 ft. pressure altitude was corrected for the 19C OAT, utilizing both an electronic computer as well as a Jeppesen CSG-1A "Slide Graphic" ("whiz-wheel") flight computer; both of which, yielded a density altitude of 8,490 ft.

The aircraft was able to hold 103% NR with 92% Tq while holding a stabilized OGE hover at a density altitude of 8,673 ft; with little or no wind at a weight of 18,643 lbs. On all the test flights, the wind speed was constantly being evaluated by cross-checking the glassy-calm surface of the lake, the airspeed indicator, the aircraft position over the ground visually, and the ground speed readout of the aircraft's Garmin 530 GPS.

At this point, the collective pitch control was slowly and intentionally pulled up to the control's top physical stop in order to bleed the NR down as far as it would go. Engine instruments indicated both engine topping limits were reached during this collective pull at: 101.8 Ng / 708C

T5 for the #1 engine and 101.5 Ng / 709C T5 for the # 2 engine. With the collective control at the top physical stop, the torques went up to 97% Tq for #1 engine and 97% Tq for #2 engine. The NR decayed down to 94% NR, stabilized there and would not go below that point. (NR Precautionary Range = 100% to 91% NR) The IVSI was indicating a slight vertical rate-of-climb of up to 100 FPM.

To complete test #1, the collective pitch was then pushed down 1 inch that resulted in a 2% decrease in torque which, in turn, resulted in the NR increasing to 100% NR within 2 seconds. Test data for tests #2, 3, 4, and 5 were very similar to the test data for test #1. On every hover test in this group of 5 tests at the approximate test GW of 18,500 lbs, the aircraft was able to hold a hover at 103% NR with 92% Tq with no indication of wind. Every time the collective pitch control was pulled up to the top physical stop, the engines read the same topping numbers of 708C T5 and 101.8% Ng for engine #1 and 709C T5 and 101.5% Ng for engine #2. Both engine torques read 97% each and the NR decayed down to (and stabilized at) 94% NR but would not go lower than 94% NR. At the end of each test, each time the collective was lowered 1 inch (approximately 2% Tq), the NR recovered to 100% within 2 seconds.

(See Appendix 1 for test result data)

The second battery of performance hover tests in flight # 2 consisted of three test hovers at a desired aircraft GW of 19,100 lbs. or more. These tests were all at slightly different GWs due to the weight of the fuel being burned during the tests; therefore, the load of water for these final three tests was intentionally adjusted to bring the gross weight of the aircraft to approximately 19,400 GW or higher.

At this point in the flight, the aircraft, pilots, test observers, and the remaining 1,900 lbs. of fuel weighed 15,343 lbs. To bring the aircraft weight up to 19,400 lbs., the load of water in the bucket needed to weigh 4,057 lbs. With the aircraft over Frenchman Lake in a 200-foot stabilized hover, the water bucket was lowered into the lake. The water bucket was then lifted vertically out of the water weighing approximately 4,500 lbs. measured by the load cell. The water load was then intentionally adjusted to 4,200 lbs., making the gross aircraft weight 19,543 lbs. for the first of the last three tests.

Utilizing normal pilot inputs and techniques, a normal takeoff and climb was initiated to climb the ridge line to the desired pressure altitude of 6,600 feet. When the aircraft reached 6,600 ft. PA, the aircraft was never actually stabilized at the planned 400-foot OGE hover before beginning the hover test maneuver. The IVSI indicated that the aircraft had a rate of descent of 150 FPM when the test was initiated. Due to the existing rate of descent with no wind at the beginning of the maximum collective pitch pull, the aircraft showed signs of "settling with power" and the descent rate increased to 300 FPM. At this point, the pilots elected to abort the test sequence since they wouldn't be able to arrest the increasing rate of descent without increasing airspeed and reducing collective pitch, either of which would compromise the test results.

Hover test #7 was performed at an aircraft GW of 19,493 lbs. When the aircraft was in a stabilized hover at a density altitude of 8,490 ft, it was able to maintain the stabilized hover with power settings of 94% Tq and 103% NR. However, once the collective was slowly pulled up to its physical stop, the NR decayed to and stabilized at 94% NR. At 94% NR, both torque readings at 97% Tq and both engines at their topping limits, a sustained 300-FPM rate of descent developed. To complete test #7, the collective pitch was lowered 1 inch and the NR recovered to 100% NR within 2 seconds and the pilot applied cyclic to establish forward flight and the helicopter began climbing.

The last test (test #8) was done at an aircraft GW of 19,393 lbs. and a density altitude of 8,551 feet. (6,600 ft. PA and 19C OAT) With the aircraft maintaining a stabilized hover at 6,600 feet PA, the collective pitch was slowly pulled up to its top physical stop. During this collective pitch pull, both engines reached their topping limits of: 101.8% Ng / 708C T5 for engine #1 and 101.5 Ng / 709C T5 for engine #2. Both engine torques were indicating 97% Tq. The NR decayed to 94% NR and stabilized there with a slight 100-FPM rate of descent developing. As previously planned, the right-seat pilot then reduced the #2 SSL (speed selector lever) which reduced the #2 engine torque down to 70% Tq. With the 27% torque loss of the #2 engine, the NR rapidly decayed down to 92% NR without stabilizing and the aircraft quickly developed a 500- to 600-foot rate of descent. At that point (simultaneously), the collective pitch was reduced slightly as the SSL was being pushed full forward to regain NR, the nose of the aircraft was lowered to gain enough airspeed to recover from the test maneuver, and the aircraft was flown into a climb.

Flight test # 8 concluded all of the planned performance test flight maneuvers.

On all the test flights, the wind speed was being constantly evaluated by cross-checking the glassy-calm surface of the lake, the airspeed indicator, aircraft position over the ground visually, and the ground speed readout of the aircraft's Garmin 530 GPS.

Documentation of flight data for the eight test flight maneuvers in flight # 2 was accomplished by video tape of the instrument panel indications, two technical observers taking notes and the pilot's verbal callout of data. Post-flight discussions also took place between the five pilots on board the test flight aircraft to discuss the flight characteristics observed. The five pilots' total helicopter flight time is estimated to be in excess of 60,000 hours. The video recording of the instrument panel was reviewed dozens of times to confirm the flight data noted during the performance test flights.

(See Appendix # 1 for flight data)

Report By ________________________

Russell G. Whipple

Whipple Aviation Services, LLC

APPENDIX 1

Hover Test Flight Data

Appendix 1

HOVER TEST FLIGHT DATA

FLIGHT # 2

CHI PERFORMANCE TEST FLIGHT				
RENO, NV // 11-03-09				
SK-61 N // Tail Number N 261 F	Test Flight # 1	Test Flight # 2	Test Flight # 3	Test Flight # 4
FLIGHT CRITERIA				
Pressure Altitude	6550 FT	6550 FT	6650 FT	6600 FT
Outside Air Temperature	19C	19C	18C	18C
Density Altitude	8490 FT	8,490 FT	8,500 FT	8,450 FT
Wind Speed	0 TO 3 MPH	0 TO 3 MPH	0 TO 3 MPH	0 TO 3 MPH
AIRCRAFT GROSS WEIGHT (GWT)	18,643 LBS	18,518 LBS	18,418 LBS	18,368 LBS
FUEL LOAD // H2O ON BOARD (LBS)	2300 // 2900	2175 // 2900	2075 // 2900	2025 // 2900
HIGHEST TORQUES (#1 eng // #2 eng.)	97% // 97%	97% // 97%	97% // 97%	97% // 97%
TURBINE TEMPs (# 1eng // #2 eng)	708C // 709C	708C // 709C	708C // 709C	708C // 709C
GAS PRODUCER RPM (#1 eng //#2 eng)	101.8% // 101.5%	101.8% // 101.5%	101.8% // 101.5%	101.8% // 101.5%
LOWEST MAIN ROTOR RPM (NR)	94% NR	94% NR	94% NR	94% NR
RATE OF CLIMB (+/-)	+100 FPM	0 FPM	+ 100 FPM	+100 FPM

FLIGHT CRITERIA	Test Flight # 5	Test Flight # 6	Test Flight # 7	Test Flight # 8
		Aborted		
Pressure Altitude	6600 FT	6600 FT	6550 FT	6600 FT
Outside Air Temperature	19C	19C	19C	19C
Density Altitude	8,551 FT	8,550 FT	8490 FT	8,550 FT
Wind Speed	0 TO 3 MPH	0 TO 3 MPH	0 TO 3 MPH	0 TO 3 MPH
AIRCRAFT GROSS WEIGHT (GWT)	18,300 LBS	19,543 LBS	19,493 LBS	19,393 LBS
FUEL LOAD // H2O ON BOARD (LBS)	1950 // 2900	1900 // 4200	1850 // 4200	1750 // 4200
HIGHEST TORQUES (#1 eng // #2 eng.)	97% // 97%	97% // 97%	97% // 97%	97% // 70%***
TURBINE TEMPs (#1 eng // #2 eng)	708C // 709C	708C // 710C	708C // 710C	708C // 600C***
GAS PRODUCER RPM (#1 eng // #2 eng)	101.8% // 101.5%	101.8% // 101.5%	101.8% // 101.5%	101.8% // 101.5%
LOWEST MAIN ROTOR RPM (NR)	94% NR	94% NR	94% NR	92% NR***
RATE OF CLIMB (+/-)	+ 300 FPM	- 250 FPM	-300 FPM	-600 FPM***

94% NR recovered to 100% NR within 2 seconds with a slight reduction of collective pitch in all 8 test flights.

***#2 Engine pulled back to 70% TQ at end of test to observe NR /ALT loss

APPENDIX 2

CHI General Maintenance Manual, Wt. & Bal. Procedures, Checklist & Worksheets

CHAPTER 12

WEIGHT AND BALANCE

TABLE OF CONTENTS

12-1. WEIGHT CONTROL PROCEDURES, GENERAL

(a) Aircraft operated by our company shall be weighed every thirty-six (36) calendar months to determine the aircraft's empty weight and corresponding center of gravity positions.

(b) It shall be the responsibility of the Director of Maintenance to monitor and record all weight changes, in the equipment list, affecting the aircraft.

(c) When the accumulated changes to the operating or basic weight and/or center of gravity position exceed plus or minus one-half of one percent (1/2 of 1%) of the maximum landing weight the loading data must be revised accordingly to reflect the changes.

(d) The results of an actual weighing or the re-established weight as described above will be recorded on Form No. 80-285. One copy will be retained in the Aircraft Flight Manual and one in the maintenance department as part of the aircraft permanent records.

12-2. SCALES

Any acceptable scale may be used for weighing provided they are properly calibrated and used in accordance with the manufacturer's instructions. Scales will be calibrated by the manufacturer or other certifying agency within one (1) year prior to weighing an aircraft or as approved for the repair facility performing the weighing unless otherwise indicated.

12-3. PREWEIGHING CHECKLIST (Form No. 80-284)

(a) Prior to actual aircraft weighing, the Preweighing checklist (Form 80-284) will be completed in its entirety by the maintenance department.

(b) The completed Preweighing checklist will be retained in the maintenance department until the aircraft is reweighed.

(c) If aircraft weighing is being performed by a repair facility which is on the list of approved repair facilities it is acceptable to use their preweigh checklist, provided their checklist includes updating of the equipment checklist and the scale calibration date is recorded.

(d) The completion of this form is self-explanatory.

(e) Insure A/C is configured in accordance with approved data.

CARSON HELICOPTER SERVICES, INC.

PREWEIGHING CHECKLIST

Form 80-284

Aircraft Number:	Aircraft Serial No.:	Location:
N261F	61771	Stead Airport, Reno

ACTION	TECHNICIAN INITIALS
1. Aircraft clean and dry.	
2. Aircraft configured I/A/W Maintenance Manual.	
3. All extraneous equipment and materials removed from the aircraft.	
4. Using an updated equipment list (CHART A), confirm all operating equipment that has a fixed location is installed and in place.	
5. Aircraft placed in normal flight configuration I/A/W Maintenance Manual.	
6. Record the weighing points to be used in inches and tenths from the datum point as per the appropriate maintenance manual.	

7.	Left	Right	Nose/Tail
Scale Manufacturer	Revere	Revere	Revere
Scale Serial No.	[illegible]	[illegible]	[illegible]
Scale Type	Load Cell	Load Cell	Load Cell
Current Calibration Date	9-28-09	9-28-09	9-28-09

ACTION	TECHNICIAN INITIALS
8. Read and follow any instructions given by the scale manufacturer.	
9. The aircraft and scales are ready for weighing.	

Technician Name:	Technician Signature:	Date:
Tito A Thornton	[redacted]	1[illegible]-09

Weight and Balance Notes #1

Form 80-282

Aircraft Reg #: N 2 6 7 F	Aircraft Serial Number: 61771	Location: Stead Airport, Reno

Weigh #1	Weigh #2	Weigh #3	Total	Avg.
(S) L/H Main 4874 (Color) +	(Y) L/H Main 4862 (Color) +	(R) L/H Main 4893.4 (Color) =	14629.4/3 =	4876.4
(R) R/H Main 5068.5 (Color) +	(B) R/H Main 5093 (Color) +	(Y) R/H Main 5105 (Color) =	15266.5/3 =	5088.7
(Y) Tail 2240 (Color) +	(R) Tail ~~L/H Main~~ 2226.7 (Color) +	(B) Tail ~~L/H Main~~ 2233 (Color) =	6699.7/3 =	2233.2
12182.3	12181.7	12231.4	Total Weight	12198.3

Scale Verification

(Rotate load cells 1 jack clockwise)

Avg. Readings from above	Load Cell Verification Readings (Not to Exceed +/- 20 LBS)
( ) L/H Main 4876.4 LBS (Color)	(B) L/H Main 4861 LBS DIFF +/- 15.4 (Color)
( ) R/H Main 5088.7 LBS (Color)	(R) R/H Main 5107.2 LBS DIFF +/- 18.5 (Color)
( ) TAIL 2233.2 LBS (Color)	(Y) TAIL 2230 LBS DIFF +/- 3.2 (Color)
TOTAL 12198.3 LBS	TOTAL 12198.2 LBS DIFF +/- .1

Technician Name: Tito Thornton	Signature: [redacted]	Certificate & #: A&P [redacted]

Weight and Balance Notes #2

Form 80-283

Aircraft Reg #:	Aircraft Serial Number:	Location:

-
-
-
-
-
-
-

Calculations

Notable Equipment List Changes

-
-
-

Technician Name:	Signature:	Certificate & #:

12-4. PROCEDURES FOR WEIGHING AIRCRAFT

(a) The aircraft will be weighed in a zero wind factor, usually in a closed hangar. There are several acceptable methods of weighing an aircraft. Mainly, the difference is caused by type of scales.

(b) When electric scales are used, the aircraft will be weighed at the jack points and in the flight level position I/A/W the applicable aircraft Maintenance Manual.

CAUTION: It should be noted that because leveling is extremely critical close attention should be given to this action and strict adherence to applicable aircraft model leveling procedures shall be followed.

(c) When platform scales are used, the aircraft is weighed at the main and tail wheels.

(d) When the aircraft is weighed at the jack points, the station reference will be adequate to establish the arms as they are at fixed positions on the aircraft. This is the prefered method of weighing our aircraft

(e) When the aircraft is weighed at the main wheels, the arms from the datum to the weighing points must be established by measurement as the wheels can be shifted by inflation of the struts or be misaligned. The measurement can be found by using plum bobs, chalk string and a tape measure.

NOTE: There are other methods to weigh an aircraft and that the future may bring new and different equipment to the weighing procedure. Our company reserves the right to use other equipment than referanced above and develop new procedures as needed. These new procedures will, if used, become a part of this manual by way of revision

(f) The aircraft shall be weighed three (3) times. The sum of which shall be divided by three (3) and considered as the true aircraft weight. Between each weighing ensure the load cells are completely unloaded and zeroed as per weighing system manual.

(g) Load Cell Verication Procedure: After the weighing procedure has been completed,ie; the sum of (3) three weighings has been annotated. Rotate load cells clockwise (1) one position. Reweigh. If the weights obtained from Individual cells differ the average of previous weighings by Plus+ or Minus 20 pounds the weighing procedure must be considered to be flawed. Reread instructions to ensure procedures are being followed correctly. If the results remain the same the scales must be considered suspect and tagged and sent in for calibration. The aircraft will need to have its weight and balance completed on a acceptable set of scales.

(h) Notes Page: This page shall be used during the aircraft weighing procedure for all your measurements, calculations, and notes. It shall be submitted as a part of your weight and balance documentation package

12-5. AIRCRAFT ACTUAL WEIGHT AND HORIZONTAL BALANCE REPORT, CHART B (Form 80-287)

(a) The Aircraft Weight and Balance Report will be used each time an aircraft is weighed. It is the responsibility of the Director of Maintenance to verify the actual weighing and completion of Form 80-287. An A&P mechanic who has been trained in company GMM weight and balance procedures may be assigned to perform the weighing.

****NOTE****

Form 80-287 is specific to the Sikorsky S-61N and is used in this manual as an example. Other aircraft types will differ in Station Numbers and Weight Point Locations. Forms containing equivalent data are acceptable.

(b) If aircraft weighing is being performed by a repair facility which is on the list of approved repair facilities it is acceptable to use their Aircraft Weight and Balance Report X if it contains equivalent data.

(c) One copy of CHART B (form 80-287) will be retained in the maintenance department as part of the aircraft permanent records and one copy will be retained in the Aircraft Flight Manual

(d) Form 80-287 will be completed as follows:

AIRCRAFT WEIGHT AND BALANCE REPORT Page 1 of 2

(1) Enter the name of the agency or person performing the weighing procedure.

(2) Enter the date the weighing took place here

(3) Enter the aircraft registration number here.

(4) Enter AIRCRAFT SERIAL NUMBER

(5) Enter LEFT MAIN SCALE number here.

(6) Enter the LEFT MAIN/SIDE SCALE READING here.

(7) Enter the TARE reading here.

(8) Subtract the TARE from the LEFT MAIN/SIDE SCALE READING to arrive at a NET WEIGHT and enter here.

(9) Enter RIGHT MAIN SCALE number here.

(10) Enter the RIGHT MAIN/SIDE SCALE READING here.

(11) Enter the TARE reading here.

(12) Enter TAIL SCALE number here.

(13) Enter the NOSE/TAIL SCALE READING here.

(14) Enter the TARE here.

(15) Subtract the TARE reading from the NOSE/TAIL SCALE READING to arrive at a NET WEIGHT and enter here.

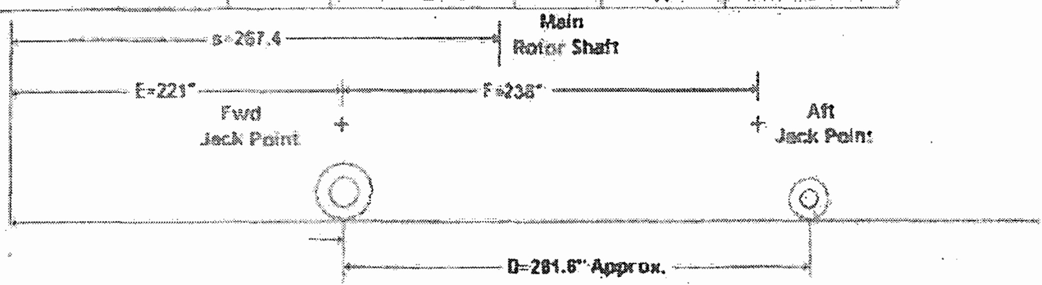
(16) Total LEFT MAIN, RIGHT MAIN, AND NOSE/TAIL WEIGHT and enter here

AIRCRAFT ACTUAL WEIGHT AND HORIZONTAL BALANCE, CHART B
S-61N MODEL HELICOPTER "L" GEAR INSTALLED (Form 80-287)

Prepared By: Tito A Thornton

Date: 11-03-09 Reg. No. N261F Serial No. 61771

SCALE POSITION	SCALE No.	SCALE READING (lbs)	TARE	SYMBOL	NET WEIGHT
LEFT MAIN POINT	701737	4876.4	Ø	Wl	4876.4
RIGHT MAIN POINT	701729	5088.7	Ø	Wr	5088.7
NOSE/TAIL POINT	701732	2233.2	Ø	Wt	2233.2
TOTAL WEIGHT		12198.3		W	12198.3



CENTER OF GRAVITY TO FORWARD DATUM (HORIZ. DIST. – AS WEIGHED)

Weighing on Wheels $E + \frac{Wt\,(D)}{W}$ ______________ =

Weighing on Jack Points $E + \frac{Wt \times F}{W}$

CORRECTED WEIGHT AND HORIZONTAL BALANCE

ITEMS ADDED & SUBTRACTED	WEIGHT (lbs)	HORIZONTAL DIST (in) C.G. TOFWD DATUM	MOMENT (lb. in.)
Aircraft as Weighed			
Plus -			
Minus -			
TOTAL EMPTY/GROSS WEIGHT			
BALANCE (corrected)	Horizontal Dist. – s =	in. **Fwd/Aft** of Main Rotor Centroid	

Form # 80-287

Witnessed By: ______________________

12-6. WEIGHT AND BALANCE / EQUIPMENT CHANGE LIST (CHART C) (Form 80-285)

(a) The purpose of Form 80-285 is to provide a record of changes to an individual aircraft's weight and balance and data on current basic operating weight and center of gravity location brought about by modifications, alterations, repairs, or changes in configuration with accumulated changes to the operating weight exceeding plus or minus one-half of one percent (1/2 of 1%) of the maximum landing weight.

(b) This form is initiated and is kept current by the maintenance personnel assigned to the aicraft. A copy will be entered in the Aircraft Flight Manual and be current to the aircraft configuration prior to all flights. Any time the Chart C is amended a copy shall be submitted to the main office as per Chap 3 para 3-2, with the corresponding AFML page containing the return to service sign off for the item removed or installed.

(c) The Weight and Balance/Equipment Change List will be completed as follows:

(1) Enter make and model of aircraft

(3) Enter aircraft registration number or other identification reference

(4) Enter aircraft serial number

(5) Enter page number (corresponding with previous page if applicable)

(6) Enter aircraft date, weight, moment, and center of gravity from "Chart B-Form 80-287)

(8) Enter date weight and balance change was made

(10) Check if change is a removal or installation and enter description of items removed or installed

(11) Enter weight of item(s) removed or installed with proper sign (+ or -) for removal or installation

NOTE

If weight of item to be removed or installed is not listed on Chart "A" weight must be obtained by physical weighing of individual item(s).

(12) Enter arm of item removed or installed

(13) Multiply weight by arm and enter moment

(14) Compute all Weights being careful to observe + or - signs and enter newly established basic empty weight

(15) Add all Moments, being careful to observe + or - signs and enter new moment

(16) Divide moment by basic empty weight and enter new center of gravity

CHART C – BASE WEIGHT AND BALANCE RECORD

Form # 80-285

Make & Model				Reg. No			Serial No.			Page No.		
DATE (MMDDYY)	ITEM NUMBER		DESCRIPTION OF ARTICLE OR MODIFICATION	WEIGHT CHANGE						CURRENT TOTAL BASIC AIRCRAFT		
				ADDED (+)			REMOVED (-)					
	IN	OUT		WEIGHT	ARM	MOMENT	WEIGHT	ARM	MOMENT	WEIGHT	MOMENT	C.G.

12-7. DERIVATION OF BASIC OPERATING WEIGHT CHART D

Once the aircraft has been weighed and a Basic Equipped Weight has been established and computed, it will be necessary to compute a Basic Operating Weight (BOW). For procedure in determining the Basic Operating Weight refer to the Carson Helicopter Services, Inc. General Operations Manual Appendix B "Weight and Balance".

APPENDIX 3

N261F Chart A
Dated 10-14-09

Chart A - Empty weight Checklist

13Mar.09 10-May-09 1-Jun-09 14-Oct-09

Aircraft Model- S61N - S/N 61771 -

as weighed Rev. 1 as weighed as weighed

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1		Check 2		Check 3		Check 4		Check 5		Check 6		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
A	Cockpit Compartment (32-110)																				
A-1	Indicator, Airspeed, 812961-04-003 (2)	2.0	61.0	1.2		X		X		X		X									
A-2	Altimeter, 5934P-3	1.5	61.0	0.9		X		X		X		X									
A-3	Altimeter, 5934P-3	1.5	61.0	0.9		X		X		X		X									
A-4	Indicator, Attitude, Compass System (HZ-6B) Sperry (2)	14.0	62.0	8.7		O		O		O		O									
A-5	Indicator, Vertical Gyro,4005-AC-LEAR (2)	9.0	62.0	5.6		X		X		X		X									
A-6	Indicator,Vertical Speed, RC-30-V-10) (2)	3.0	64.0	1.9		X		X		X		X									
A-7	Indicator, Course, 331A-3F (1)	3.0	64.0	1.9		O		O		O		O									
A-8	Clock, W33-7540-10 (2)	2.0	64.0	1.3		O		O		O		O									
A-9	Clock, M803 (2)	1.2	64.0	0.8		X		X		X		X									
A-10	Tachometer, Gas Generator, 8DJ81 (2)	3.0	61.0	1.8		X		X		X		X									
A-11	Torquemeter, 6300-C38A-155-31 (2)	3.0	63.0	1.9		X		X		X		X									
A-12	Tachometer, Triple, B31521-10-008 (2)	6.0	64.0	3.8		X		X		X		X									
A-13	Misc. Instruments:			0.0																	
	* Indicator,Hydraulic Press, SR-152A Type 3 (2)	1.0	63.0	0.6		X		X		X		X									
	*Indicator,Trans. Oil Temp, 16382	0.5	63.0	0.3		X		X		X		X									
	*Indicator,Trans. Oil Press, SR-152AType 3	0.5	63.0	0.3		X		X		X		X									
	*Indicator, Eng. Oil Press, SR151A Type 2 (2)	1.0	62.0	0.6		X		X		X		X									
	*Indicator, Eng. Oil Temp, 163B2) (2)	1.0	62.0	0.6		X		X		X		X									
	*Indicator, Eng. Fuel Press, SR-151A) (2)	1.0	62.0	0.6		X		X		X		X									
	*Indicator, PTIT, BH 185R-5 (2)	2.0	62.0	1.2		O		O		O		O									
	*Indicator, PTIT, Diamond J, 61000-044 (2)	1.2	62.0	0.7		X		X		X		X									
	*Indicator, Fuel Quantity, 393085-43708	1.0	62.0	0.6		X		X		X		X									
	*Indicator, Fuel Qty, 393004-01-884 (2)	2.0	62.0	1.2		X		X		X		X									
	*Volt\Ammeter, AC, 570-382	1.0	63.0	0.6		X		X		X		X									
	*Volt\Ammeter, DC, NAF 1225-300	1.0	63.0	0.6		X		X		X		X									
A-14	*Standby Compass, KCA104W (2)	1.5	87.0	1.3		X		X		X		X									
A-15	Cushions, Seat, Pilot & Co-Pilot (2)	6.0	92.0	5.5		X		X		X		X									
A-16	Safety Belt, 1101155-0 (2)	4.0	97.0	3.9		X		X		X		X									
A-17	Seats, Pilot & Co-Pilot, 677R20000	44.0	99.0	43.6		X		X		X		X									
A-18	Bumpers, Seats, Pilot & Co-Pilot, KLH4T0024-	0.6	110.0	0.7		O		O		O		O									
A-19	Cushions, Back, Pilot & Co-Pilot	4.0	103.0	4.1		X		X		X		X									
A-20	Shoulder Harness (2)	2.0	103.0	2.1		X		X		X		X									
A-21	Jump Seat and safety Belt	7.0	104.0	7.3		O		O		O		O									
A-22	First Aid Kit	2.0	108.0	2.2		O		O		O		O									

Chart A - Empty weight Checklist

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as weighed Rev. 1 as weighed as weighed

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1		Check 2		Check 3		Check 4		Check 5		Check 8		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
A-23	Portable Fire Extinguisher, 6120-71117	7.0	108.0	7.6		X		X		X		X									
A-24	Free Air Temp Indicator, 2289	0.2	71.0	0.1		X		X		X		X									
A-25	Light, Map, 15-007-3 (2)	1.0	100.0	1.0		X		X		X		X									
A-26	Windshield washer bag	4.0	108.0	4.3		O		O		O		O									
A-27	Windshield wiper Inst.	11.0	52.0	5.7		X		X		X		X									
A-28	HSI, Astronautics, 11320-5	6.5	63.0	4.1		X		X		X		X									
A-29	HSI, Astronautics, 11320-5	6.5	63.0	4.1		X		X		X		X									
A-32	Panel, Annunciator Switch, Mid Continent, MD41-1468A	0.5	64.0	0.3		X		X		X		X									
A-33	Panel, Annunciator Switch, Mid Continent, MD41-1468A	0.5	64.0	0.3		X		X		X		X									
A-34	Transponder, GTX330	4.2	75.2	3.2		X		X		X		X									
A-35	Encoder, Altitude, Transcal, SSD120-30A-RS232	0.6	81.0	0.5		X		X		X		X									
A-36	Transceiver, GPS\NAV\COM, #1, GNS-430	6.5	61.0	4.0		X		X		X		X									
A-37	Transceiver, GPS\NAV\COM, #2, GNS-430	6.5	62.0	4.0		X		X		X		X									
A-38	Indicator, Attitude, Stand-by, 4300-412	3.0	68.0	2.0		X		X		X		X									
A-39	Transceiver, VHF\FM, TDFM-136	6.0	76.0	4.6		X		X		X		X									
A-40	Transceiver, VHF\FM, TFM-500	6.0	76.0	4.6		X		X		X		X									
A-41	Display, Multifunction, MX-20	4.7	61.0	2.9		X		X		X		X									
A-42	Indicator, DME Control, KDI572	1.6	63.0	1.0		O		O		O		O									
A-43	Indicator, Radar Altimeter, RA-220 (2)	1.0	63.0	0.6		X		X		X		X									
A-44	Panel, Fuel Level Selector	1.0	88.0	0.9		X		X		X		X									
A-45	Panel, Audio, A-710, LH	2.4	80.0	1.9		X		X		X		X									
A-46	Panel, Audio, A-710, RH	2.4	80.0	1.9		X		X		X		X									
A-47	Control, CVR 1634-02	0.3	81.0	0.2		X		X		X		X									
A-48	CVR-30	13.2	101.0	13.3		X		X		X		X									
A-49	Amp, Summing, CVR, A6912-1	1.0	93.0	0.9		X		X		X		X									
A-50	Switch, Inertia, CVR, 3LO-87116	0.3	92.0	0.3		X		X		X		X									
A-51	Microphone, CVR, 16301-02	0.1	90.1	0.1		X		X		X		X									
A-52	Indicator, C-39, E84 Load Weigh System	0.4	63.0	0.3		X		X		X		X									
A-53	Indicator, Analog, E84 Load Weigh System	0.4	76.0	0.3		X		X		X		X									
A-54	Control, Cargo Hook	1.0	75.0	0.8		X		X		X		X									
A-55	Panel, ICS Tie Control	0.3	78.5	0.2		X		X		X		X									
A-56	Panel, Compass Control, 212-077-163-001	0.3	80.0	0.2		X		X		X		X									
A-57	Panel, Asst	0.3	81.0	0.2		X		X		X		X									

Chart A - Empty weight Checklist

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as weighed Rev. 1 as weighed as weighed

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1 In Aircraft	Check 1 Chart C Entry	Check 2 In Aircraft	Check 2 Chart C Entry	Check 3 In Aircraft	Check 3 Chart C Entry	Check 4 In Aircraft	Check 4 Chart C Entry	Check 5 In Aircraft	Check 5 Chart C Entry	Check 6 In Aircraft	Check 6 Chart C Entry	Check 7 In Aircraft	Check 7 Chart C Entry	Check 8 In Aircraft	Check 8 Chart C Entry
A-58	Panel, ELT Control	0.3	83.0	0.2		X		X		X		X									
A-59	Panel, Landing Gear Control, A4503M8	0.5	85.0	0.4		O		O		O		O									
A-60	Panel, AFCS Control, S6190-60060-041	0.3	73.0	0.2		X		X		X		X									
A-61	Panel, AFCS Channel Monitor, S6190-60045-5	0.3	77.0	0.2		X		X		X		X									
A-62	Rotorcraft Flight Manual	10.0	103.0	10.3		X		X		X		X									
B	Electronic Compartment (32-110)																				
B-1	Landing light, RH	16.0	66.0	10.6		X		X		X		X									
B-2	Landing light, LH	16.0	66.0	10.6		X		X		X		X									
B-3	Time temp. recorded (2)	9.0	64.0	5.8		O		O		O		O									
B-4	Relay, Hartman, A927 (2)	5.0	76.0	3.8		X		X		X		X									
B-5	Compass, Gyrosyn, C-14A	5.5	105.0	5.8		X		X		X		X									
B-6	Regulator, Voltage, VR1010-24-2A	1.6	73.0	1.2		X		X		X		X									
B-7	Regulator (Hartman E1597)	3.0	75.0	2.3		X		X		X		X									
B-8	Control Gyro, Lear 7000B (2)	14.0	80.0	11.2		X		X		X		X									
B-9	Transformer Rectifier, *RN167-YF1A	21.0	84.0	17.6		X		X		X		X									
B-10	Panel, Supervisory, 21517-10B (2)	6.0	77.0	4.6		X		X		X		X									
B-11	Control, Heater, CYLZ-1886-4	3.0	86.0	2.6		O		O		O		O									
B-12	Inverter, Ground, MGH228-100	14.0	84.0	11.8		X		X		X		X									
B-13	Amplifier, AFCS, 6190-60056	15.0	102.0	15.3		X		X		X		X									
B-14	Amplifier, Lag, AFCS, 6192-61090	2.0	88.0	1.8		X		X		X		X									
B-15	Controller, Eng. Anti-Ice, 1378-1B	11.0	103.0	11.3		X		X		X		X									
B-16	Gyro, Rate Of Turn, A2850-5 (2)	3.0	91.0	2.7		X		X		X		X									
B-17	Transceiver, DME, KDM706A	1.7	82.0	1.4		O		O		O		O									
B-18	Converter, Voltage, AK-551	1.5	93.0	1.4		X		X		X		X									
B-19	Transceiver, Radar Altimeter, RT-300	4.5	102.0	4.6		X		X		X		X									
B-20	Tracker, Satellite, Sky Connect	4.0	78.0	3.1		X		X		X		X									
B-21	Chim Unit	0.6	85.5	0.5		X		X		X		X									
B-23	Adapter, GPS, GAD-42	2.2	78.0	1.7		X		X		X		X									
B-24	Adapter, GPS, GAD-42	2.2	78.0	1.7		X		X		X		X									
B-25	Interface, Radio, NAT, AA34-300, USFS Option	0.4	76.0	0.3		X		X		X		X									
B-26	Panel, Control, PA\Siren, NAT, AA22-160, USFS Option	0.3	77.0	0.2		X		X		X		X									
B-27	Amplifier, PA\Siren, PA220-010, USFS Option	8.0	90.0	7.2		X		X		X		X									
B-28	Panel, Audio Interconnect, A-740	1.0	79.0	0.8		X		X		X		X									
B-29	Amplifier, Cabin PA, NAT, 250	2.4	84.0	2.0		X		X		X		X									

Chart A - Empty weight Checklist

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Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1 (as weighed)		Check 2 (Rev. 1)		Check 3 (as weighed)		Check 4 (as weighed)		Check 5		Check 6		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
B-30	Transceiver/Antenna, Wx Radar, ART2000	9.9	23.0	2.3		X		X		X		X									
B-31	Controller, Pulse Lights, 11505-4	2.0	69.0	1.4		X		X		X		X									
B-32	Battery, Nose (Concord RG-380E/44)	85.0	45.0	38.3		X		X		X		X									
B-33	Vibration Damper, Nose Battery	93.4	45.0	42.0		O		O		O		O									
C	Cabin (110-493)																				
C-1	Heater, AC, ME611-000	34.0	117.0	39.8		X		X		X		X									
C-2	Cargo Net Installation	6.0	447.5	26.9		O		X		X		X									
C-3	Cargo Net	6.8	447.5	30.4		O		X		X		X									
C-4	Board Papers, FWD Cabin RH	24.9	113.0	28.1		O		O		O		O									
C-5	Aux Battery, FWD Baggage Comp.	85.0	120.0	102.0		X		X		X		X									
C-6	Hoist Floor FWD Cabin RH	28.0	152.0	42.6		O		O		O		O									
C-7	Hoist Bag, FWD Cabin RH	56.9	152.0	86.5		O		O		O		O									
C-8	Lower Hook Relay (2)	2.0	163.0	3.3		X		X		X		X									
C-9	Cabin Speaker (AI-5150CX-4)	1.2	163.0	2.0		X		X		X		X									
C-10	Cabin Speaker (AI-5150CX-4)	1.2	203.0	2.4		X		X		X		X									
C-11	Cabin Speaker (AI-5150CX-4)	1.2	203.0	2.4		X		X		X		X									
C-12	Cabin Speaker (AI-5150CX-4)	1.2	263.0	3.2		X		X		X		X									
C-13	Cabin Speaker (AI-5150CX-4)	1.2	317.0	3.8		X		X		X		X									
C-14	Cabin Speaker (AI-5150CX-4)	1.2	387.0	4.6		X		X		X		X									
C-15	Amplifier, Passenger Intercom, NAT, AA38-301	1.0	142.0	1.4		X		X		X		X									
C-16	Panel, Audio, A-710, FWD Cabin	2.4	184.0	4.4		X		X		X		X									
C-17	Panel, Audio, A-710, Rear Cabin	2.4	300.0	7.2		X		X		X		X									
C-18	Control, FM, Remote, Technisonic, RC500	1.2	329.0	3.9		O		O		O		O									
C-19	DBL Seat & Belt, Comp C1	26.0	128.5	33.4		O		O		O		O									
C-20	Single passenger seat & belts C6	19.0	167.0	31.7		O		O		O		O									
C-21	Double Seat (Sicma) & Harness, Comp C7	41.0	201.0	82.4		O		O		O		O									
C-22	Single Seat (Sicma) & Harness, Comp C7	23.5	201.0	47.2		O		O		O		X									
C-23	Double Seat (Sicma) & Harness, Comp C8	41.0	235.0	96.4		O		X		X		X									
C-24	Single Seat (Sicma) & Harness, Comp C8	23.5	235.0	55.2		O		X		X		O									
C-25	Double Seat (Sicma) & Harness, Comp C9	41.0	269.0	110.3		O		X		X		X									
C-26	Single Seat (Sicma) & Harness, Comp C9.	23.5	269.0	63.2		O		X		X		X									
C-27	Double Seat (Sicma) & Harness, Comp C10	41.0	303.0	124.2		O		X		X		X									
C-28	Single Seat (Sicma) & Harness, Comp C10	23.5	303.0	71.2		O		X		X		O									
C-29	Single Seat (Sicma) & Harness, Comp C11	23.5	337.0	79.2		O		O		O		X									
C-30	Single Seat (Sicma) & Harness, Comp C13	23.5	371.0	87.2		O		O		O		O									

Chart A - Empty weight Checklist

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as weighed Rev. 1 as weighed as weighed

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1		Check 2		Check 3		Check 4		Check 5		Check 6		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
C-31	Double Seat (Sicma) & Harness, Comp C14	41.0	374.9	153.7		O		O		O		O									
C-32	Double Seat (Sicma) & Harness, Comp C15	41.0	405.0	166.1		O		O		O		O									
C-33	Single Seat (Sicma) & Harness, Comp C15	23.1	405.0	93.6		O		O		O		O									
C-34	Upholstered Interior	129.0	301.5	388.9		X		X		X		X									
C-35	Carpet	65.0	273.0	177.5		O		O		O		O									
C-36	Fire Extinguisher, AFT Cabin, RH	2.0	420.0	8.4		X		O		O		O									
C-37	Fire Extinguisher, FWD Cabin	2.0	120.0	2.4		X		X		X		X									
C-38	First Aid Kit., FWD Cabin, LH	2.0	110.0	2.2		X		X		X		X									
C-39	Unusable Fuel, FWD Tank	2.0	204.0	4.1		X		X		X		X									
C-40	Unusable Fuel, CTR Tank	2.0	252.0	5.0		X		X		X		X									
C-41	Unusable Fuel, AFT Tank	3.0	306.0	9.2		X		X		X		X									
C-41	Survial Kit	28.0	375.0	105.0		O		X		X		X									
C-42	USFS First Aid kit	7.5	375.0	28.1		O		X		X		X									
D	Engine & transmission compartment (160-360)																				
D-1	Starter, #1, GE 2CM270D3	35.0	179.0	62.7		X		X		X		X									
D-2	Starter, #2, GE 2CM270D3	35.0	179.0	62.7		X		X		X		X									
D-3	Oil tank, #1, S6130-60205	8.0	181.0	14.5		X		X		X		X									
D-4	Oil tank, #2, S6130-60206	8.0	181.0	14.6		X		X		X		X									
D-5	Usable Oil #1 & #2 Engines, 5 US Gal	37.9	192.5	73.0		X		X		X		X									
D-6	Unusable Oil #1 & #2 Engines, .67 US Gal	5.1	200.0	10.2		X		X		X		X									
D-7	Engine, #1, CT58-140-2	326.0	207.0	672.8		X		X		X		X									
D-8	Engine, #2, CT58-140-1	325.0	207.0	672.8		X		X		X		X									
D-9	Oil, MGB & Cooler	77.0	274.0	211.0		X		X		X		X									
D-10	Pump, Hydraulic, Primary, 65WAP200	18.0	292.0	52.6		X		X		X		X									
D-11	Pump, Hydraulic, Secondary, 66WAP200	18.0	292.0	52.6		X		X		X		X									
D-12	Generator, DC, Bendix 30E20-39	47.0	300.0	141.0		X		X		X		X									
D-13	Generator, #1, AC, Bendix, 2AE20-27A)	96.0	295.0	283.2		X		X		X		X									
D-14	Generator, #2, AC, Bendix, 2AE20-27A)	96.0	295.0	283.2		X		X		X		X									
D-15	Fire Extinguiser, #1, Engine, 891134	19.0	329.0	62.5		X		X		X		X									
D-16	Fire Extinguiser, #2, Engine, 891134	19.0	329.0	62.5		X		X		X		X									
D-17	Cooler, Transmission Oil, Dry, 8582061	28.0	332.0	93.0		X		X		X		X									
D-18	Blower, Oil Cooler	8.0	317.0	25.4		X		X		X		X									
D-19	Detector, Chip, Electric (2)	0.1	188.0	0.2		X		X		X		X									
E	Tail Cone & pylon (493-705)																				
E-1	Catwalk	4.0	543.0	21.7		X		X		X		X									

Chart A - Empty weight Checklist

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Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	as weighed Check 1 In Aircraft	Check 1 Chart C Entry	Rev. 1 Check 2 In Aircraft	Check 2 Chart C Entry	as weighed Check 3 In Aircraft	Check 3 Chart C Entry	as weighed Check 4 In Aircraft	Check 4 Chart C Entry	Check 5 In Aircraft	Check 5 Chart C Entry	Check 6 In Aircraft	Check 6 Chart C Entry	Check 7 In Aircraft	Check 7 Chart C Entry	Check 8 In Aircraft	Check 8 Chart C Entry
E-2	Flux valve & compensator	2.0	543.0	10.9		X		X		X		X									
E-3	Oil, IGB & TGB	5.1	687.0	35.0		X		X		X		X									
E-4	ELT, Artex 406 HM	3.1	511.0	15.8		X		X		X		X									
F	External Equipment																				
F-1	Landing Gear, Main, Fixed	375.0	221.0	828.8		X		X		X		X									
F-2	Landing Gear, Main, Retractable	971.0	221.0	2145.9		O		O		O		O									
F-3	Main tires 6.50x10	50.0	227.0	113.5		X		X		X		X									
F-4	Main tires 6.50x10	50.0	227.0	113.5		X		X		X		X									
F-5	Main tires 6.50x10	50.0	227.0	113.5		X		X		X		X									
F-6	Main tires 6.50x10	50.0	227.0	113.5		X		X		X		X									
F-7	Tail tire 6.00x6	9.0	505.0	45.5		X		X		X		X									
F-8	Ice Deflectors, Engine Intakes	33.0	154.0	50.8		O		O		O		O									
F-9	FOD Screen, Engine Intakes	30.0	167.0	50.1		X		X		X		X									
F-11	Hoist Installation	90.0	154.0	138.6		O		O		O		O									
F-12	Hoist Installation, No Winch		154.0	0.0		O		O		O		O									
F-13	Hoist Installation, Rapel Bracket	25.5	154.0	39.3		O	X	O		O		O									
F-14	Helipro Utility Logging System	85.0	267.0	227.0		X		X		X		X									
F-15	Cabin Entry Steps, FWD	26.0	154.0	40.0		X		X		O		O									
F-16	Antenna, VHF, DMC60-1	3.1	525.0	16.3		X		X		X		X									
F-17	Antenna, VHF, DMC60-1	3.1	630.0	19.5		X		X		X		X									
F-18	Antenna, Glideslope, DMNS25-1	1.0	604.0	6.0		X		X		X		X									
F-19	Antenna, VOR, RH, DMN4-4	1.0	604.0	6.0		X		X		X		X									
F-20	Antenna, VOR, LH, DMN4-4	1.0	604.0	6.0		X		X		X		X									
F-21	Antenna, VHF\FM, Comant, CI-292-3	0.5	89.0	0.4		X		X		X		X									
F-22	Antenna, VHF\FM, Comant, CI-292-3	0.5	89.0	0.4		X		X		X		X									
F-23	Antenna, UHF, Comant, CI-275-3	0.5	70.0	0.4		X		X		X		X									
F-24	Antenna, DME, CI-105-5-100-2	0.3	89.0	0.3		X		X		X		X									
F-25	Antenna, Transponder, Comant, CI-100-2	0.3	142.0	0.4		X		X		X		X									
F-26	Antenna, VHF\FM, Comant, CI-292-3, USFS	0.5	155.0	0.8		X		X		X		X									
F-27	Antenna, VHF\FM, Comant, CI-292-3, USFS	0.5	370.0	1.9		X		X		X		X									
F-28	Antenna, GPS, RH, Trimble, 16248-20, USFS	0.4	120.0	0.5		X		X		X		X									
F-29	Antenna, GPS, LH, Trimble, 16248-20, USFS	0.4	120.0	0.5		X		X		X		X									
F-30	Antenna, GPS, GA-56	0.3	120.0	0.3		X		X		X		X									
F-31	Antenna, GPS, GA-56	0.3	120.0	0.3		X		X		X		X									
F-32	Antenna, Radar Altimeter, S67-2002 (2)	1.0	91.0	0.9		X		X		X		X									

Chart A - Empty weight Checklist

13Mar.09 10-May-09 1-Jun-08 14-Oct-09

Aircraft Model- S61N - S/N 61771 -

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1 (as weighed)		Check 2 (Rev. 1)		Check 3 (as weighed)		Check 4 (as weighed)		Check 5		Check 6		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
F-33	Antenna, ELT	0.5	406.0	1.8		X		X		X		X									
F-34	Antenna, Satellite Phone, A72775	0.8	120.0	0.7		X		X		X		X									
F-35	Light, Strobe,30-0848-17	2.0	150.0	3.0		X		X		X		X									
F-36	Light, Strobe,30-0848-17	2.0	707.0	14.1		X		X		X		X									
F-37	Speaker, External, RH, NAT, TS100WR, USFS	3.9	221.0	8.6		X		X		X		X									
F-38	Speaker, External, LH, NAT, TS100WR, USFS	3.9	221.0	8.6		X		X		X		X									
G	Rotor and Rotor Equipment																				
G-1	Blades, Main Rotor, 61170-20201-067, BIM	1145.0	267.5	3062.9		O		O		O		O									
G-2	Fairing, Main Rotor, Upper Vertical	8.0	267.0	21.4		X		X		X		X									
G-3	Blades, Tail Rotor	31.0	705.0	218.6		X		X		X		X									
G-4	Harness, Bim, Main Rotor	6.6	267.0	17.6		O		O		O		O									
G-5	Blades, Main Rotor, Carson P/N 163-101-1	1135.0	267.0	3030.5		O	X	X		X		X									
H	Additional equipment																				
H-1	Modem, C-1000A, Blue Sky System	4.8	523.0	25.1		X		X		X		X									
H-2	Mount, VS61-0628A-631, C-1000A,, Blue Sky System	0.9	523.0	4.7		X		X		X		X									
H-3	Modem, D-1000C, Blue Sky System	5.6	523.0	29.3		X		X		X		X									
H-4	Mount, VS61-0628A-631, D-1000C, Blue Sky System	0.9	523.0	4.7		X		X		X		X									
H-5	Cabin Unit, 100100, Blue Sky System	1.8	110.0	2.0		X		X		X		X									
H-6	Mount, VS61-0628A-621, Cabin Unit, Blue Sky System	0.7	110.0	0.8		X		X		X		X									
H-7	Adapter, Telephone, PTA12-100, Blue Sky System	0.6	84.0	0.5		X		X		X		X									
H-8	Head, Control, ACH-1000, Blue Sky System	1.2	84.0	1.0		X		X		X		X									
H-9	Antenna, Dual Channel, S67-1575-165, includes Mount, Blue Sky System	2.1	437.0	9.2		X		X		X		X									
H-10	Life Raft, FWD	73.3	138.5	101.5		O		O		O		O									
H-11	Life Raft, AFT	73.3	371.0	271.9		O		O		O		O									
H-12	Kawak Aux. Hyd. System Model 36000	108.0	308.3	332.9		O		X		O		O									
H13	Isolair Installation Kit	16.0	149.0	23.8		O		X		X		X									
H-14	Isolair Tank Assy.	695.0	259.0	1800.1		O		O		O		O									
H-15	Isolair Hover Pump Assy	90.0	207.5	186.8		O		O		O		O									
H-16	Fwd baggage bin floor liners	20.0	167.0	33.4		O		X		O		O									

Chart A - Empty weight Checklist

13Mar.09 10-May-09 1-Jun-09 14-Oct-09

Aircraft Model- S61N - S/N 61771 -

Item Number	ITEMS AND LOCATION GROUPED BY COMPARTMENT	Weight	Arm	Moment/100	Delivery Equipment	Check 1 (as weighed)		Check 2 (Rev. 1)		Check 3 (as weighed)		Check 4 (as weighed)		Check 5		Check 6		Check 7		Check 8	
						In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry	In Aircraft	Chart C Entry
H-17	Aft baggage bin floor liners	10.0	370.0	37.0		O		X		X		X									

APPENDIX 4

N261F Chart B Reverse
Dated 10-14-09

Chart "B" Reverse

DESCRIPTION	NET WT	HORZ	HORZ MOMENT	1 MOMENT/100	LAT	LAT MOMENT	1 MOMENT/100
TOTAL (As weighed) (From front side)	12297.2	261.8	3219255.6		0.0	0	
TOTAL OF ITEMS WEIGHED BUT NOT PART OF WEIGHT EMPTY	370.5		109851.3	subtracted		0	
TOTAL OF WEIGHT EMPTY ITEMS NOT IN AIRCRAFT WHEN WEIGHED	0.0		0.0	added		0	
BASIC AIRCRAFT (Post to Chart C)	11926.7	260.7	3109404.4	31094.0	0.0	0	0.0

COLUMN I

ITEMS WEIGHED BUT NOT PART OF WEIGHT EMPTY	WEIGHT	HORZ ARM	MOMENT	LAT ARM	MOMENT
C-22 Single Seat C7	23.5	201.0	4723.5		
C-26 Single Seat C9	23.5	269.0	6321.5		
C-28 Single Seat C11	23.5	337.0	7919.5		
C-23 double seat C8	41.0	235.0	9635.0		
C-25 double seat C9	41.0	269.0	11029.0		
C-27 double seat C10	41.0	303.0	12423.0		
C-34 Upholstered Interior	129.0	301.5	38893.5		
C-2 Cargo net installation	6.0	447.5	2685.0		
C-3 Cargo net	6.5	447.5	2908.8		
C-41 Survival Kit	28.0	375.0	10500.0		
C-42 USFS First aid kit	7.5	375.0	2812.5		
TOTAL	370.5		109851.3		0.0

COLUMN II

WEIGHT EMPTY ITEM NOT IN AIRCRAFT WHEN WEIGHED	WEIGHT	HORZ ARM	MOMENT	LAT ARM	MOMENT
				0	0
TOTAL	0.0		0.0		0

REACTIONS USED

TYPE SCALE Evergreen Model 3-0057-BA-C4
SERIAL NUMBER 1078-C4
CALIBRATION DATE (MMDDYY) 03/20/08
CALIBRATED ACCURACY

REMARKS

THE MAINTENANCE DESCRIBED ABOVE HAS BEEN PERFORMED IN ACCORDANCE WITH THE APPLICABLE STANDARDS OF AIRWORTHINESS

[redacted]

Sign Date ACA

* Enter constant used

APPENDIX 5

N261F Chart C
Dated 10-14-09

WEIGHT EMPTY and BALANCE RECORD

CONTINUOUS HISTORY OF CHANGES IN STRUCTURE OR EQUIPMENT AFFECTING WEIGHT & BALANCE

MODEL S-61N SERIAL NO

CHART C SHEET

DATE	ITEM NO IN	ITEM NO OUT	DESCRIPTION OF ARTICLE OR MODIFICATION	ADDED (+) WEIGHT (LB)	ADDED (+) HORIZONTAL MOM/100	ADDED (+) LATERAL MOM/100	REMOVED (-) WEIGHT (LB)	REMOVED (-) HORIZONTAL MOM/100	REMOVED (-) LATERAL MOM/100	RUNNING TOTAL EMPTY AIRCRAFT WEIGHT (LB)	RUNNING TOTAL EMPTY AIRCRAFT HORIZONTAL MOM/100	RUNNING TOTAL EMPTY AIRCRAFT HORIZONTAL C.G	RUNNING TOTAL EMPTY AIRCRAFT LATERAL MOM/100	RUNNING TOTAL EMPTY AIRCRAFT LATERAL C.G
Oct. 14/09			Aircraft as Weighed							12297.2	32192.6	261.8	0.0	0.0
							Running Totals			12297.2	32192.6	261.8	0.00	0.0

APPENDIX 6

Aircraft Calibration Certificate

CALIBRATION CERTIFICATE

KIT MODEL: 7 - 0057 - BA - 4C DATE: MARCH 20, 2009

KIT S/N: 1078 - 4C

INDICATOR S/N: 1078 - 4C

ROAD RUNNER I

SCALE SYSTEM FOR VEHICLES & AIRCRAFT

CALIBRATION DATA

Kgs Applied	YELLOW S/N 1705 READING	YELLOW S/N 1705 FINAL	BLUE S/N 1853B READING	BLUE S/N 1853B FINAL
500	498	500	499	500
1000	997	1000	998	999
1500	1496	1500	1497	1499
2000	1995	2000	1996	1999

Kgs Applied	GREEN S/N 1016 READING	GREEN S/N 1016 FINAL	RED S/N 1065 READING	RED S/N 1065 FINAL
500	500	500	500	500
1000	999	1000	1000	1000
1500	1498	1500	1500	1500
2000	1999	2000	1999	2000

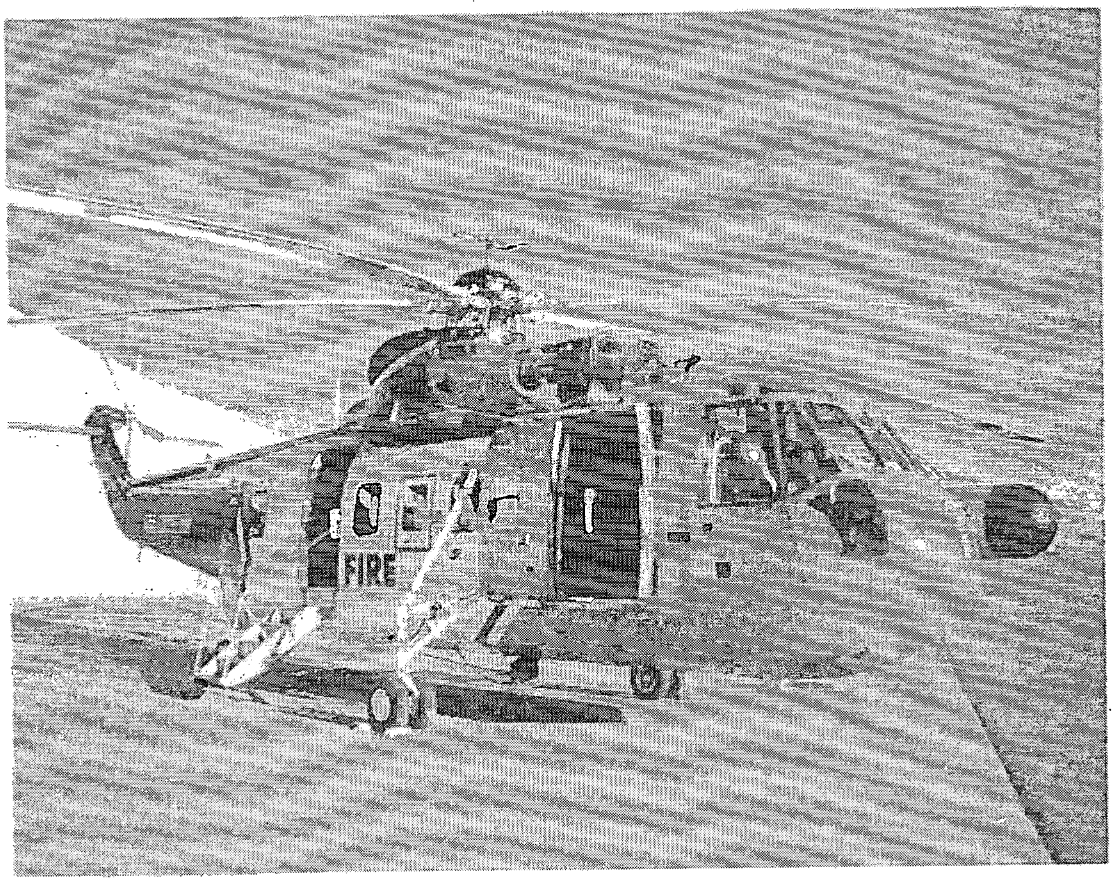
CALIBRATION TECHNICIAN: [redacted]

Island Scales Limited 21 Cadillac Place Nanaimo, B.C V9R 6Z5
Phone: (250) 741-0093 Fax: (250) 741 0093

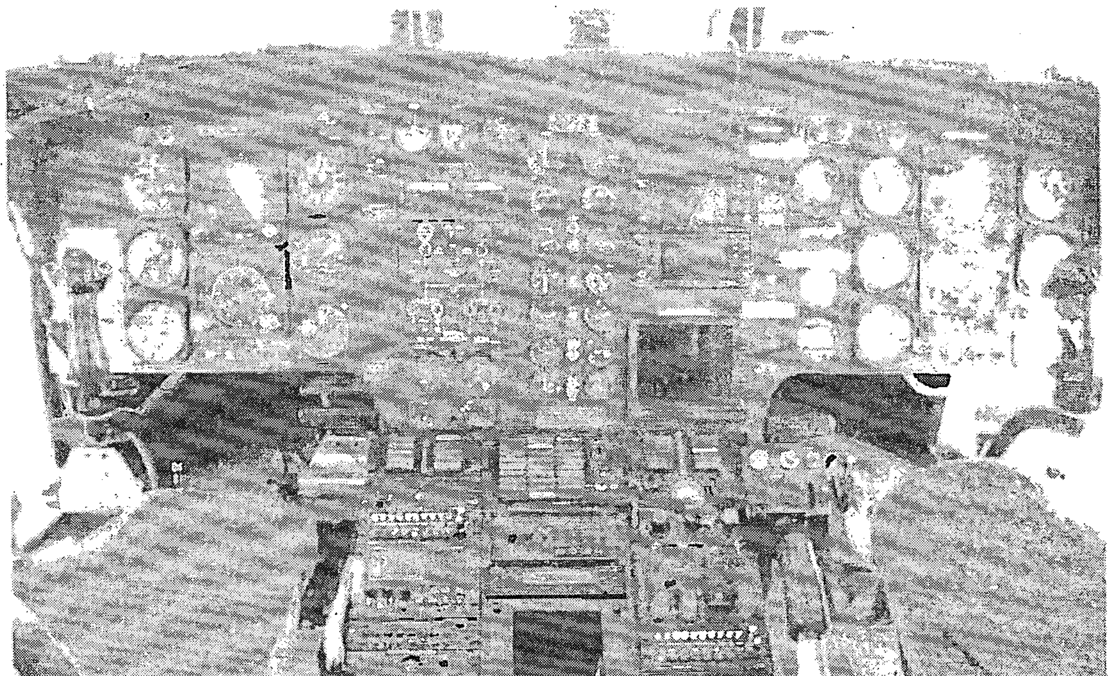
Scale(s) Have Been Calibrated With Certified and Traceable Test Weights

APPENDIX 7

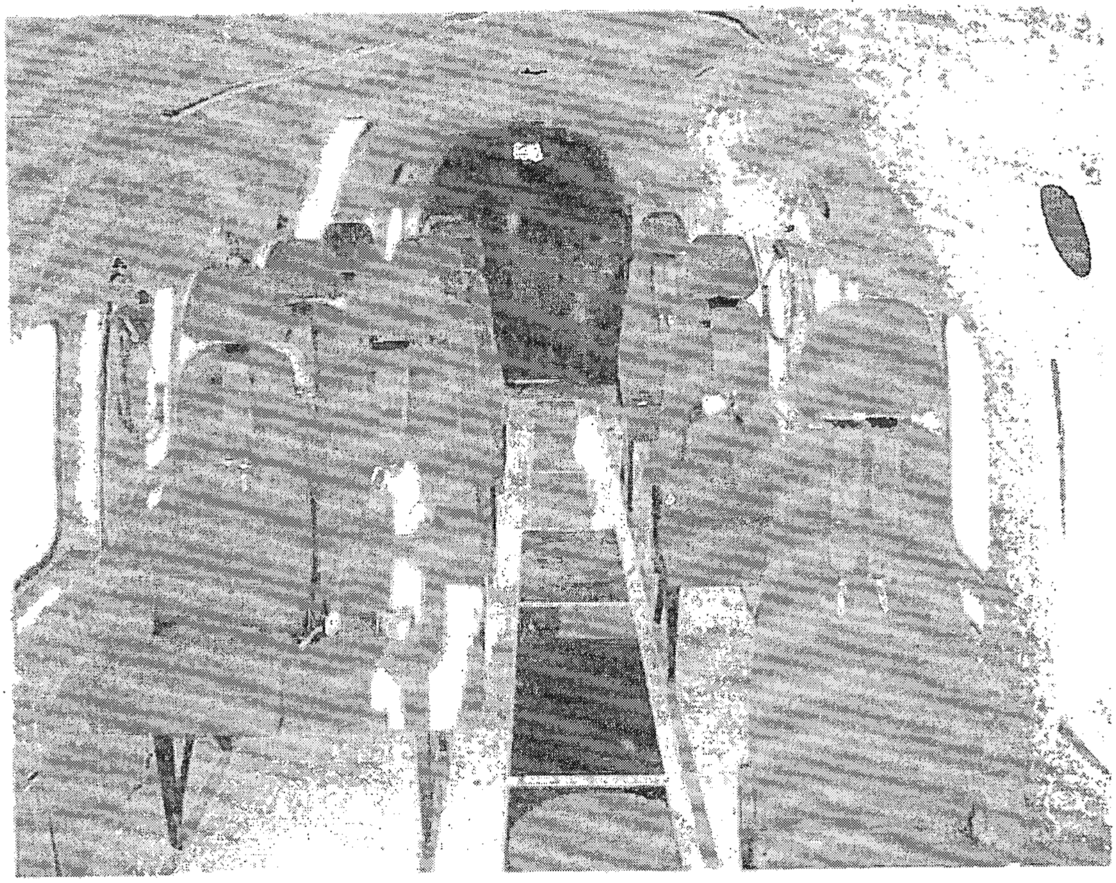
Reference Pictures



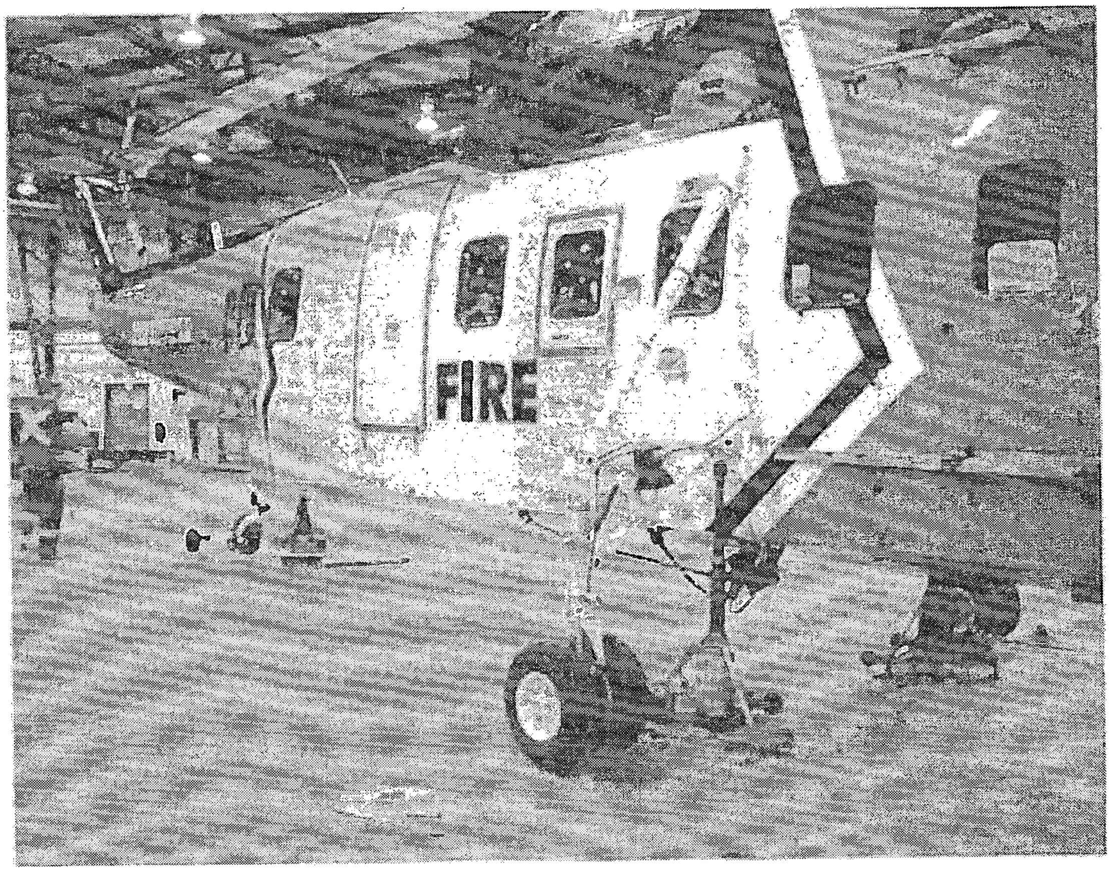
N 261F Exterior



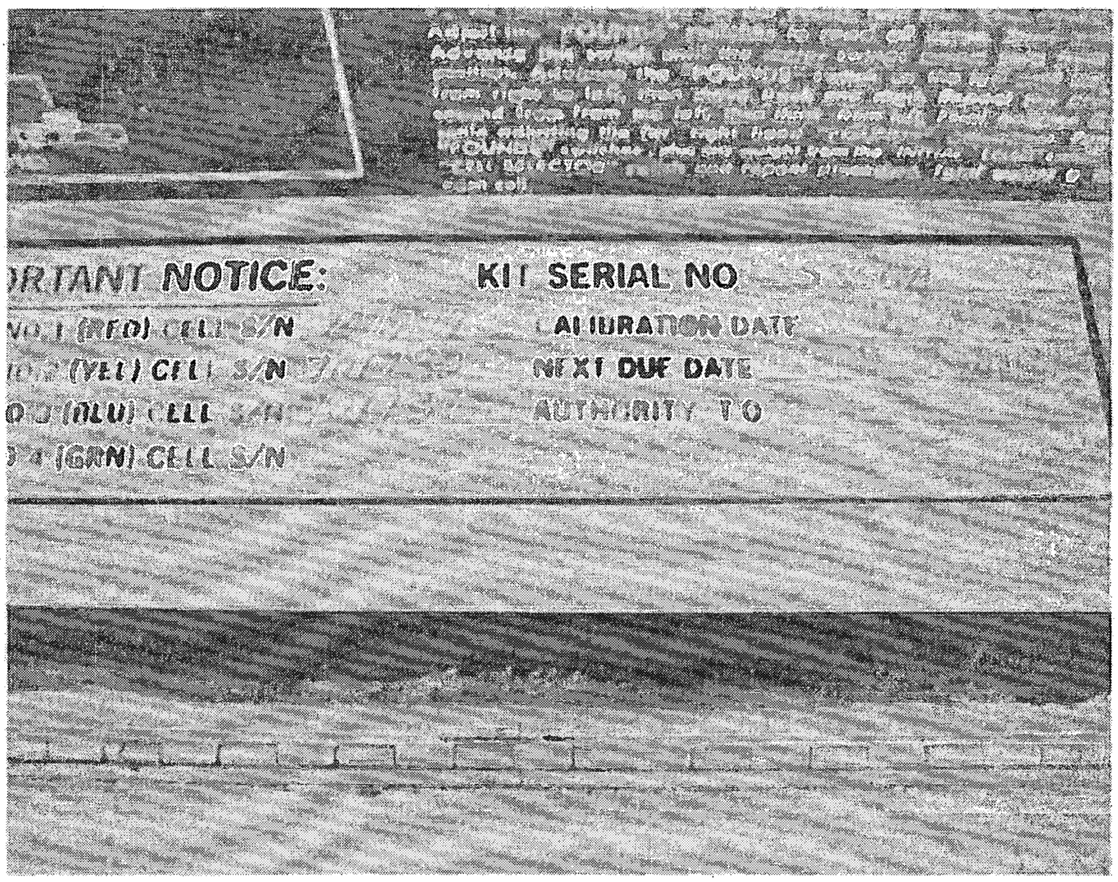
N 261F Cockpit



N 261F Passenger Cabin



N 261F On Aircraft Scales



Scale Calibration Tag

Carson Helicopters Flight Evaluation with S61N Helicopter

RE: Weaverville Helicopter Accident N612AZ; Summary of 3 November 2009 Flight Test

1. Basic Description of Evaluation

On 3 November 2009, a flight performance evaluation was done by Whipple Aviation Services in conjunction with VIH Cougar Helicopters on behalf of Carson Helicopters, Inc. The evaluation utilized an S-61N helicopter equipped similarly to helicopter N612AZ when it crashed near Weaverville, CA on 5 August, 2008. The purpose of the evaluation was to assess the helicopter's performance when configured like N612AZ and flown at a density altitude similar to that experienced by N612AZ during the takeoffs from Helispot 44. The aircraft was also flown at gross weight conditions significantly in excess of the NTSB's theoretical weight of N612AZ during the accident takeoff.

The test aircraft was an S-61N long body, fixed gear helicopter equipped in firefighting configuration with a 700 gallon water bucket and 200 ft. longline. The use of the longline attached to a calibrated load cell on the aircraft allowed precise metering of the water/weight load to allow accurate control of the flown weights. The aircraft was de-fueled and weighed at Reno the day of the test utilizing calibrated scales and witnessed by an FAA Designated Airworthiness Representative prior to being placed in the Experimental Category for purposes of the test. The load cell was calibrated on 9/9/09. The engines were tuned and calibrated to match the topping limits and power output of N612AZ as of 8/4/08 (the last power check performed prior to the accident). Winds were calm for the evaluation flights. The flights were monitored by an independent aviation consultant and were videotaped. The helicopter was flown by VIH Cougar pilots. The five onboard pilots observing the flights from three different firms had combined flight experience in excess of 60,000 hours.

Carson disputes the meteorological conditions during the accident takeoff that are reported in the NTSB accident group investigation reports. For comparison purposes, the NTSB estimates the takeoff conditions as 5,980 ft. pressure altitude and 23 deg. C temperature, for a density altitude of 8,476 ft., with no wind. N612AZ lifted off from H44 in ground effect, came to a short hover about 50 – 60 ft. above ground level (AGL), in or near ground effect, then transitioned to forward flight. Carson's analysis is that the temperature was 20 degrees C., with a quartering headwind of 3 – 5 knots. The NTSB's listed conditions are based on meteorological analysis of extrapolated data taken from weather stations located several miles from the accident site. Carson's analysis is based on instrument readings taken from the cockpit voice recorder from the accident aircraft, ground witnesses who were qualified weather observers, and analysis of local conditions by an independent meteorologist.

Carson also disputes the current listed weight for N612AZ as formulated by the NTSB investigators. The NTSB postulates that the takeoff weight of N612AZ was approximately 19,010 lbs. Carson's reconstruction and analysis shows that the aircraft weighed approximately 18,600 lbs. Despite any confusion regarding the weight or weather conditions of N612AZ at the time of the accident, the 3 November 2009 flight test shows that with normally operating engines and rotor system N612AZ should have had sufficient power to safely take off and conduct its mission at the time of the accident, even at the higher weight the NTSB has ascribed to the aircraft.

The test aircraft was flown at density altitudes ranging from <u>8,450 ft. to 8,551 ft.</u>, with all but one test point exceeding the NTSB's theoretical density altitude for the accident. The winds at the location and altitude of the test were negligible, matching the conditions stated in the Group Operations report.

On each test run, the aircraft picked up its water/weight load from a lake at 5,588 ft. above mean sea level (MSL) and then ascended to the desired pressure altitude of 6,700 ft. above MSL to achieve the desired density altitude. The aircraft then came to a hover at 400 ft. AGL, completely out-of-ground effect (OGE). The collective pitch control was then pulled up to its Maximum Stop in order to bleed Main Rotor RPM down as low as possible and held there to duplicate sustained maximum rotor droop conditions.

2. <u>Primary Observations from the Test</u>

Full detailed results are contained in the Whipple Aviation Services Report, but several important facts should be highlighted:

<u>1st Test Run</u> – aircraft weight 19,100 lbs. – from a stabilized out-of-ground effect hover, full collective was pulled up, Main Rotor RPM (NR) decayed to 94% and stabilized there; Main Rotor RPM would not droop below 94%. Aircraft was still exhibiting a 200 feet per minute (FPM) positive rate of climb. A one inch deflection (lowering) of the collective resulted in Main Rotor RPM recovery to 100% within 2 seconds.

<u>2nd Test Run</u> – Eight separate hover performance tests were conducted during this test run as outlined below. Each test was at slightly different gross weight due to fuel consumption.

Tests 1 to 5 – Aircraft weight ranged from 18,643 lbs. to 18,300 lbs. From a stabilized out-of-ground effect hover at 400 ft. above ground level, full collective was pulled up and sustained at the stop; Main Rotor RPM drooped to 94%, then stabilized and would not decay below 94%. The aircraft exhibited rates of climb varying from neutral to +300 FPM. One inch of collective deflection brought the Main Rotor RPM back to 100% or above within two seconds.

Tests 6 to 8 – Aircraft weight ranged from 19,543 to 19,393 lbs. Aircraft flew from the lake up to 400 ft. above ground level and came to a stabilized hover out-of-ground effect. With full collective pulled up, Main Rotor RPM drooped to 94%, but would not decay below 94%. The aircraft very slowly settled, with power, with a negative rate of climb of -250 FPM. One inch deflection of collective restored Main Rotor RPM to 100% or above, and the aircraft exhibited immediate positive rates of climb.

Test 8 – This test was performed by pulling up maximum collective as in the prior tests, but the speed selector lever – throttle (SSL) for the number 2 engine was then reduced, bringing the engine output torque down to 70%. The Main Rotor RPM rapidly decayed below 91% without stabilizing or hesitating and the aircraft developed a rapid -500 to -600 FPM rate of descent. The collective was then reduced, the SSL advanced to restore power to the number 2 engine, and the aircraft recovered torque and Main Rotor RPM and was flown into a climb.

3. Key Conclusions

A. In every case, even at weights exceeding 19,500 lbs. (well above what the accident aircraft could have weighed), the test helicopter successfully (i) picked up water weight from a lake at 5588 ft.; (ii) flew up to 400 ft. above ground level; and (iii) came to a stabilized hover.

B. From a stabilized out-of-ground effect hover, maximum sustained collective input representing maximum rotor droop conditions beyond what would normally be applied, resulted in a droop to a stabilized 94% Main Rotor RPM, beyond which the rotor system would not droop. Even at this maximum condition, the aircraft exhibited positive rates of climb.

C. The most minor collective correction by the pilots resulted in recovery of the rotor system within 2 seconds to 100% Main Rotor RPM or above, and positive rates of climb.

D. Even at weights several hundred pounds greater than the weight of N612AZ at the time of the accident, the one and only condition in which rapid rotor droop below 94% Main Rotor RPM with unrecoverable flight conditions could be induced was by reducing power to one engine by approximately 25%.

Restoration of power and minimal collective drop resulted in immediate recovery of the Main Rotor RPM and a positive rate of climb, even at 19,400 lbs.

The evaluation clearly demonstrates that even with an aircraft loaded to weights beyond the accident aircraft, an exemplar helicopter at the same density altitude with the composite main rotor system could repeatedly:

- Safely ascend and come to a hover well out of ground effect and fly the loads effectively with normal pilot input.

- Maintain a 94% Main Rotor RPM and hover even *with* maximum droop induced by maximum collective input. At all but the heaviest possible weights, the aircraft still maintained a positive rate of climb under these maximum droop conditions.

- Recover Main Rotor RPM to 100% in less than 2 seconds and immediately register positive rates of climb with a very minimal deflection of collective input.

The only condition under which this aircraft could mimic the rapid Main Rotor RPM decay below 91% as shown on the cockpit voice recorder spectrum analysis of the accident aircraft and not effectively fly the heaviest loads encountered was when power was rolled off of one engine by 25%. The flight test indicates that at the time of the accident, N612AZ should have been able to successfully take off and complete its mission absent an event resulting in loss of power to the rotor.

Whipple Aviation Services LLC

Russell Whipple is an independent contract pilot and aviation safety consultant. He has owned and operated Whipple Aviation Services for 15 years and specializes in operational efficiency as well as safety and risk management issues for both fixed wing and helicopter operations worldwide. He has several major industry clients in the energy sector, and has done consulting work for auditing aviation operations for government agencies. He has been called upon to conduct safety audits, construct safety programs, and engage in pilot training operations, as well as appear as an expert witness for aviation related matters.

Mr. Whipple is certified as both a US and Canadian Airline Transport Pilot and is type rated in the SK-64,SK-61, HU-500, B-206.

He has been a professional pilot for more than 40 years flying a variety of missions all over the world, in mountain conditions, beginning in Vietnam in 1969 as an AH1-G Cobra pilot.

He has worked for a variety of commercial operators in addition to his own consulting business, engaging in a mix of external load and part 135 transport operations.

Major Flight time

Sikorsky CH-54,SK-64 E & F: SK-61 A,V,L,& N	12,550+ hours
Bell AH-1 G,J, F Cobra; B-204,B-205 A-1, Bell 214 B-1 Bell 206,Bell 47, B-1, UH-1 A,B,,C,D, H, M	5,100 hours
Hughes 269-A; HU-300 C; HU-500 A,C,D,E,F	3,800 hours
Assorted Fixed wing airplane time	900+ hours
Total approximate flight time	**22,350 + hours**

Confidential & Proprietary

From: Confidential & Proprietary
Sent: Monday, June 09, 2008 8:36 AM
To: Brandon VanAtta
Subject: TEARDOWN REPORT PO# 2080722
Attachments: CARSON P5308-T.pdf

Don & Jeff-

Attached is a teardown report on your Fuel Control, S/N 89674BR, PO# 2080722, WO# P5308.

Contamination found in all areas of Fuel Control inspected. Due to the amount of contamination we require approval to disassemble & clean for a contamination repair and estimate. Warranty is not accepted due to this contamination.

We will await your approval to proceed.

COLUMBIA HELICOPTERS

Brandon Van Atta
Propulsion Systems | Maintenance Marketing Representative
14452 Arndt Road NE, Aurora, Oregon 97002
[redacted]

REMOVED FROM 612A7
5-12-08

Form No. CHI-M-737
~~02/12/03~~
04/07/03

COLUMBIA HELICOPTERS, INC.

AURORA AIRPORT
AURORA, OREGON 97002
FAA APPROVED REPAIR STATION #CHIR823C

OVERHAUL/REPAIR REPORT

P/N: 725725-5	S/N: 89674BR	DATE: 05-23-08
TSO: 45.1	TT: UNK	W/O#: P5308

CUSTOMER INSTRUCTIONS: WARRANTY REPAIR CONSIDERATION REQUESTED

REASON FOR REMOVAL: LOST POWER, DID NOT RESPOND TO SPEED SELECTOR OR MANUAL THROTTLE

EXTERNAL CONDITION: GOOD

COVERS INSTALLED: YES PRESERVED: NO

TEST BEFORE STRIP: NO

STRIP REPORT SUMMARY

COMPONENT	PART NO.	CONDITION

WORK UNDERTAKEN: INSPECTED FILTER, PRESSURE REGULATING VALVE, AND THROTTLE VALVE END CAP.

REMARKS: FOUND CONTAMINATION (METAL AND OTHER MATERIAL) IN ALL AREAS INSPECTED. DUE TO CONTAMINATION WARRANTY IS NOT ACCEPTED.

MECHANICS SIGNATURE: DATE: 06-04-08

FORM NO. CHI-M-C146
DESC FUEL CONTROL

CUST # 300304 - CARSON SERVICES INC

REPAIR STATUS Repair

P/N 725725-5
MFG S\N 24928 S/N
WHS NO TSO 1231.8
ZONE NO TT
BIN NO TC
QTY 1.0

CARSON SERVICES INC
952 BLOOMING GLEN RD
PERKASIE, PA 18944

AIRCRAFT AND COMPONENT WORK ORDER

Columbia Helicopters, Inc.
PO BOX 3500
PORTLAND, ORE. 97208
AURORA AIRPORT
AURORA, ORE. 97002
(503) 678-1222
Approved Repair Station CHIR823C

W.O. NO. **P5350**
Pg 1 of 1

DATE	06/23/2008
SHOP	ENG
TYPE	Non-Inventory
60 Month Shelf Life (Five Years)	
WO PLANNER	Van-Atta
EST. COMP. DATE	08/23/2008

PO# 2080856 **COST EST. REQ'D**REPAIR IAW SEI 185 R18**LARGE FLUCTUATIONS OF NG, Q, FUEL PRESSURE WHEN USING SPEED SELECTOR. NO FLUCTUATIONS WHEN USING EMERGENCY THROTTLE**

CUSTOMER

REMARKS	OPER NO.	DESCRIPTION	CMP DATE	INL/STAMP
	31	PRELIMINARY INSPECTION	7-1-08	
	33	REPAIR	7-2-08	
	34	NDT INSPECTION — NOT REQUIRED AT THIS LEVEL OF MAINTENANCE	NA	itial & Pr
	35	ASSEMBLE/BALANCE	7-2-08	
	36	TEST	7-8-08	
	106	SAFETY AND PAPERWORK		
	37	FINAL INSPECTION		
	599	SHIPPING		

REMOVED FROM 61242 6/7/08
COLUMBIA REPLACED LEVU LLG
VALVE + SLEEVE, + PRV SLEEVE
AND INSTALLED ON TEST BENCH.
FAILED TEST BENCH FOR
FLUCTUATIONS. SUBSEQUENTLY
SHIPPED TO PERKASIE

P5433 2-18-2009

BILLED JAN 2 3 2009

RECEIVED

DATE ________ INITIALS ________

ISSUED TO ________
CHARGE TO

COST CODE 082

Date the Maint
Print name of
approved the

DATE ________ NAME ________

COL 002618

A/C Reg. No/Comp No. 725725-5	Comp. S/N: 24928	A/C/Comp TT: UNK	Work Order No.: P5350	Shop: ENG

Item No.	Date	Discrepancy	R.I.I. (Check if required)	Corrective Action
31-1	7/1/08	LEAD LAG VALVE AND SLEEVE STICKS PN 573370		REPLACED VALVE AND SLEEVE IAW. SGI 185 REV 18 SECTION 73-20-5

Ser. No. Off	Ser. No. On	Date Corrected
1170	527	7/2/08

Discovered By	Corrected By	Inspected By
		CHI 114

Confidential & Proprietary

Item No.	Date	Discrepancy	R.I.I. (Check if required)	Corrective Action
31-2	7/1/08	PRV SLEEVE HAS ID OF .3785 PRV VALVE OD OF .3771 RESULTING IN .0014 DIFERENCE PN 734913-1		REPLACED PRV SLEEVE IAW SGI 185 REV 18 SECTION 73-20-5

Ser. No. Off	Ser. No. On	Date Corrected
NR	NR	7/2/08

Discovered By	Corrected By	Inspected By
		CHI 139

Confidential & Proprietary

Item No.	Date	Discrepancy	R.I.I. (Check if required)	Corrective Action
31-3	7/1/08	AD 81-18-03 NOT COMPLIED WITH		C/W AD 81-18-03

Ser. No. Off	Ser. No. On	Date Corrected
NR	NR	7/2/08

Discovered By	Corrected By	Inspected By
		CHI 114

Confidential & Proprietary

Item No.	Date	Discrepancy	R.I.I. (Check if required)	Corrective Action
36-1	8/20/08	Fluctuations on Engine test Cell See CHI-M-1184.		

Ser. No. Off	Ser. No. On	Date Corrected
		/ /

Discovered By	Corrected By	Inspected By
Mike Creestad		

RECORD ALL WORK ACCOMPLISHED ON AIRCRAFT/COMPONENT

COLUMBIA HELICOPTERS, INC.

IN-SHOP DISCREPANCY/WORK RECORD

Form No. CHI-M-24D
~~Dec 15/82~~
Aug 26/02

USE COMPLETE LAST NAME

COL 002654

Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A02P0320

LOSS OF ENGINE POWER / COLLISION WITH TREE

HAYES HELICOPTER SERVICES LIMITED
SIKORSKY S-61N (SHORTSKY) HELICOPTER C-FHHD
LAKE ERROCK, BRITISH COLUMBIA
16 DECEMBER 2002

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

Loss of Engine Power / Collision with Tree

Hayes Helicopter Services Limited
Sikorsky S-61N (Shortsky) Helicopter C-FHHD
Lake Errock, British Columbia
16 December 2002

Report Number A02P0320

Summary

At about 1200 Pacific standard time, the Sikorsky S-61N helicopter, C-FHHD, serial number 61490, took off from the service landing area near Lake Errock, British Columbia, with two pilots and an aircraft maintenance engineer on board to carry out performance adjustments to the engines. Two minutes later, while the helicopter was climbing through about 1000 feet above sea level (asl) at about 65 knots, the crew became aware of an intensifying whining sound which was followed by a single, loud bang. Immediately the number 1 engine lost power and the number 2 engine did not automatically compensate for the power loss.

The pilot-in-command (PIC) lowered the collective lever to enter autorotation and pushed the cyclic stick forward. Acrid smoke filled the cockpit, and flames appeared from the lower left section of the main rotor gearbox in the cabin. The PIC manoeuvred the helicopter for a southwest autorotative landing on a vacant and straight segment of Highway 7 near the Lake Errock village. During the last seconds before touchdown, the pilots saw powerlines across the road, and the PIC increased the collective to reduce the descent to avoid them. The helicopter was landed on the road at about 20 knots ground speed and the wheel brakes were applied. During the roll-out, the helicopter struck other powerlines across the road, and the main rotor blades severed a large tree on the left side of the road. The helicopter veered right and the tail rotor and tail pylon struck the same tree and broke away from the fuselage. The helicopter then started to vibrate severely, with large airframe oscillations, but it remained upright and stopped at the right-hand edge of the road. The three occupants received minor injuries, and the helicopter was substantially damaged. The in-flight fire in the cabin roof was brief and localised, and it self-extinguished.

Ce rapport est également disponible en français.

Other Factual Information

Pilots

The pilots were trained and licensed appropriately for the helicopter and the mission. They were each experienced and qualified heli-logging pilots and had worked for the operator for several years.

Both pilots were wearing seat lap-belts and protective helmets, however, neither was wearing the available shoulder harness. Their helmets sustained damage from multiple strikes with the cockpit interior during the oscillations on the ground that likely would have caused serious injuries to an unprotected head. The aircraft maintenance engineer was not seated and was injured as a result of repeated contact with the interior cabin structure near the cockpit entry.

General Information

No formal weather observation exists for the area of the accident; however, the general weather conditions were an overcast sky with fog patches and light wind.

A review of the aircraft technical logs indicates that the helicopter was certificated and maintained according to the required Transport Canada (TC) standards.

After the accident, the two fuel gauges on the cockpit instrument panel each showed a fuel quantity of about 1000 pounds. Given that the flight lasted only two minutes, the helicopter took off with a total fuel quantity in the order of 2100 pounds. Fuel samples were examined from the refuelling source, the helicopter tanks, and all the engine fuel control components. As a result of these tests, it was concluded that the fuel on-board the helicopter at the time of the accident was not contaminated and was not a factor in the accident.

Using the most recent weight and balance records, it was determined that the helicopter was about 13 300 pounds at take-off with a centre of gravity (CG) about 270 inches aft of the datum. The maximum allowable weight of the helicopter is 22 000 pounds with a CG range of 258 to 276 inches aft of the datum. Accordingly, weight and balance were not factors in this accident.

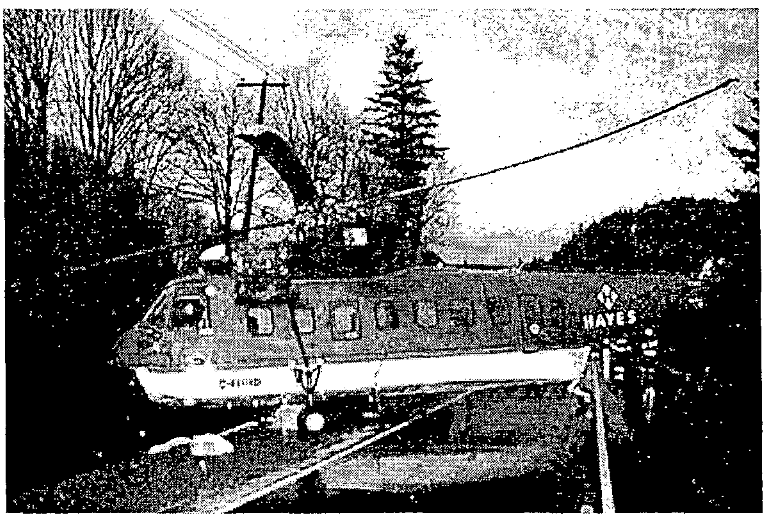


Photo 1. C-FHHD on Highway 7 after the accident

Sikorsky S-61N C-FHHD

C-FHHD was owned and operated by Hayes Helicopter Services Limited of Duncan, British Columbia (B.C.), and was principally engaged in heli-logging activities in B.C. The helicopter was originally manufactured by Sikorsky Aircraft in 1971, and was later modified by Heli-Pro Corporation in March 1996 to the shorter, civilian *Shortsky* model, similar in size to the military SH-3 "Sea King" helicopter. Sikorsky Aircraft Design Engineering was not involved in the modification, and Hel–Pro Corporation was not Sikorsky-approved. The modification was not approved by Sikorsky; however, it was approved by Transport Canada (TC). The helicopter is equipped with two General Electric Aircraft Engines (GEAE) model CT58-140-1 gas-turbine engines. At the time of the accident, the helicopter had accumulated about 30 323 hours total flight time as both original and modified airframes.

Main Rotor Gearbox

The main rotor gearbox (MGB) had been most recently overhauled by the TC-approved Hayes overhaul facility in Duncan and was installed in C-FHHD on 29 September 2002. At the time of the accident, it had accumulated 361 hours in service since overhaul, for a total service life of 27 220 hours. Following the accident, the MGB was removed from the airframe and inspected, disassembled, and examined at a TC-approved overhaul facility in Richmond, B.C., under the direct supervision of TSB investigators.

The MGB attachment fittings on the fuselage were intact. The MGB was undamaged, with the exception of the Number 1 (left)[1] input pinion gear (Photo 2) which had fractured just forward of the forward bearing journal, and its associated forward plain bearing (located in the MGB cover) which had mostly disintegrated. The splined coupling showed severe rub on the gimbal ring.

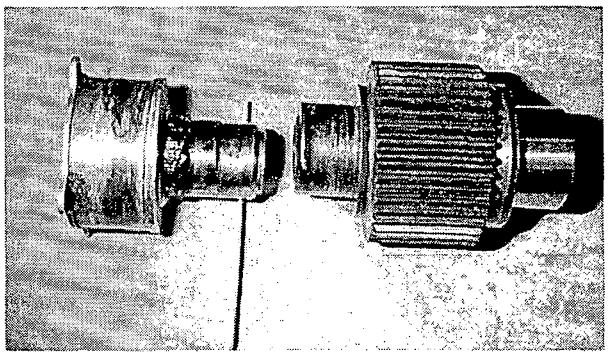


Photo 2. Fractured left input pinion

Number 1 Input Pinion Gear

Once the number 1 plain bearing began to fail, the adjacent carbon seal broke down, allowing oil to spray out from the MGB. Without sufficient lubricant, the number 1 pinion rapidly overheated and weakened, leading to thermal distress, distortion, and subsequent fracture. The pinion fracture surface exhibits equiaxed ductile dimples, indicating tensile or bending overload, rather than torsional overload. Accordingly, the torque on the pinion was low when it broke. While components adjacent to the fracture were covered with soot, oil, and grease, the fracture surface itself was free of contamination, which may indicate that the break occurred after the grease and oil sprayed from the damaged bearing and coupling, and after the fire.

Dimensional examinations revealed about four degrees of bend on the pinion and about four degrees of bend in the high-speed shaft. By design, the splined coupling accommodates about four degrees of deflection before either the high-speed shaft or the pinion starts to bend. As well, the forward end of the shaft exhibits damage that occurred when the forward flexible coupling was bent beyond normal limits, and while the shaft was still rotating. Theoretically, it is likely

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1 For consistency, the term "Number 1" refers to the left-hand MGB input components: similarly "Number 2" refers to the right-hand components.

that about eight degrees of misalignment existed, and likely less since the deviation was a dynamic whirl, not static bending. Such misalignment may have been possible with intact engine mounts and MGB attachment fittings.

Structural analyses of the stresses present at the fracture site revealed that the initial effect of lubricant loss was severe and rapid friction wear between the pinion gear and the bearing. As the wear progressed, the gear radially displaced from the centerline of rotation, allowing the entire shaft assembly to orbit, creating a centrifugal load imbalance that would have been manifest as a high-frequency vibration. The imbalance would have also created a remarkable bending load on the components, forming the highest stress at the fracture point on the pinion. Calculations showed that such centrifugal forces can create bending loads that exceed the ultimate tensile strength of the pinion with about three degrees of coupling misalignment. Since the pinion was subjected to thermal distress as well, the ultimate tensile strength would have been reduced, and the misalignment required to fail the component would have been proportionally less. Given this situation, it could be said that the misalignment could have occurred with intact engine mounts; although a possibility, there is insufficient information to be conclusive.

Input Freewheel Units

The input freewheel units (IFWU) were installed in the MGB on 26 November 2002 at 30 303 airframe hours, and each had accumulated 20 hours in service at the time of the accident. The IFWUs demonstrated normal wear with no evidence of slip or spit-out. There are, however, inconclusive marks of skidding on roller G on the number 1 IFWU. Damage to such specific areas can indicate IFWU slip or roller spit-out; absence of such evidence is not conclusive that slip or spit-out did not occur. As well, a small amount of fine debris from the disintegrated plain bearing was found in both IFWUs; such contamination can cause IFWU slip.

Rotor Blades

The main- and tail-rotor blades exhibited damage patterns and overload fractures that are consistent with considerable rotor rpm at impact with an object, and characteristic of blades that were not being driven at impact. One main rotor blade fractured about four feet from the blade root, and other pieces of the main rotor blades were found several hundred feet away. Such blade damage caused massive main rotor dynamic imbalance and led to the severe vibration and airframe oscillations experienced on the ground.

CT58-140-1 Engines - General

The two gas-turbine engines are the GEAE CT58-140-1 model, serial numbers 280309KL (Number 1) and 280324KL (Number 2). The number 1 engine was installed in C-FHHD on 12 August 2002 at 29 571 airframe hours, with 998 hours since major overhaul; at the time of the accident it had accumulated another 752 hours, for a total time of 1750 hours since overhaul. The number 2 engine was installed in C-FHHD on 27 November 2002 at 30 303 airframe hours with zero hours since major overhaul; at the time of the accident it had accumulated 20 hours total time since overhaul. Both engines had been most recently overhauled by TC-approved Aero Turbine Support Limited (ATS) of Richmond, B.C.

Both engines were taken to the TSB regional wreckage examination facility in Richmond and inspected, disassembled, and examined in detail. In summary, the examinations of the two engines revealed several anomalies, as described in the following paragraphs.

The CT58-140-1 engine is equipped with an overspeed shutoff valve that by design interrupts the fuel flow in the fuel control unit (FCU) in the event of a free power turbine overspeed. Activation of this overspeed protection does not leave any mechanical indication that the engine shut down, and it could not be determined if an overspeed shutdown occurred in either engine. The overspeed shutoff valve closes when the power turbine speed exceeds 23 400 rpm (123%Nf) . The valve re-opens when the turbine speed reduces, and introduces fuel into the combustion chamber. Since the engine does not have re-ignition, the fuel will not ignite, and as a result, the combustion area can become wet with the unburnt fuel. Such fuel wetting or staining in the combustion section of the engine may indicate an overspeed shut down from a high power setting. In this installation, the engine speed reached when the overspeed protection functions is such that no dimensional or metallurgical changes to the power turbine would be expected to occur. Dimensional and metallurgical examinations[2] of the 1st stage turbine rotor disc and the power turbine rotor disc, of both engines, revealed no indication of either overspeed or over-temperature conditions.

According to the engine manufacturer, GEAE, the T58-GE-5 military engine can be converted to the commercial variant CT58-140 provided the "*Special Workscope for Conversion of T58 Engines to CT58-140*" is complied with. In part, the workscope (item 7) prescribes the following "*Replace nameplate and mark with CT58 engine model. Use the same engine serial number and mark with an "R" after the serial number to indicate the engine is converted.*" The serial number on the nameplates (dataplates) on these two engines had not been so marked.

Furthermore, GEAE advises that the use of military parts on commercial engines is not recommended; however, using the military power section assembly is acceptable provided that the rotating components within the assembly are replaced with new or commercial components, and a new data plate is attached to record such change.

Number 1 Engine (280309KL)

The number 1 engine was intact and free to rotate. The three airframe engine mounts—two front mounts and the aft gimbal ring on the support tube—had broken in overload. The engine had disconnected from the MGB at the fractured input pinion. The variable inlet guide vanes (VIGV) were found in the closed position; as gas generator speed drops through about 64% during a normal engine shutdown, reducing fuel pressure causes the vane actuator piston to fully retract causing these vanes to rotate to the closed position and remain there during coast down. The vanes are closed at engine idle speed, which is about 54%.

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2 Reference: GE SEI manual, part 183

The compressor rotor was not damaged, although a small amount of mixed debris was present and slight blade tip rub was indicated on the casing. The debris comprised particles of fibreglass, stainless steel, white paint, and probably Teflon(c).

The lower combustion and aft compressor areas of the number 1 engine were wet and stained with unburnt fuel, which can indicate an overspeed shutdown. Post-accident manipulation of the engine may also have spread any residual fuel internally.

The data plate on the power turbine section of this engine had been modified in that the model number had been changed to *CT58-140,* the power turbine assembly number had been changed, and the serial number had been intentionally obliterated. For this particular turbine section, records show that the rotating components had been replaced with commercial components, as required by GEAE.

Number 2 Engine (280324KL)

The number 2 engine was also intact and free to rotate. Both forward engine mounts had broken in overload, but the aft gimbal ring mount was intact. The input drive shaft and attachment fittings were not damaged. The VIGVs were found in the closed position. The main oil filter contained carbon and metal debris. The compressor and turbine sections had both sustained considerable damage by foreign objects and contained debris comprised mainly of fibreglass and titanium. Many of the compressor blades and stator vanes were damaged.

The 3rd stage turbine nozzle and the power turbine blades exhibited significant amounts of molten titanium alloy splatter. Metallurgical analyses determined that this could only happen when an engine is operating, that is, with the combustion process occurring, not just residual heat following shutdown. The titanium and fibreglass found in the power turbine section matched material from the firewall, centre engine mount, and the foreign object damage (FOD) shield, all of which had been damaged.

The data plate on the power turbine section of this engine recorded the model number as *T58-GE-100,* where the *-100* portion of the model number had been vibro-peened on, the serial number recorded as *GE-273,* and the power turbine assembly number had not been recorded. For this particular turbine section, records show that the rotating components had been replaced with commercial components, as required by GEAE.

Compressor Disc Shaft Locknut

In each engine, the torque on the locknut of the number 1 bearing on the front compressor disc shaft was significantly higher than the value specified by the engine manufacturer and a specific assembly tool would not function properly. Subsequent research showed that such overtorque likely weakens the locknut, but certainly collapses the hollow disc shaft and creates a smaller inside diameter, thereby jamming the inserted tool. Had the locknut or shaft separated during engine operation, it is likely that catastrophic engine damage would have occurred. During overhaul assembly, ATS had routinely applied extra torque to the locknut on all CT58 engines, unaware that the dimension was being affected. This anomaly did not contribute to the accident.

Engine Test Cell Runs

To examine the operation and performance of the various fuel delivery components of each engine in their undisturbed state, the components were attached to a slave engine and run in a test cell at an independent, approved engine overhaul facility in Richmond. The components included the FCU, flow divider, fuel purifier, and stator vane actuator (SVA). The Ng and Nf tach-generators were also tested; all four operated normally.

The test cell runs were unremarkable with two minor exceptions. When the number 1 engine components were run, the engine "rumbled" during acceleration tests, likely as a result of poor airflow. When the number 2 engine components were run, the engine ran too cool, requiring adjustment to the SVA linkage, and the normal topping limit was not reached.

FCU and Component Examinations

The same components were then bench-tested and disassembled by an FAA[3]-approved facility in the United States under the direct supervision of TSB investigators. With the exception of the FCU from the number 2 engine, all the components tested within specification limits and were unremarkable. The number 2 engine FCU failed the bench test and the anomalies found are discussed in the following paragraphs.

The FCU is a Hamilton Standard JFC26 and is standard equipment on the GEAE T58/CT58 model gas-turbine engine. The SVA on the number 2 engine was out-of-adjustment such that the stator vanes would have begun to open sooner than required. Upon disassembly of the Ng governor unit, the flyweight spring and bearings were found to have been worn to limit. Such wear would have affected the SVA set points during the bench tests and, in part, given rise to the anomalous readings. Furthermore, this wear may have caused inconsistent FCU performance.

Specific tests to assess the topping and bottoming calibrations revealed several defects: the internal fuel pressure differential (delta-P) was unstable; the minimum fuel flow (bottoming) was abnormally low; and the maximum fuel flow (topping) was grossly below normal (486 pph vice 650 pph). The topping adjustment screw was then manually turned to achieve the 650 pph bench-mark. The individual effect of the low bottoming setting would have caused the engine to idle at lower than normal rpm.

A review of the most recent series of topping adjustments showed that the operator had adjusted the topping screw on the number 2 engine in an effort to match the lower performing number 1 engine. Adjusting the topping screw conforms to conventional engine performance balancing techniques for this helicopter type in the field. As well, the operator had experienced occasional difficulties when starting the engine.

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[3] Federal Administration Authority of the United States of America

The number 2 FCU fuel filter contained a significant amount of mixed contaminants; however, it could not be determined if the filter had gone into bypass. Further disassembly revealed that the pressure regulating valve (PRV) in the FCU was jammed with contaminant significantly different to that found in the filter. Earlier bench tests had showed that the PRV was sticking; a sticking or immoveable PRV would cause unstable SVA operation, engine starting difficulties, and inconsistent topping settings. Collective experience from US operators of this FCU show that sticking or jammed PRVs also lead to unpredictable and degraded engine performance.

Microscopic and infra-red analysis of the debris found in the PRV determined that it comprised particulates of chip board[4], bleached cellulose[5], paint, and metal; the FCU filter contaminant comprised cellulose, paint, human hair, and unidentifiable fibres. Laboratory examination of the debris found in the airframe fuel filter and the aft fuel tank boost pump revealed particulates of mainly chip-board, cellulose, paint, silk, human hair, and polyethylene. The source(s) of these various contaminants, or the time of their introduction, could not be determined. The aft fuel tank had been removed, repaired, and replaced on 27 November 2002.

Plain Bearing Monitoring

The operator's field experience with this helicopter type led them to assess that new plain bearings in the MGB appear to fail within a period of about 30 service hours following the removal and installation of the input pinion gear—regardless of the TSN of the bearing; bearings that pass this milestone usually survive to their scheduled replacement cycle. Indeed, an informal study of similar events tends to support this view. As part of the normal process to monitor the plain bearing following their installation, temperature probes were temporarily attached to the unit to identify excessive temperatures in the bearing, which are reliable indications of impending bearing failure. After a "run-in" period, the probes were removed. Following this accident, Hayes Helicopter Services opted to keep the bearing temperature portion of the approved MGB run-in test equipment in their S-61 helicopters to monitor the temperatures of the bearings at all times, in an attempt to identify a failing plain bearing.

Analysis

General

Some of the physical evidence gathered during this investigation is conflicting, and does not lead to a conclusive determination of the sequence of events. While the initiating event is clearly the failure of the plain bearing in the MGB cover for the number 1 input pinion gear, there are two scenarios concerning the fracture sequence of the input pinion gear itself, and each is discussed in the following paragraphs.

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4 Pressed wood particle board

5 Lignin-free paper fibre

Plain Bearing Failure

The initial failure of the plain bearing was a rapid degeneration, with loss of lubrication leading to rapid overheating, massive wear, and diverging rotational imbalance. As a result, the pinion bearing journal wore down, resulting in the high frequency vibration and the whining sound. At the same time, the input pinion gear began weakening because of the overheating and bending forces. The high-speed shaft, the input pinion gear, and the couplings all exhibit considerable bending. In turn, the carbon seal for the plain bearing disintegrated, allowing MGB oil to spray onto the pinion. The sprayed oil ignited on the overheated pinion and led to the fire at the base of the transmission.

Scenario 1: Input Pinion Fracture In Flight

Following the failure of the plain bearing, the overheated and weakened input pinion gear then fractured in flight as a result of the severe and rapid bending forces it was experiencing during the imbalance, causing the loud bang heard by the crew. This in turn would have led to the immediate overspeed and shutdown of the number 1 engine. The whirling and bending of the shaft and couplings require the engine and MGB to have been still connected but misaligned by about three degrees. Such displacement is within the limits of coupling flexion, and is possible with intact engine mounts. In this scenario, the pinion would likely have been exposed to a moderate-to-high torque load and, had it failed while so loaded, the fracture surface would be expected to exhibit torsional fracture characteristics, such as rotational smearing. These qualities, however, were not found.

Scenario 2: Input Pinion Fracture On the Ground

Following the failure of the plain bearing, the number 1 IFWU slipped[6], leading to the overspeed and shutdown of the number 1 engine in flight, and after touch down, the overheated pinion fractured during the violent airframe oscillations on the ground. For this to have occurred, however, the bending of the shaft and couplings require the engine and MGB to have been intact but misaligned to the order of eight degrees; displacement of this magnitude is unlikely with intact engine mounts. In this scenario, the pinion would have been exposed to a low torque load since the engine had shut down, and had it failed while so loaded, the fracture surface would be expected to exhibit tensile fracturing with little rotation or smearing. The equiaxed dimpling observed on the fracture surfaces is consistent with these qualities.

Engine Mounts

To break the engine mounts and misalign the engine in flight would require considerable and obvious forces. Concomitantly, the forces required to fracture the number 1 engine mounts would also have fractured the number 2 engine mounts in flight. The flight crew did not experience such forces in flight—but they did so on the ground—nor was there reasonable

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6 It is possible that the number 1 IFWU slipped from contamination and caused an overspeed shutdown of the number 1 engine; however, no definitive evidence of IFWU slip exists, nor does the FCU record an overspeed shutdown, had it occurred.

mechanical explanation for such failures to have occurred in flight. Wreckage analysis supports that the FOD shield and the engine mounts were damaged and broken during the violent airframe oscillations on the ground, and that fragments passed into both engines.

Number 1 Engine

If the number 1 engine had shut down as a result of an overspeed when the pinion broke on the ground, it would have ingested similar fragments of the engine mounts and the FOD shield that the number 2 engine ingested, because it would have still been operating at moderate power when the mounts and shield broke up. The foreign object ingestion by the number 1 engine, however, is considerably less than the number 2 engine, indicating that the engine was not turning at high speed when the ingestion occurred. As well, the slight blade tip rub indicates that the engine was turning at low rpm when the rub occurred; it is most likely that the rub occurred during the ground oscillations. Had the number 1 engine mounts broken in flight, the violence of the disconnection would likely have caused the blades to leave conclusive witness marks. It is most likely, therefore, that this engine had shut down in flight. near the beginning of the sequence of events.

Number 2 Engine

As a result of the number 1 engine shutting down, the total power being transmitted to the MGB was reduced. The number 2 engine then tried to compensate for the sudden power loss of the number 1 engine. This should have been instantaneous, but because of the misadjusted FCU and sticking PRV, it was incapable of assuming the load rapidly and producing its rated power. At this point, the pilot-in-command reacted to the power loss and cabin fire, and lowered the collective lever to maintain rotor rpm and to enter autorotation. The number 2 engine apparently continued to operate at low rpm, which coincidently was possible owing to the PRV malfunction.

Furthermore, the molten titanium splatter in and the foreign object damage to the number 2 engine is a convincing argument that this engine was operating when fractured pieces of airframe firewall and FOD shield entered the compressor inlet. It is highly unlikely that the airframe damage—including the engine mounts failing—occurred in flight, and thus the number 2 engine was operating during the oscillations on the ground.

Collison With Tree

The autorotation and landing portion of the flight was, in a technical sense, relatively straight forward. The pilot-in-command manoeuvred the helicopter to a successful touch down on the road, but could not prevent the helicopter from striking the tree. This collision resulted in the tail pylon damage and precipitated the main rotor blade damage and resultant dynamic imbalance that caused the large airframe oscillations on the ground. This flailing led to the fracture of the engine mounts, the firewall, and the FOD shield.

Conclusion Regarding Engine Power Loss

In consideration of all the factual information at hand, it is solely the lack of smearing of the fracture surface on the input pinion that supports the circumstances of Scenario 2. While it cannot be said with certainty, the preponderance of the evidence supports the circumstances postulated in Scenario 1, that is, that the failure of the plain bearing in the main gearbox cover for the number 1 input pinion led to the in-flight fracture of the input pinion, which immediately caused the number 1 engine to over speed and shut down. The number 2 engine was incapable of assuming the sudden load demand and did not produce its rated power. As a result of this combined power loss, the pilot entered autorotation to maintain rotor rpm and carried out a forced landing on the road.

Use of Shoulder Harness by the Pilots

On helicopters used in vertical reference flying, such as the S-61, cockpit dimensions and fuselage width require the pilot-flying to lean markedly to one side to be able to clearly see the longline and load suspended below the helicopter. Because such a body position is physically impossible to achieve by a pilot wearing the shoulder harness of the seat restraints, it is a wide-spread practice for the pilot manoeuvring the helicopter to use the seat belt portion only. In helicopters dedicated to vertical-reference flying, it is common for the shoulder straps to be semi-permanently stowed behind the seat back to prevent them from interfering with the pilot's movements.

Accident investigation and research carried out by the TSB has consistently shown that the use of the shoulder harness portion of the seat restraint system is effective in reducing or preventing injury during moderate impact forces. Given that vertical reference flying necessitates upper-body freedom of movement, the universal dismissal of the shoulder harness, in its present configuration, is almost inevitable. In consideration of potential injury and human survivability in an aircraft during in-flight upset or collision with the terrain, an unrestrained person is certainly exposed to the greatest risk of injury.

Findings as to Causes and Contributing Factors

1. The plain bearing in the main gearbox cover for the number 1 input pinion failed, lost lubrication, and disintegrated, resulting in diverging rotational imbalance and causing the input pinion gear to overheat and weaken.

2. This rotational imbalance created bending forces that exceeded the strength of the input pinion gear causing it to fracture in overload, thereby resulting in number 1 engine overspeed and shutdown.

3. At the same time, the carbon seal for the failed plain bearing disintegrated, allowing main gearbox oil to spray onto the pinion, where the oil ignited and caused the fire at the base of the transmission.

4. Movement of the pressure regulating valve in the number 2 fuel control unit was restricted by contamination, thereby causing unstable stator vane actuator operation, engine starting difficulties, inconsistent topping settings, and unpredictable and degraded engine performance.

5. The combination of the misadjusted stator vane actuator, the fuel control unit topping settings, and a sticking pressure regulating valve prevented the number 2 engine, when number 1 engine lost power, from assuming the total load.

6. After the helicopter landed, the rotor blades and tail section struck a tree creating severe oscillations on the ground, which resulted in both engines breaking free from the airframe, causing the engines to injest varying amounts of debris from the broken engine mounts and foreign object damage shield.

Findings as to Risk

1. The aircraft maintenance engineer was not secured in the cabin seat and, as a result, was injured by repeated contact with the interior cabin structure near the cockpit entry.

2. Although the pilots were not injured during the severe ground oscillations, the damage to their protective helmets—and the potential risk of serious head injuries—would have been lessened had they been wearing their available shoulder harnesses.

3. In each engine, the locknut of the number 1 bearing on the front compressor disc shaft was intentionally overtorqued during overhaul assembly, collapsing the disc shaft and likely weakening the locknut. Had the locknut or shaft separated during engine operation, it is likely that catastrophic engine damage would have occurred.

Other Findings

1. The flyweight spring and bearings in the Ng governor on the number 2 fuel control unit were worn to limits, which affected the set points during the bench tests and may have caused inconsistent engine performance.

2. The data plates for the engines and power turbine assemblies each contained incomplete or inaccurate data, and were not in accordance with the engine manufacturer's instructions.

Safety Action

Hayes Helicopter Services has opted to keep the bearing temperature portion of the approved main rotor gearbox run-in test equipment in their S-61 helicopters to monitor the temperatures of the bearings at all times, in an attempt to identify a failing plain bearing.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 15 September 2004.

Service Difficulty Report

1. Submitter Information

(a) Unique Control #: CA090820007 (b) Difficulty Date: 08/16/2009
(c) Registration # : (d) Submitter Type : W - FOREIGN PART 129
(e) Submitter Designator: (f) Submission Date: 10/23/2009 6:57:53 AM

2. Codes

(a) Operator Designator : (b) Operator Type : General Aviation
(c) JASC/ATA Code : 7321
(d) Stage of Operation : NR - NOT REPORTED
(e) How Discovered : O - Other
(f) Nature of Condition : R - PARTIAL RPM/PWR LOSS
: J - WARNING INDICATION
(g) Precautionary Procedures: O - OTHER
(h) FAA Region : CA (i) District Office :

3. Major Equipment Identity

	Manufacturer	Model	Serial Number	Total Time	Total Cycles
(a) Aircraft	SKRSKY	S61N			
(b) Engine	GE	CT581401			
(c) Propeller					

4. Problem Description

(CAN) THE NUMBER ONE ENGINE WAS UP TO OPERATING RPM THEN DEACCELERATED TO FLIGHT IDLE FOR NO REASON. THE FOLLOWING UNITS WERE REPLACED TO TROUBLE SHOOT THE DEFECT. FUEL CONTROL P/N725725-5 S/N 45275 TSO 3531. PILOT VALVE P/N 6028T23G01 S/N ESS30030 TSN: 17726.4 TSO 685.1 FUEL PUMP P/N 5002T83P02 S/N 1616A TSN 31772.9 TSO 2667.9 (TC# 20090820007)

5. Specific Part or Structure Causing Difficulty

(a) Part Name : FUEL CONTROL (b) Manufacturer's Name :
(c) Part Number : 7257255 (d) Serial Number :
(e) Part Condition: MALFUNCTIONED (f) Part/Defect Location: NR 1 ENGINE
(g) Total Time : (h) Total Cycles :
(i) Time Since : 3531 OVERHAUL

6. Component/Assembly That Includes Defective Part

(a) Component Name: (b) Manufacturer's Name :
(c) Part Number : (d) Serial Number :
(e) Model Number : (f) Location :
(g) Total Time : (h) Total Cycles :
(i) Time Since :

7. Structure Causing Difficulty

(a) Body or Fuselage Station - From/At: To:
(b) Water Line - From/At: To:
(c) Crack Length : (d) Number of Cracks:
(e) Stringer - From/At: To:
(f) Butt Line - From/At: To:
(g) Wing Station - From/At: To:
(h) Structural Other: (i) Corrosion Level :

End Of Report

Service Difficulty Report

1. Submitter Information

(a) Unique Control #: 2009FA0000960
(b) Difficulty Date: 11/18/2009
(c) Registration # :
(d) Submitter Type : B - REPAIR STATION PART 145
(e) Submitter Designator:
(f) Submission Date: 11/18/2009 1:23:35 PM

2. Codes

(a) Operator Designator :
(b) Operator Type : General Aviation
(c) JASC/ATA Code : 7200
(d) Stage of Operation : NR - NOT REPORTED
(e) How Discovered : O - Other
(f) Nature of Condition : C - F.O.D.
: R - PARTIAL RPM/PWR LOSS
(g) Precautionary Procedures: O - OTHER
(h) FAA Region : NM
(i) District Office : 09

3. Major Equipment Identity

	Manufacturer	Model	Serial Number	Total Time	Total Cycles
(a) Aircraft	SKRSKY	S61N			
(b) Engine	GE	CT581401			
(c) Propeller					

4. Problem Description

A CT-58 FUEL CONTROL UNIT (FCU) PN 725725-5 SN 29172)) , STATOR VANE ACTUATOR (SVA) PN 4004T63G10 SN KTR4579BR)) , AND PILOT VALVE (PV) PN 6028T23G01 SN KTR3098BR)) WERE DELIVERED BY THE NTSB AND CARRIER FOR INSPECTION. INITIAL DISASSEMBLY OF THE FCU, SVA, AND PV SHOWED CONTAMINATION FROM AN UNKNOWN EXTERNAL SOURCE (WHICH MAY STILL BE PRESENT ON IN-SERVICE AIRCRAFT) AND POSSIBLE CONTAMINATION FROM THE CENTRIFICAL FUEL PURIFIER (WHICH WAS NOT DELIVERED WITH THE UNIT FOR EXAMINATION). DISASSEMBLY OF THE UNIT REVEALED THAT THE MAIN FUEL CONTROL FILTER HAD ALSO BEEN REMOVED PRIOR TO DELIVERY TO CHI HOWEVER THERE WAS ONE SMALL METALLIC NON-MAGNETIC SLIVER OF DEBRIS FOUND IN THE MAIN FUEL CONTROL FILTER HOUSING. OUR INITIAL EVALUATION AND DISASSEMBLY OF THESE UNITS REVELED NO EVIDENCE OF MECHANICAL FAILURE OR IMPROPER ASSEMBLY.

5. Specific Part or Structure Causing Difficulty

(a) Part Name : FUEL CONTROL
(b) Manufacturer's Name : HAMSTD
(c) Part Number : 7257255
(d) Serial Number : 29172
(e) Part Condition: CONTAMINATED
(f) Part/Defect Location: ENGINE
(g) Total Time : 4000
(h) Total Cycles :
(i) Time Since : 18 OVERHAUL

6. Component/Assembly That Includes Defective Part

(a) Component Name:
(b) Manufacturer's Name :
(c) Part Number :
(d) Serial Number :
(e) Model Number :
(f) Location :
(g) Total Time :
(h) Total Cycles :
(i) Time Since : OVERHAUL

7. Structure Causing Difficulty

(a) Body or Fuselage Station - From/At: To:
(b) Water Line - From/At: To:
(c) Crack Length :
(d) Number of Cracks:
(e) Stringer - From/At: To:
(f) Butt Line - From/At: To:
(g) Wing Station - From/At: To:
(h) Structural Other:
(i) Corrosion Level :

End Of Report

Service Difficulty Report

1. Submitter Information

(a) Unique Control #: CHIR0297 — (b) Difficulty Date: 11/20/2009
(c) Registration # : — (d) Submitter Type : B - REPAIR STATION PART 145
(e) Submitter Designator: CHIR — (f) Submission Date: 11/20/2009 7:49:26 PM

2. Codes

(a) Operator Designator : CHIA — (b) Operator Type : General Aviation
(c) JASC/ATA Code : 7321
(d) Stage of Operation : NR - NOT REPORTED
(e) How Discovered : O - Other
(f) Nature of Condition : R - PARTIAL RPM/PWR LOSS
: J - WARNING INDICATION
(g) Precautionary Procedures: A - UNSCHED LANDING
(h) FAA Region : NM — (i) District Office : 09

3. Major Equipment Identity

	Manufacturer	Model	Serial Number	Total Time	Total Cycles
(a) Aircraft	SKRSKY	S61N			
(b) Engine	GE	CT581401			
(c) Propeller					

4. Problem Description

ON 11/18/09 OUR REPAIR STATION PERFORMED AN INSPECTION ON A FUEL CONTROL P/N 7257255, PILOT VALVE P/N 6028T23G01, THAT WERE IN AN FAR135.415 SERVICE DIFFICULTY REPORT CONTROL NUMBER CA090820007, INCIDENT DATE 8/16/09, REPORT DATE 10/23/2009 6:57:53 AM. OUR INITIAL INSPECTION REVEALED THIS FCU WAS CONTAMINATED FROM AN EXTERNAL SOURCE (MOST LIKELY CAME FROM FUEL PURIFIER WHICH WAS NOT PROVIDED FOR INSPECTION).THERE WERE NO MECHANICAL IRREGULARITIES, OR SIGNS OF IMPROPER ASSEMBLY.

5. Specific Part or Structure Causing Difficulty

(a) Part Name : FCU — (b) Manufacturer's Name : HAMSTD
(c) Part Number : 7257255 — (d) Serial Number : 45275
(e) Part Condition: CONTAMINATED — (f) Part/Defect Location: ENGINE
(g) Total Time : — (h) Total Cycles :
(i) Time Since : REPAIR

6. Component/Assembly That Includes Defective Part

(a) Component Name: — (b) Manufacturer's Name :
(c) Part Number : — (d) Serial Number :
(e) Model Number : — (f) Location :
(g) Total Time : — (h) Total Cycles :
(i) Time Since :

7. Structure Causing Difficulty

(a) Body or Fuselage Station - From/At: UNK To:
(b) Water Line - From/At: To:
(c) Crack Length : — (d) Number of Cracks:
(e) Stringer - From/At: To:
(f) Butt Line - From/At: To:
(g) Wing Station - From/At: To:
(h) Structural Other: — (i) Corrosion Level :

End Of Report

SAFECOM
Aviation Safety Communique'

Tracking #: 06-0800
Date Submitted: 8/2/2006 8:55:00 AM

EVENT

Date: 7/29/2006 Local Time: 1930 Injuries: No Damage: No
Location: WEST TEXAS SUMMER FIRE State: Texas
Operational Control: State > Texas

MISSION

Type:	Fire, Water Drop (Helicopter Fixed-Tank)		Other:		
Procurement:	CWN (Call when needed)		Other:		
Persons Onboard:	2	Special Use: No			Hazardous Materials: No
Departure Point:	MWL		Destination: MWL		

AIRCRAFT

Manufacturer: Sikorsky Model: 61

NARRATIVE

#2 ENGINE TORGUE DROPPED 20% AND FLUCTUATED WHEN AIRCRAFT WAS AT MAX POWER. NG & T5 FLUCTUATED CORRESPONDINGLY. THE PILOT FELT THE AIRCRAFT WAS IN FULL CONTROL AT ALL TIMES. THE PILOT JETTISONED THE LOAD OF WATER AND RETURNED TO BASE WITH NO FUTHER INCIDENT. HELICOPTER WAS PLACED OUT OF SERVICE.

CORRECTIVE ACTION

THE FUEL CONTROL ON #2 ENGINE WAS CHANGED. AIRCRAFT MAINTANCE FLIGHT WAS PREFORMED SATISFACTORLY UNDER MAX POWER. THIS HAS BEEN AN OFF & ON PROBLEM FOR THE LAST 15 DAYS AND WILL BE MONITORED CLOSELY. RMI WAS CONTACTED AND THE HELICOPTER WAS PLACED BACK IN SERVICE.

Categories:
Maintenance:Engine

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SAFECOM
Aviation Safety Communique'

Tracking #: 06-0924
Date Submitted: 8/14/2006 12:55:00 PM

EVENT

Date: 8/12/2006 Local Time: 830 Injuries: No Damage: No
Location: Choteau Airport State: Montana
Operational Control: Forest Service (USFS) > Region 01 Northern Rockies Region > Helena NF

MISSION

Type: Fire, Ferry/Repositioning Flight Other:
Procurement: CWN (Call when needed) Other:
Persons Onboard: 2 Special Use: Yes Hazardous Materials: No
Departure Point: Choteau Airport Destination: Lincoln Airstrip

AIRCRAFT

Manufacturer: Sikorsky Model: 61N

NARRATIVE

On start-up the fuel pressure went up then dropped on the number 2 engine below starting capabilities. The mechanic thought we had a fuel pump failure.

CORRECTIVE ACTION

We went non-available, brought in two engine specialists with parts. They replaced the fuel pump, fuel purifier, fuel control, pilot valve, and flow divider. We also replaced the oil tank on the number one engine, it had a slow leak and they found a hairline crack in a welded seam. We notified the R1 safety maintenance inspector and described the problem and then faxed the maintenance log book on all work completed. He approved the work and placed the aircraft on contract availability at 15:30. The maintenance flight and power check were done and fully operational.

Categories:
Maintenance:Engine

SAFECOM
Aviation Safety Communique

Tracking #: 07-0513
Date Submitted: 7/12/2007 4:31:00 PM

EVENT

Date: 7/9/2007 Local Time: 1630 Injuries: No Damage: No
Location: Canyon Fire State: Iowa
Operational Control: Forest Service (USFS) > Region 04 Intermountain Region > Boise NF

MISSION

Type: Fire, Water Drop (Helicopter Fixed-Tank) Other:
Procurement: CWN (Call when needed) Other:
Persons Onboard: 2 Special Use: Yes Hazardous Materials: No
Departure Point: Lucky Peak Helibase Destination: Canyon Fire

AIRCRAFT

Manufacturer: Sikorsky Model: 61N

NARRATIVE

Helicopter was supporting the fire with water drops. Helicopter finished it's fuel cycle and had returned to Lucky Peak Helibase for fuel. Helicopter had shut down for fuel and during the start up pilot noticed indications of a fuel control problem to the #1 engine. Pilot shut helicopter down and notified manager. Crew chief confirmed that #1 fuel control valve was faulty. Helicopter was put into contract un-availability status at 1630 hrs and appropriate personal were notified.

CORRECTIVE ACTION

#1 Fuel Control was replaced. Leak and Ops check was good. Returned to Contract Availability by R4 AMI. RASM Remarks: No further action.

Categories:
Maintenance:Engine

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SAFECOM
Aviation Safety Communique

Tracking #: 07-0725
Date Submitted: 7/30/2007 12:37:00 PM

EVENT

Date: 7/28/2007 Local Time: 1100 Injuries: No Damage: No
Location: Libby State: Montana
Operational Control: Forest Service (USFS) > Region 01 Northern Rockies Region > Kootenai NF

MISSION

Type: Fire, Water Drop (Helicopter Bucket) Other:
Procurement: CWN (Call when needed) Other:
Persons Onboard: 2 Special Use: Hazardous Materials:
Departure Point: Libby Destination: Wabuno Fire

AIRCRAFT

Manufacturer: Sikorsky Model: 61N

NARRATIVE

The aircraft had made one bucket drop on a fire when the pilot noticed a "problem with the gauges" and returned to the helibase. After a few hours of trouble-shooting (the gauge was replaced and a power check completed), the mechanic determined that an engine needed to be replaced.

CORRECTIVE ACTION

The aircraft was placed in unavailable status, the Regional Maintenance Inspector and Contract Specialist were notified. The company flew in another engine that same evening. As of the time of this submital the installation was still not completed. FAO followup: Engine was installed. Non-revenue test flight was conducted, maintenance inspector was contacted and aircraft was returned to contract availability. No further problems. RASM BJB no additional action needed

Categories:
Maintenance:Engine

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SAFECOM
Aviation Safety Communique'

Tracking #: 07-0786
Date Submitted: 8/4/2007 2:54:00 PM

EVENT

Date: 8/2/2007 Local Time: 1000 Injuries: No Damage: No
Location: East Zone Complex State: Idaho
Operational Control: Forest Service (USFS) > Region 04 Intermountain Region > Payette NF

MISSION

Type: Fire, Water Drop (Helicopter Fixed-Tank) Other:
Procurement: Exclusive use contract Other:
Persons Onboard: 2 Special Use: Hazardous Materials: No
Departure Point: Copeland Helibase Destination: FIRE

AIRCRAFT

Manufacturer: Sikorsky Model: 61A

NARRATIVE

Helitanker was dipping out of lake and pilot felt a slight jerk to the right. Pilot hit the emergency release button on the cyclic to open tank doors and release water. Pilot noticed the #1 engine torque was 90 and the #2 engine torque was at 30. Pilot applied the #2 emergency throttle to match the torques and then flew out of the dipsite. He immediately notified air attack and helibase that they had an engine problem but felt they could safely fly back to helibase. As the helitanker was about to land at the helibase, pilot noticed the torques split again and the #2 emergency throttle was not fully engaged. Pilot was able to land helitanker safely at helibase. Upon inspection of the #2 engine, mechanic noticed the fuel control was not functioning correctly and caused the #2 emergency throttle to come loose. Unavailability for the rest of the day.

CORRECTIVE ACTION

Mechanic installed a new fuel control and fuel pump. A maintenance test flight was performed and power check results were in good operating range. Maintenance inspector gave permission to return to contract availability. RASM Remarks: Good airmanship by the pilot! No further action.

Categories:
Incident:Precautionary Landing (Mechanical)
Maintenance:Engine

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SAFECOM
Aviation Safety Communique'

Tracking #: 08-0217
Date Submitted: 5/13/2008 6:24:00 AM

EVENT

Date: 5/11/2008 Local Time: 2000 Injuries: No Damage: No
Location: MUS SWAMP FIRE State: Florida
Operational Control: Forest Service (USFS) > Region 08 Southern Area Region > National Forests in Florida

MISSION

Type:	Fire, Water Drop (Helicopter Fixed-Tank)	Other:	
Procurement:	CWN (Call when needed)	Other:	
Persons Onboard:	2	Special Use: No	Hazardous Materials: No
Departure Point:	TLH	Destination: FIRE	

AIRCRAFT

Manufacturer: Sikorsky Model: 61

NARRATIVE

ON RETURN TO TALLAHASSEE HELIBASE PILOT NOTICED A REDUCE IN POWER FOR (#) 2 ENGINE . AFTER LANDING MECH,S PULLED FUEL FILTERS AND FOUND NO PROBLEMS. ON FURTHER INSPECTIONS THE FUEL CONTROL VALVE WAS DETERMINED TO BE BAD. PART WAS ORDERED .

CORRECTIVE ACTION

05/12/08 THE (#) 2 ENGINE WAS REMOVED AND NEW FUEL CONTROL VALVE WAS INSTALLED. ENGINE WAS REINSTALLED AND AIRCRAFT WAS RUN UP AND OPS CHECK WAS GOOD. R-8 MAINT INSP. WAS CALLED AND INFORMED OF PROBLEM AND THEN SHE CAME BY HELIBASE LATER AND PUT AIRCRAFT BACK ON CONTRACT AVAILABILITY. RASM note; Catch 'em early. No further action required.

Categories:
Maintenance:Engine

SAFECOM
Aviation Safety Communiqué

Tracking #: 08-0217
Date Submitted: 5/13/2008 6:24:00 AM

EVENT

Date: 5/11/2008 Local Time: 2000 Injuries: No Damage: No
Location: MUS SWAMP FIRE State: Florida
Operational Control: Forest Service (USFS) > Region 08 Southern Area Region > National Forests in Florida

MISSION

Type: Fire, Water Drop (Helicopter Fixed-Tank) Other:
Procurement: CWN (Call when needed) Other:
Persons Onboard: 2 Special Use: No Hazardous Materials: No
Departure Point: TLH Destination: FIRE

AIRCRAFT

Manufacturer: Sikorsky Model: 61

NARRATIVE

ON RETURN TO TALLAHASSEE HELIBASE PILOT NOTICED A REDUCE IN POWER FOR (#) 2 ENGINE . AFTER LANDING MECH,S PULLED FUEL FILTERS AND FOUND NO PROBLEMS. ON FURTHER INSPECTIONS THE FUEL CONTROL VALVE WAS DETERMINED TO BE BAD. PART WAS ORDERED .

CORRECTIVE ACTION

05/12/08 THE (#) 2 ENGINE WAS REMOVED AND NEW FUEL CONTROL VALVE WAS INSTALLED. ENGINE WAS REINSTALLED AND AIRCRAFT WAS RUN UP AND OPS CHECK WAS GOOD. R-8 MAINT INSP. WAS CALLED AND INFORMED OF PROBLEM AND THEN SHE CAME BY HELIBASE LATER AND PUT AIRCRAFT BACK ON CONTRACT AVAILABILITY. RASM note; Catch 'em early. No further action required.

Categories:
Maintenance:Engine

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SAFECOM
Aviation Safety Communique

Tracking #: 08-0224
Date Submitted: 5/19/2008 12:32:00 PM

EVENT

Date: 5/18/2008 Local Time: 1230 Injuries: No Damage: No
Location: Mustang Fire, Home State: Florida
Operational Control: DOI Aviation Management Directorate (DOI) > National Park Service (NPS)

MISSION

Type: Fire, Helitack Other:
Procurement: CWN (Call when needed) Other:
Persons Onboard: 2 Special Use: Hazardous Materials:
Departure Point: Destination:

AIRCRAFT

Manufacturer: Sikorsky Model: S-61

NARRATIVE

At 1230 HT XXX was doing water drops on the mustang fire divz. Helicopter went into the dip site and experienced a loss of power and a fluctuation on the fuel guage. They returned to Helibase.

CORRECTIVE ACTION

Upon inspection by mechanics they determined that there was a problem with the fuel system. Agency Regional inspector was notified at 1430. Helicopter is awaiting part. Aviation Ops Specialist comments: Contractor coordinated with Agency inspector, were able to resolve issue and bring back to availability in short order.

Categories:
Maintenance:Fuel

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SAFECOM
Aviation Safety Communique

Tracking #: 08-0528
Date Submitted: 7/9/2008 2:33:00 PM

EVENT

Date: 7/8/2008 Local Time: 1300 Injuries: No Damage: No
Location: American River Complex Helibas State: California
Operational Control: Forest Service (USFS) > Region 05 Pacific Southwest Region > Tahoe NF

MISSION

Type:	Fire, Water Drop (Helicopter Bucket)	Other:	
Procurement:	CWN (Call when needed)	Other:	
Persons Onboard:	2	Special Use: Yes	Hazardous Materials: No
Departure Point:	Blue Canyon Helibase	Destination: Blue Canyon Helibase	

AIRCRAFT

Manufacturer: Boeing Vertol Model: 107

NARRATIVE

The ship flew two fuel cycles dropping water and retardant on the American River Complex fire, all operations were normal. Upon restart of the engine the pilot in command noticed that the speed to temperature ratio on start up and idle was not normal. No limits were exceeded and the pilot shut the aircraft down to investigate the cause.

CORRECTIVE ACTION

Submitters Comments: The engine of concern was replaced, tests were performed that the new engine was working properly and the ship was brought back into service. The north zone maintenance inspector reviewed the maintenance log and approved the work performed.

Categories:
Maintenance:Engine

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either A/C 75 or 92

Same day
Same Fire
2 ea 107 from Columbia had FCU problem

SAFECOM
Aviation Safety Communiqué

Tracking #: 08-0531
Date Submitted: 7/9/2008 3:46:00 PM

EVENT

Date: 7/8/2008 Local Time: 1800 Injuries: No Damage: No
Location: State: California
Operational Control: Forest Service (USFS) > Region 05 Pacific Southwest Region > Tahoe NF

MISSION

Type: Fire, Water Drop (Helicopter Bucket) Other:
Procurement: Exclusive use contract Other:
Persons Onboard: 2 Special Use: No Hazardous Materials: No
Departure Point: Blue Canyon Helibase Destination: Blue Canyon Helibase

AIRCRAFT

Manufacturer: Boeing Vertol Model: 107

NARRATIVE

The ship flew 4 fuel cycles {7.4hrs with 3 pilots available} dropping water and retardant on the American River Complex, all operations were normal. Upon restart the {#}2 engine would not start. No limits were exceeded and the pilot shut the aircraft down to investigate the cause.

CORRECTIVE ACTION

Submitters Comments: The engine of concern was replaced, tests were performed that the new engine was working properly and the ship was brought back into service. The north zone maintenance inspector reviewed the maintenance log and approved work performed.

Categories:
Maintenance:Engine

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either A/C 75 or 92

Same day
Same Fire
2 ea 107 from Columbia had FCU problem

SAFECOM
Aviation Safety Communique

Tracking #: 08-0817
Date Submitted: 8/21/2008 7:30:00 PM

EVENT

Date: 8/18/2008 Local Time: 1130 Injuries: No Damage: No
Location: Glide HLB-North Fork Fire State: Oregon
Operational Control: Forest Service (USFS) > Region 06 Pacific Northwest Region > Umpqua NF

MISSION

Type: Fire, Water Drop (Helicopter Bucket) Other:
Procurement: Exclusive use contract Other:
Persons Onboard: 2 Special Use: Hazardous Materials:
Departure Point: Glide HLB Destination: Incident # 8125

AIRCRAFT

Manufacturer: Boeing Vertol Model: 107

NARRATIVE

On 8-18-2008, at 1130, the helicopter was starting up to go on the first mission of the day. During start up engine {#}1 went from full power for take off back to idle, the pilots then called Helibase to notify of maintenance issue and would be shutting down; the helicopter never lifted off the ground.

CORRECTIVE ACTION

Engine was replaced. AMI(MC)comments: #1 engine was replaced, ops check and run-up/test flight was completed. This helicopter was returned to contract availability... Local FAO comments: All procedures followed- no issues.

Categories:
Maintenance:Engine

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A/C # 85CH

SAFECOM
Aviation Safety Communique

Tracking #: 08-0970
Date Submitted: 10/7/2008 11:12:00 AM

EVENT

Date: 9/30/2008 Local Time: 930 Injuries: No Damage: No
Location: State: California
Operational Control: Forest Service (USFS) > Region 05 Pacific Southwest Region > Tahoe NF

MISSION

Type: Fire, Water Drop (Helicopter Bucket) Other:
Procurement: Exclusive use contract Other:
Persons Onboard: 2 Special Use: Yes Hazardous Materials: No
Departure Point: Fort Hunter Liggett Destination: Chalk Fire

AIRCRAFT

Manufacturer: Boeing Vertol Model: 107

NARRATIVE

Enroute to the fire for a water dropping mission the pilots reported a uncommanded (#)1 engine fuel pressure fluctuation with corresponding NG & temp increase and returned back to helibase for further diagnosis, then decided to replace the (#)1 engine and had one delivered to helibase that day.

CORRECTIVE ACTION

Submitters Comments: The (# 1 engine was replaced, test were performed that the new engine was working properly and the ship was brought back into service. I emailed the maintenance log to R5 AMI and he approved the work preformed.

Categories:
Maintenance:Engine

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A/C 75D
PIC Pilmer

SAFECOM

Aviation Safety Communiqué

Tracking #: 09-0176
Date Submitted: 4/25/2009 4:59:00 PM

EVENT

Date: 4/24/2009 Local Time: 1130 Injuries: No Damage: No
Location: Alpine airport State: Texas
Operational Control: Forest Service (USFS) > Region 08 Southern Area Region

MISSION

Type: Fire, Retardant Drop (Helicopter) Other:
Procurement: Exclusive use contract Other:
Persons Onboard: 2 Special Use: No Hazardous Materials: No
Departure Point: N/A Destination: N/A

AIRCRAFT

Manufacturer: Boeing Vertol Model: 107

NARRATIVE

Crew did routine engine wash requiring an engine run up. On run up the pilot in comand(PIC) noticed excessive temps on the {(#)}1 engine during start and acceleration. The PIC immediately shut down the aircraft and the maintance crew diagnosed it as a fuel control problem. The Maintance crew opted to change the {(#)}1 engine because it was the most efficient/expedient way to bring the aircraft back to service. At that time I made phone calls to dispatch, the D-AOBD, and the region maintance inspector to let them know we were out of service and why.

← Columbia will do this 99% of the tim rather than just change a FCU

CORRECTIVE ACTION

The mantance crew swaped out the {(#)}1 engine that day and did run ups and test flights the following day. Once that was done the crew chief notified me that the air craft was back in sevice. At that time I called region maintance inspector to notify them that the aircraft was ready to be made available, and also faxed the maintance records. The inspector approved the work and the aircraft was brought back to service, and I made calls to dispatch and the D-AOBD to let them know that we were back in service.

Categories:
Maintenance:Engine
Maintenance:Fuel

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Aviation

Ron Garman
Turboshaft Engine Project Department
CT58/T58 International Program Manager

1000 Western Avenue, Mail Drop 34002
Lynn, Massachusetts 01910
USA

[redacted]

Mr. Greg Weinfurter
Engine Shop Supervisor
Columbia Helicopters, Inc.
P.O. Box 3500
Portland, Oregon 97208

December 5, 2005

Dear Mr. Weinfurter:

GE has completed an engineering investigation of the fuel control pressure regulating valve (PRV) that was removed from a fuel control that was installed on a CT58-140-1 engine operated by Carson Helicopters, Inc. Columbia Helicopters, Inc. sent us the PRV. The GE reference number for this investigation is Service Revealed Difficulty A-PROJ-04-002.

Background:

On November 7, 2003, Columbia Helicopters notified GE of a stuck PRV that was removed from fuel control P/N 6003T91P15 (725725-6) S/N 90030. According to Columbia, the fuel control had been removed from an aircraft because of engine Ng fluctuations that were later duplicated on an engine in the Carson Helicopters test cell. The fuel control time since overhaul was reported to be 1367.0 hours. The PRV piston and sleeve part numbers were reported to be 543457 and 734913-1, respectively. Columbia sent the piston and sleeve, still in the stuck condition, to GE for further investigation.

Results:

The PRV that was sent to GE was received in the stuck condition. The fuel control filter was not available for examination at the time of this investigation. The PRV was sent to the fuel control manufacturer, Hamilton Sundstrand in Windsor Locks, Connecticut for further examination.

Hamilton Internal Correspondence and Lab Analysis FI-04-56 cite silica fibers (fiberglass), and hard angular oxides trapped in the clearance area between the inner diameter and outer diameter of the valve assembly as the cause of the seizure of the PRV. The contamination particle sizes found range in size from 2.5 micron to 25 micron, which have made their way through the fuel control 40-micron filter and into the valve tight clearances. The valve geometry met current drawing dimensional requirements and exhibited normal wear patterns.

(continued)

Conclusions:

The silica fibers were the dominant contaminants found in the valve assembly during inspection and were determined to be root cause of the valve seizure. The silica fibers and other contaminants passed through the control filter and into the bypass valve. It is not known if the control filter had gone into bypass during operation, but the particle sizes found are small enough to go through the filter when working normally. Changing of the fuel control filter relief pressure will not keep particles smaller than the filter opening from going through the filter.

The contaminant type that was found is not normally in the fuel system environment and is believed to have been brought into the fuel system externally, either during servicing of the fuel system hardware or during bypass of an aircraft fuel filter. Validation of the engine fuel control design was not required utilizing this type of contaminate, again as it is not normally part of engine fuel system components, and its performance under these conditions is undetermined. Although the valve design is about 40 years old, it still meets current valve design standards for this application.

Recommendations:

The source of the relative abundance of silica (glass) fibers that were found should be investigated; the possible use of a glass fiber filter within the aircraft fuel system would appear to be a logical starting point. It was suggested by Columbia Helicopters that the likely source of the silica fibers would have been the aircraft fuel piping fireproof coatings. GE recommends that the operators investigate further. It is also suggested that the aircraft fuel system filtration be reviewed to ensure that adequate measures are in place to minimize risk of bypassing the aircraft barrier filters (10 micron), thus minimizing the size of contaminants that can be carried to the tight clearances within the control and other fuel system components. There are no engineering changes to the fuel control filtration and / or bypass valve being recommended at this time.

Additional Comments:

There was a similar finding involving the same valve design in service with different operator. Details are included in the enclosed report from Hamilton Sundstrand. It is understood that these two valves and operators had these events occur in different operating regions. Common factors found during this investigation would include 1) the use of common aerospace fuel system components, 2) common type of fuel, and 3) same fuel control maintenance facility. The findings of the silica fibers in both valve components, having operated in two different regions, should remain a concern until the source of the silica fibers in identified.

Regards,

[redacted]

Ron Garman
CT58/T58 International Program Manager

cc Mr. Dave Wolf, Carson Helicopters, Inc.
Mr. Dave Bennett, GE - Aviation Field Service Engineer
Mr. Chuck Beaston, GE - Aviation Customer Support Representative

enc. Hamilton Sundstrand report FI-04-56 dated November 10, 2004, 17 pages.

Internal Correspondence

Hamilton Sundstrand
A United Technologies Company

FI-04-56
November 10, 2004

To: C. Iani

cc: D. Augustine T. Boysen D. Grulke T. Yacono

From: Paul Seegert IF 5472-1

Subject: JFC26 Fuel Control - Pressure Regulating Valve (PRV), P/Ns 543461 & 734913-1 (Control P/N 725725)

Background

Two (2) JFC26 Pressure Regulating Valves were recently submitted to Materials Engineering for investigation into the cause of the spool (p/n 543461) of each valve "sticking" within its mating sleeve (p/n 734913-1). One of the submitted PRVs was installed in control s/n 90030 that was removed from a Sikorsky S-61 operated by Carson Helicopters. This control, which reportedly had accumulated 1367 hrs since its last overhaul, was removed from service due to NG fluctuations. The PRV was received jammed in the fully closed position. The second PRV was from a control (unknown hours) that was installed on a Sikorsky S-61N Short (registration C-FHHD) operated by Hayes Forest Services. This valve was reportedly found to be sticking when the control was disassembled following a non-fatal incident in December 2002; however, when received for this investigation, the spool moved freely within its sleeve.

Conclusion

- The ingestion of materials, mainly hard angular mineral oxides and silica (glass) fibers, into the tight clearance between the spool and sleeve is cited as the likely cause of the stick-slide operation and/or temporary seizure of the two PRVs.

Material & Process Specifications

Both the spool and sleeve of the subject valve are to be manufactured from type 440C martensitic stainless steel bar per AMS 5630, as specified on HS drawings 543461 and 734913, respectively. The details are to be heat treated (hardened and tempered) per HS461 to a hardness of 53-58 Rc. Passivation shall be in accordance with HS178.

Examination

Figure 1 shows the separated spool and sleeve of the Hayes PRV alongside the jammed PRV from Carson Helicopters.

PRV from Hayes Forest Services

Initial examination of the spool under an optical microscope revealed several patches of abrasive-type wear around the finished outer diameter. As shown in Figure 2, these areas of wear extended from the diaphragm end to roughly the midpoint of this interrupted diameter. Closer examination showed that the appearance of these wear sites varied from fine, uniform abrasion to more distinct axial score marks, or grooves. The former is characteristic of service wear for this valve induced by side loading of the spool relative to the sleeve. The sites of rougher abrasion were indicative of surface distress caused by hard debris/particulate. Also noteworthy on the spool were three sites of apparent erosive wear that were equally spaced around and confined to the outer land (i.e. the land at the free end of the spool), and a considerable amount of debris that had collected in the four balance grooves and in the smaller diameter at the diaphragm end of the spool. Chemical analysis of a sampling of this debris revealed mainly abrasive mineral oxides of silicon, aluminum, calcium and magnesium, as well as silica (glass) fibers roughly 0.0001" in diameter, iron-base fines, aluminum alloy fines and scattered organic material, Figure 3. The size of the angular oxides was roughly 25μ, or 0.001" (note that the specified diametral clearance between the spool and sleeve is 0.0004"-0.0008"). The diameter of the spool in a relatively unworn area measured 0.3770", which is in accordance with the drawing requirement of 0.3770"/0.3772".

As the view into the sleeve bore was rather limited, this part was sectioned axially to expose the inner diameter surface for examination. Before sectioning, the inner diameter was determined to be 0.3780" (0.3776"/0.3778" is the specified diameter). As shown in Figure 4, the inner diameter surface displayed a wear pattern that was essentially a silhouette of the mating spool diameter. The areas of wear were microscopically rough, and were characterized as axial scoring. When matched up with the spool, it was determined that the wear pattern was produced when the valve was in the open position, Figure 5, and that minute movement, or dithering, of the spool while the valve was open, in combination with the hard, third-body abrasive oxides and other particulate, was the likely cause of the wear. Trapped particulate within the tight clearance between the spool and sleeve was considered to be the likely cause of the reported sticky operation. It was also noted that the erosion wear on the spool corresponded with similar wear at the three "ligaments" between the sleeve windows (see Figure 4). This wear was associated with flow into the clearance when the valve was in the open position.

Chemical analysis of both the spool and sleeve using a Kevex X-ray fluorescence spectrometer showed that both parts were made of the specified type 440C stainless steel. The hardness of the spool and sleeve was determined to be 57 Rc and 56 Rc, respectively, indicating that the parts were properly heat-treated.

PRV from Carson Helicopters

As previously stated, this valve was received stuck in the fully closed position (the flange of the spool was in contact with the end face of the sleeve). The details were separated by hand with not much effort, and examination under an optical microscope revealed a notable amount of silt-like particulate on the mating diameters, Figure 6. There was also a collection of debris in the smaller diameter at the diaphragm end of the spool, Figure 7. Both the spool and sleeve of this valve displayed wear marks that were quite similar to that observed on the Hayes PRV. Specifically, the wear pattern on the sleeve inner diameter mirrored the contour of the spool in the open position, and evidence of erosion was noted at the spool/sleeve "ligament" interfaces.

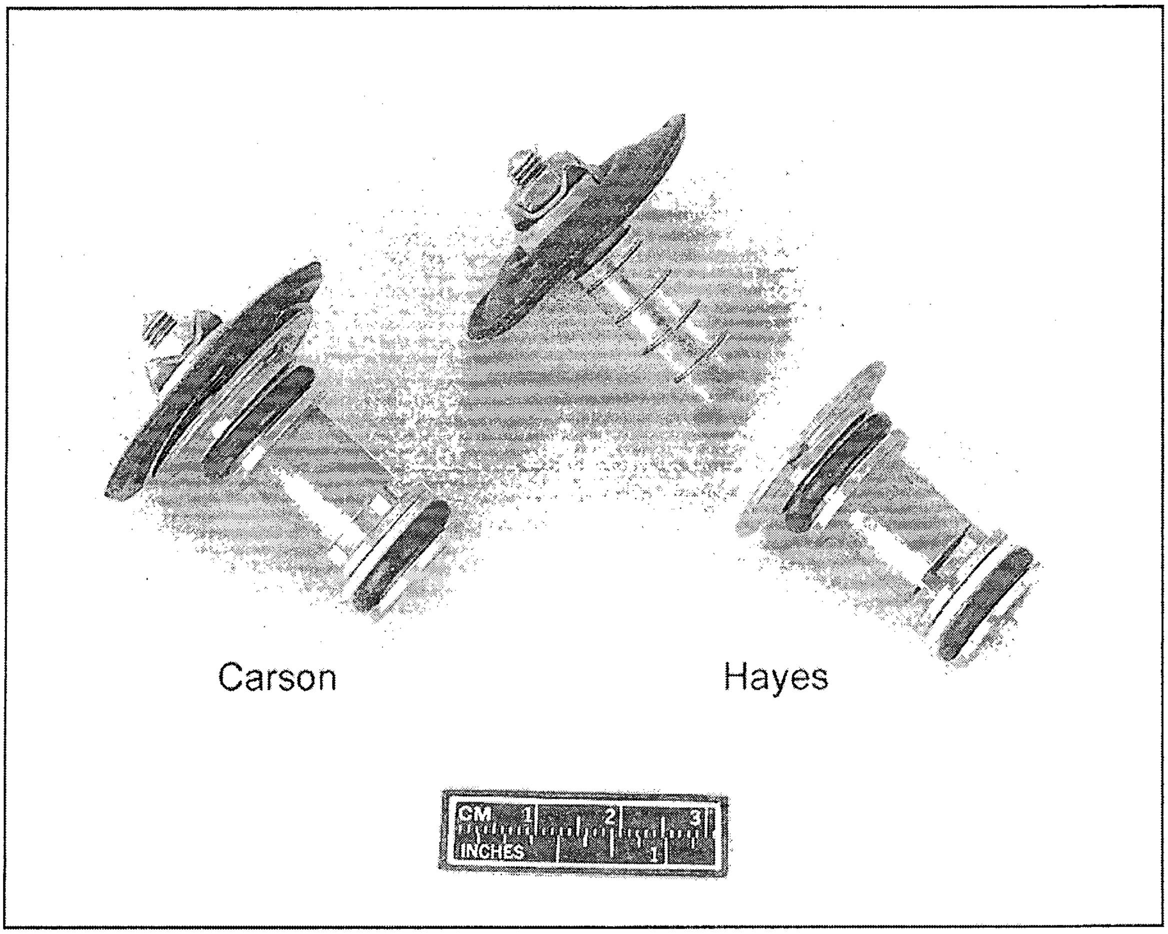
Chemical analysis of a sampling of the debris found on the spool showed a significant quantity of silica (glass) fibers, Figure 8. The analysis also showed the presence of oxides of aluminum and silicon, molybdenum disulfide (dry film lubricant) particulate, iron-base fines, discrete zinc and carbon particles, and a presence of potassium.

The outer diameter of the spool was measured as 0.3770" (meets dimension specified on drawing), while the sleeve inner diameter was 0.3779" versus the specified 0.3776"/0.3778".

The material of both the spool and sleeve of this valve was confirmed to be type 440C stainless steel, and the hardness of each detail (57 Rc for spool and 56 Rc for sleeve) was in accordance with the respective drawing requirement.

Discussion. The above examinations have shown that both JFC26 Pressure Regulating Valves exhibited abrasive wear patterns, and contained contamination comprised mainly of (1) hard, angular oxides of aluminum and silicon and (2) silica (glass) fibers. The presence of such contamination indicates a source(s) foreign to the control as the design of the JFC26 components does not include these materials. Entrapment of this debris in the diametral clearance of the valve is the likely cause of the sticking and/or jamming of the spool within its sleeve. Simultaneous small-amplitude (resonance) axial motion of the spool relative to the sleeve when the valve was in the open position likely produced the observed axial scoring/abrasion that mirrored the spool configuration. The examinations revealed no evidence that the malfunction of either valve was related to a metallurgical defect or improper heat treatment.

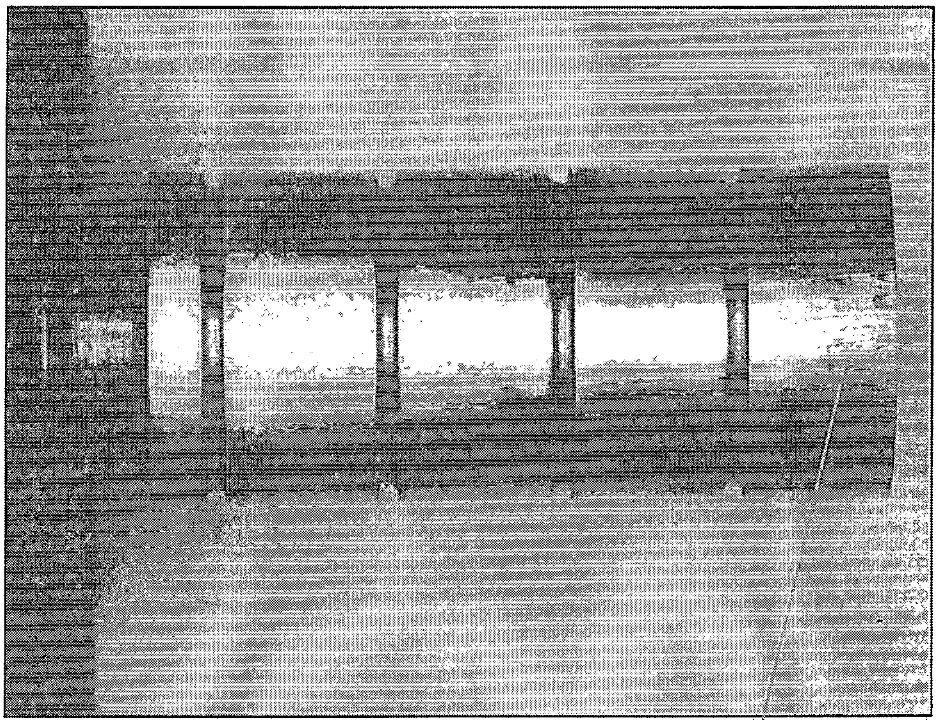
It is recommended that the system filtration be reviewed to ensure that adequate measures are in place to minimize the size of contaminants that can be carried to the tight clearances within the control. The cleanliness of the fuel supply itself should also be investigated, as should the source of the relative abundance of unusual silica (glass) fibers observed on both PRV spools.



FotoNo: 0408A00243

Figure 1

Overview of the two submitted JFC26 Pressure Regulating Valves.



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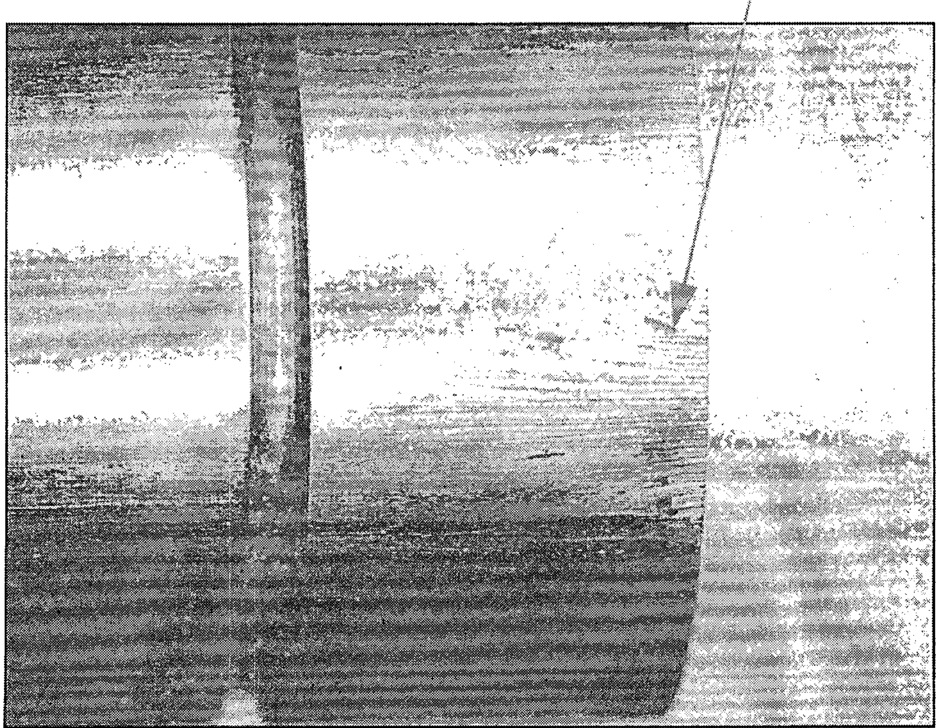


FotoNo: 0408A00274, 13.7 : 1 — 100 mils

Figure 2

Closer views of the Hayes PRV spool showing a patch of fine abrasive wear extending from the diaphragm (left) end of the finished diameter and localized erosive wear at the opposite end.

Figure 3
EDS spectrum obtained for contamination collected from the Hayes PRV spool.

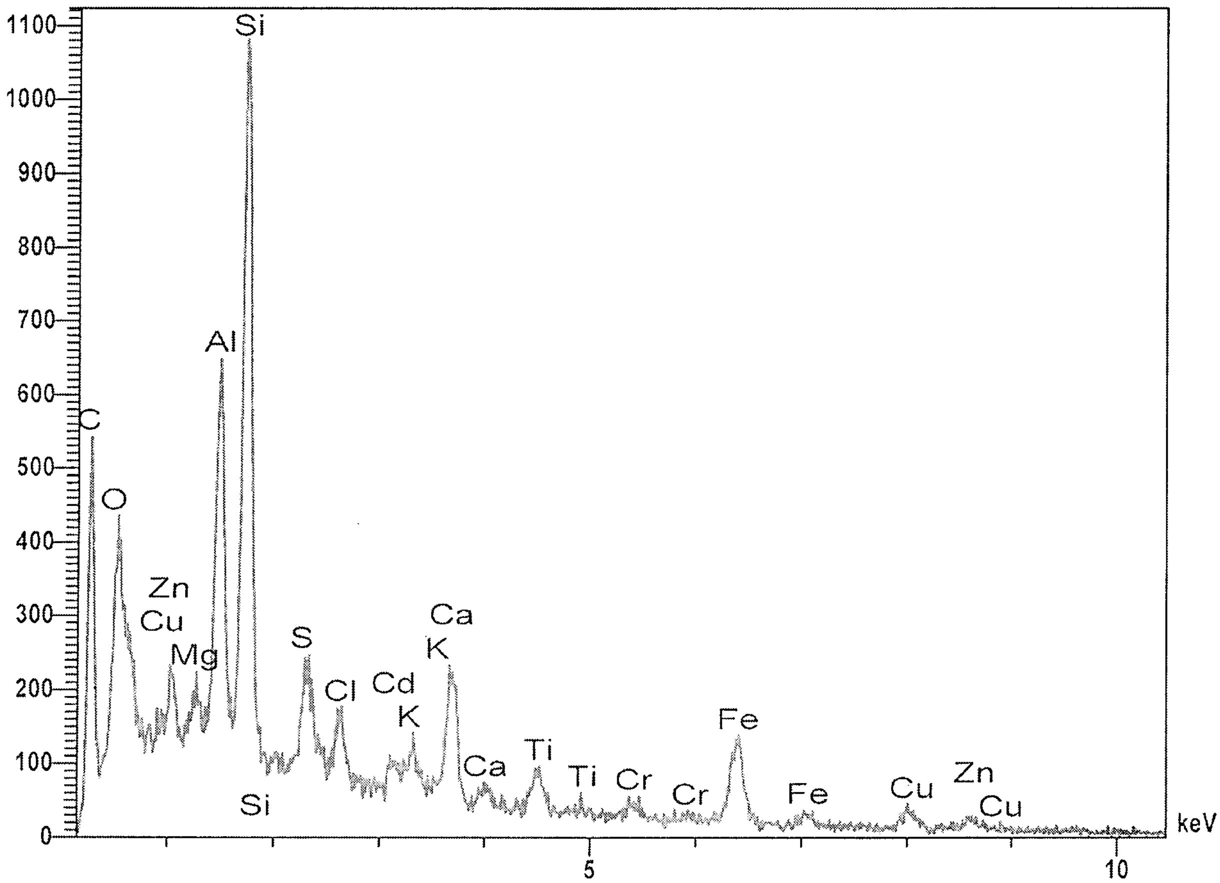
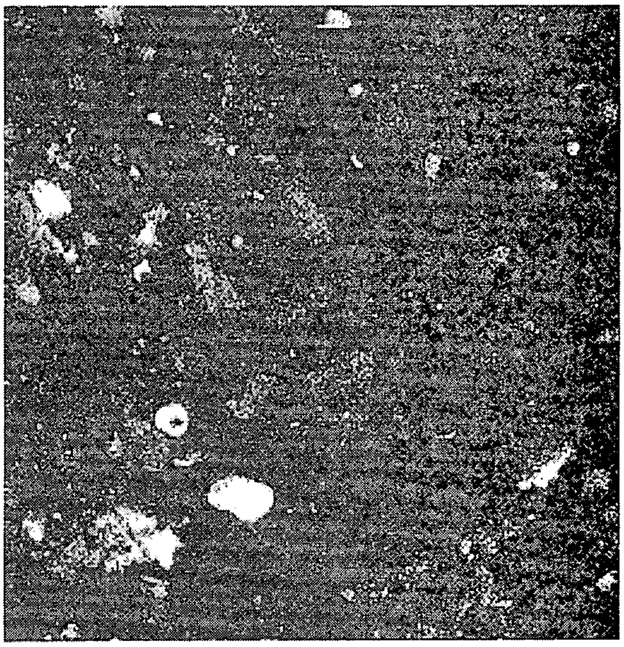
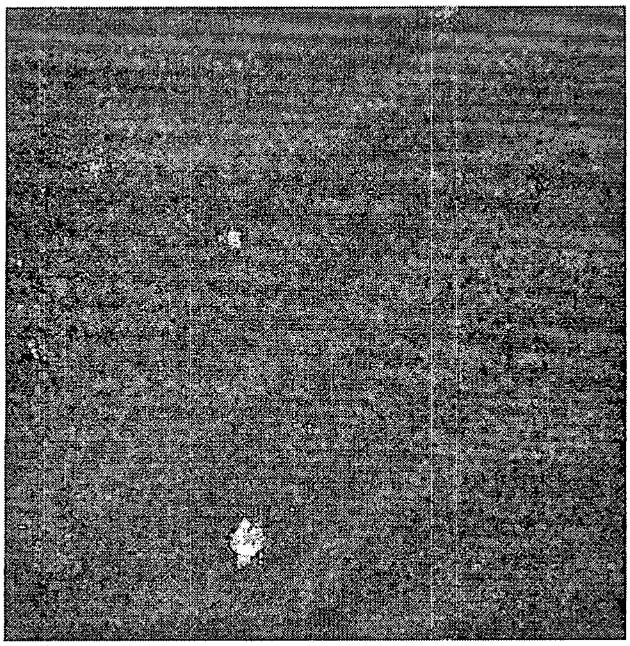


Figure 3 – cont.
Back-scattered electron image of debris and associated elemental distribution maps.

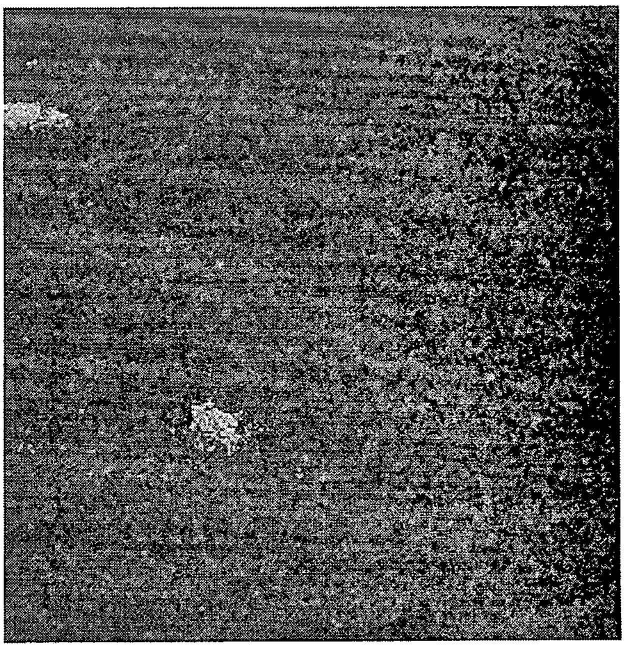
B.S.E.



Iron



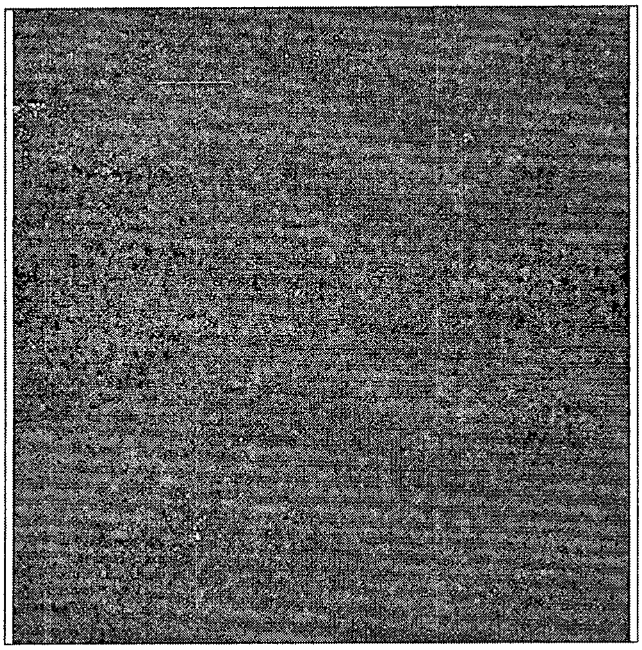
Chromium

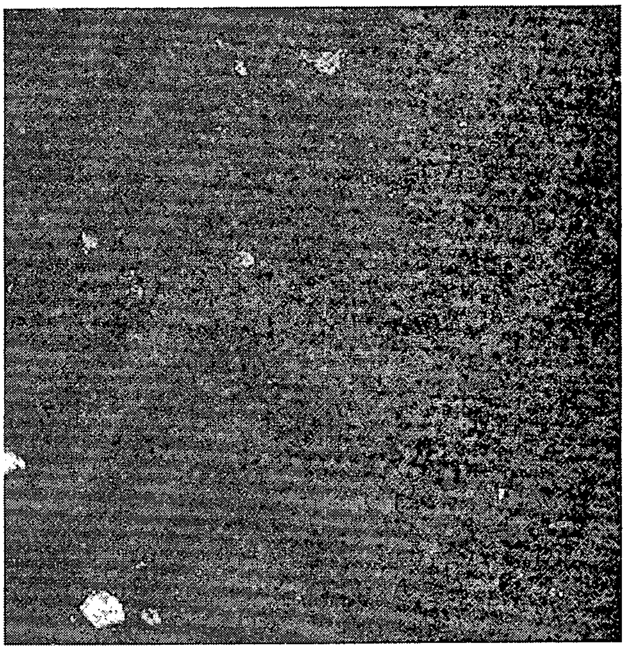


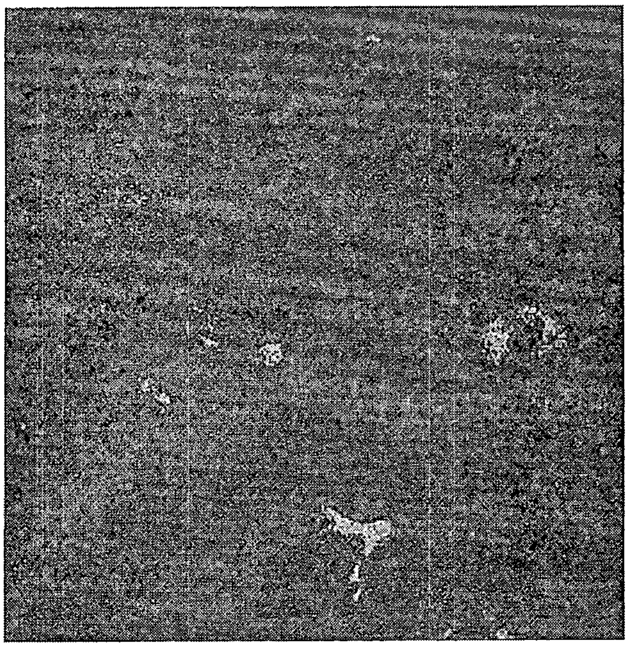
Copper

UTRC Electron Probe Microanalysis Laboratory

Figure 3 – cont.
Additional elemental distribution maps.


Zinc


Titanium


Cadmium

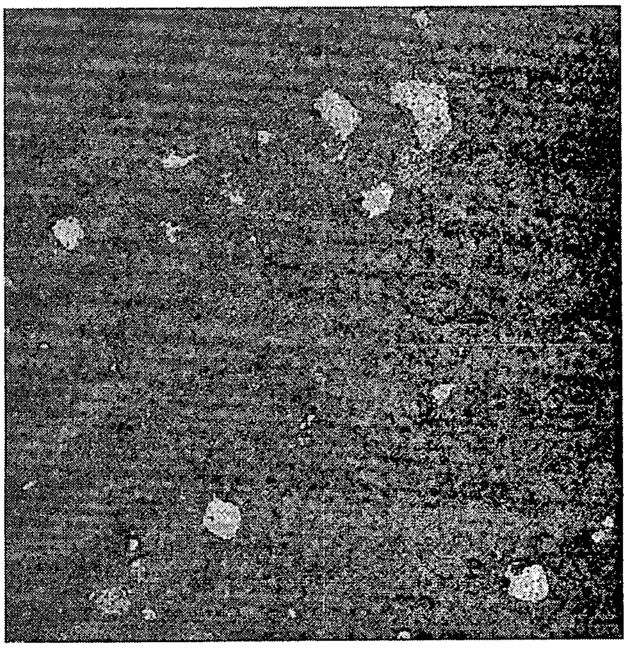
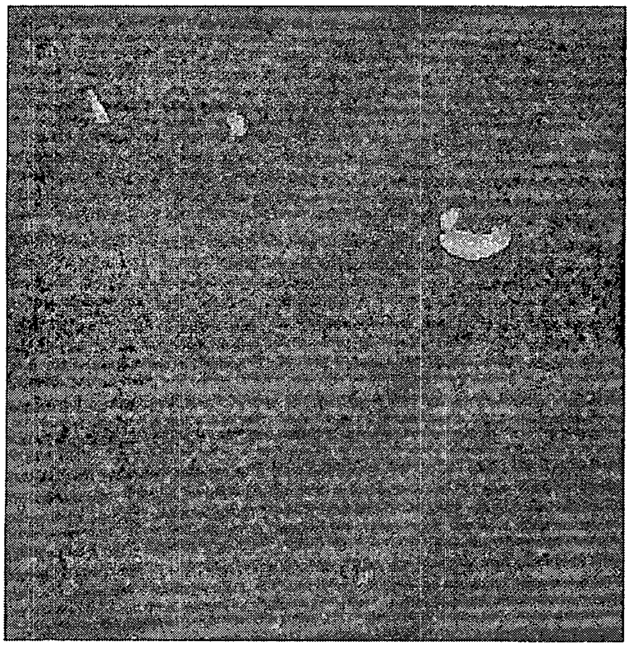
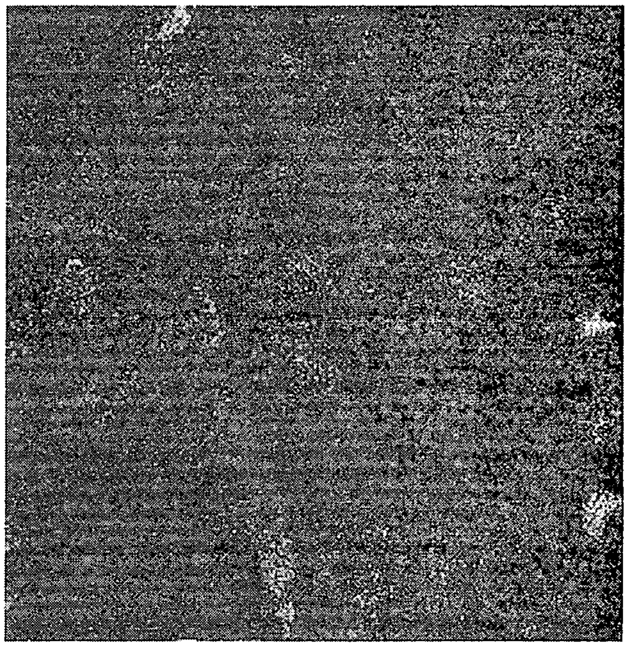

Calcium

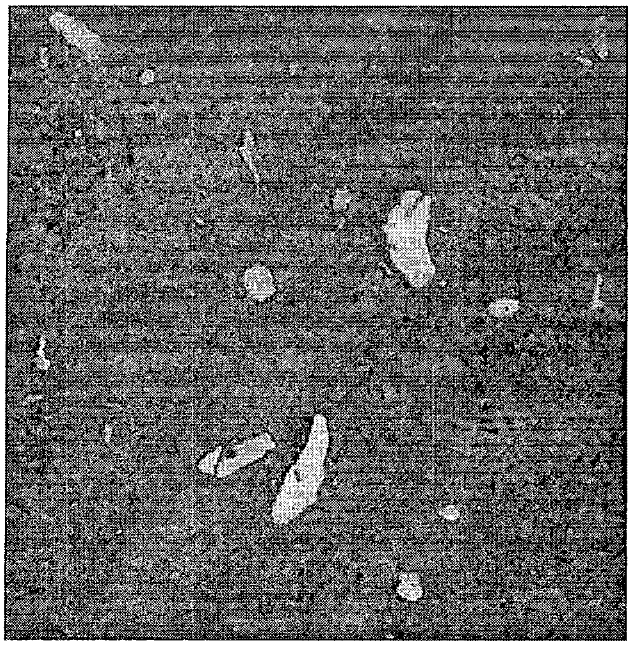
Figure 3 – cont.
Additional elemental distribution maps.



Sulfur



Chlorine

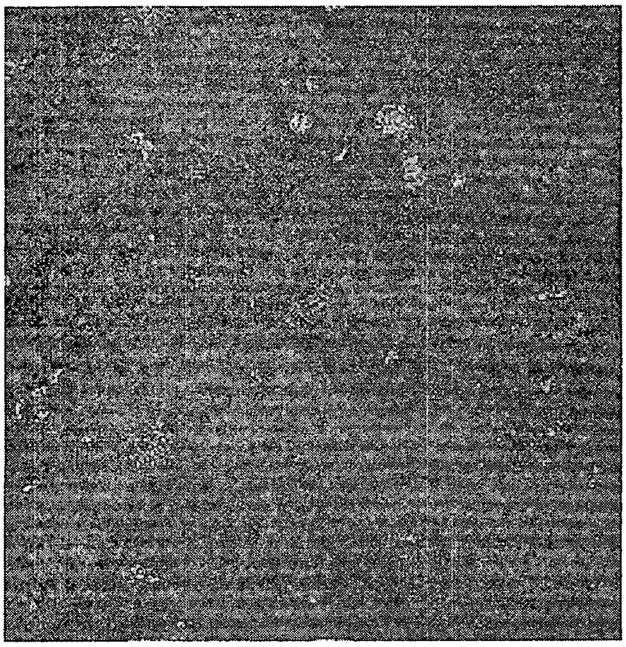


Aluminum

Silicon

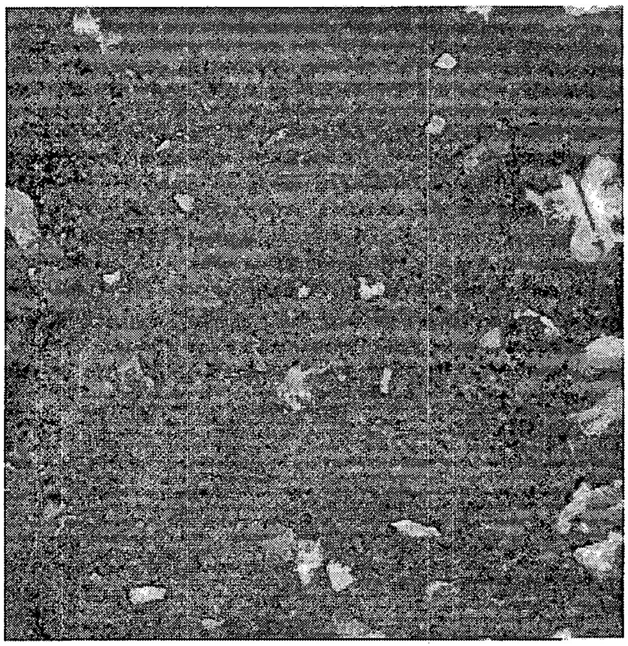
Figure 3 – cont.

Additional elemental distribution maps (note that some of the Carbon distribution is attributable to the medium used to secure the sample).

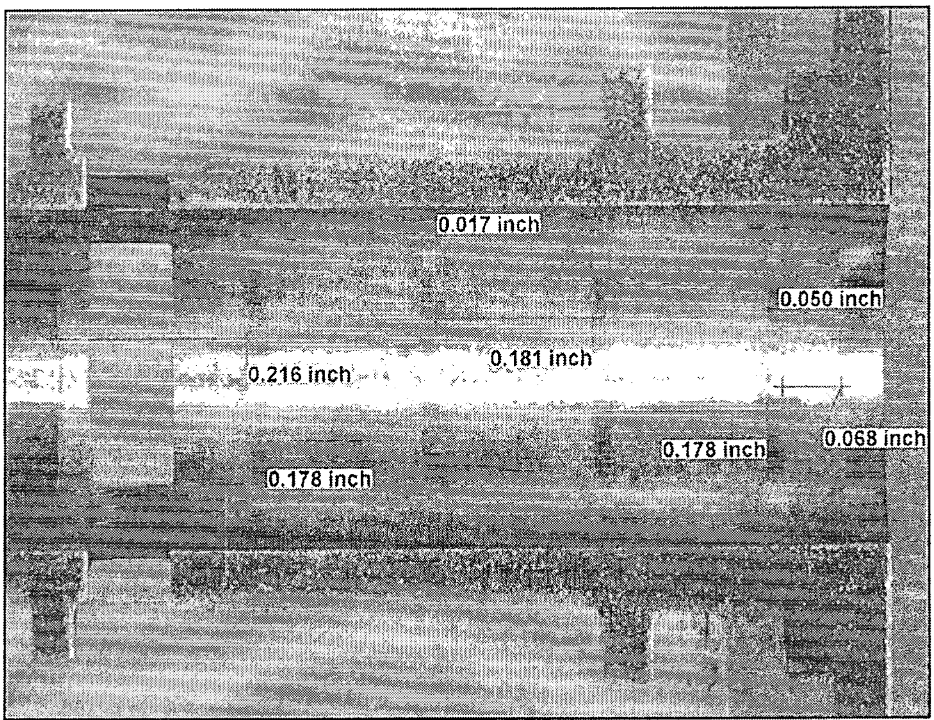


Magnesium

Oxygen



Carbon



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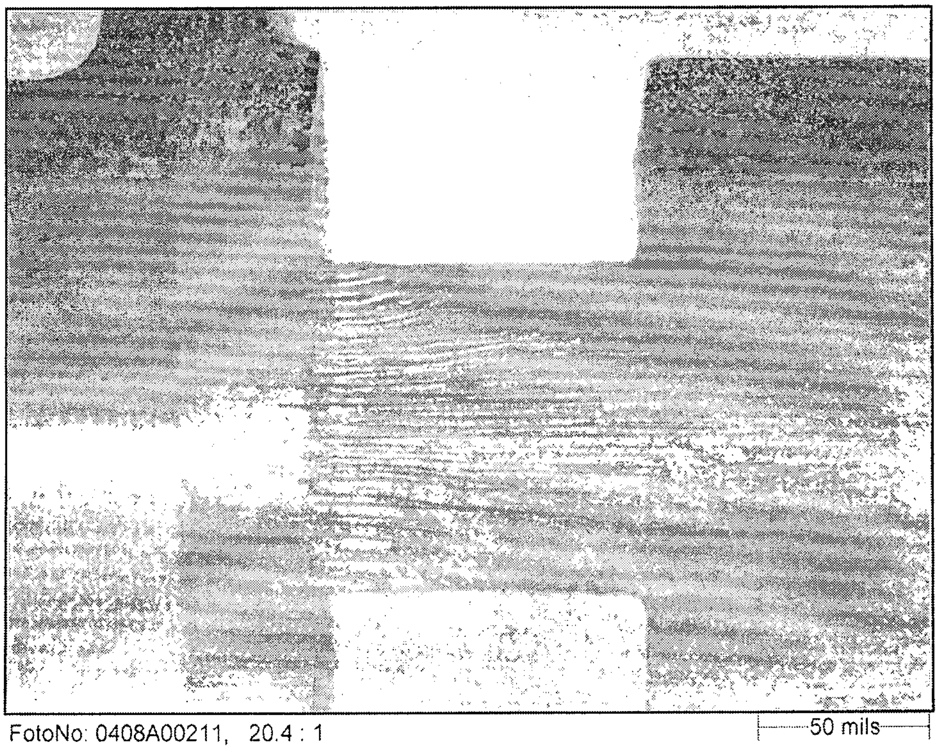
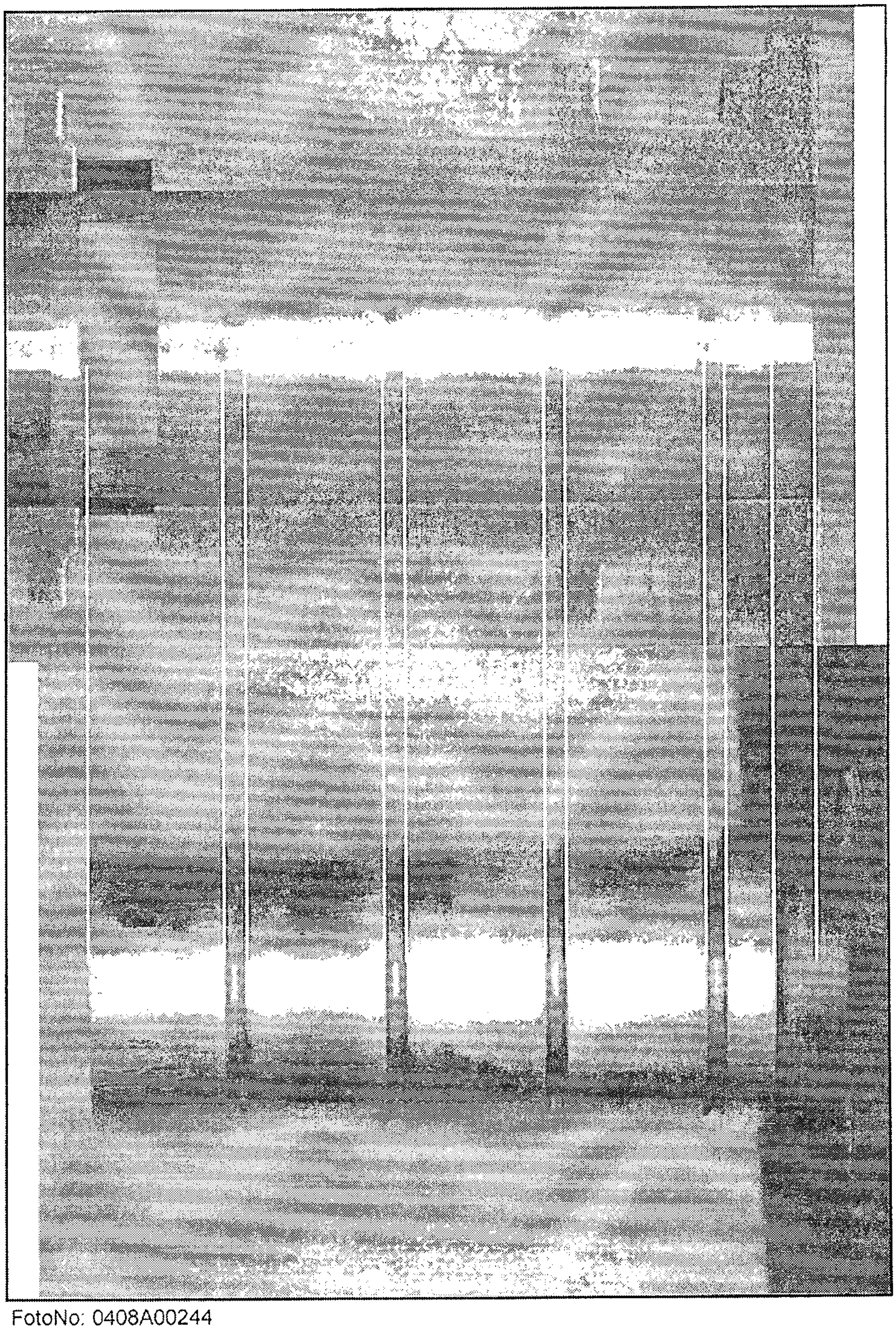


FotoNo: 0408A00211, 20.4 : 1 ⊢50 mils⊣

Figure 4

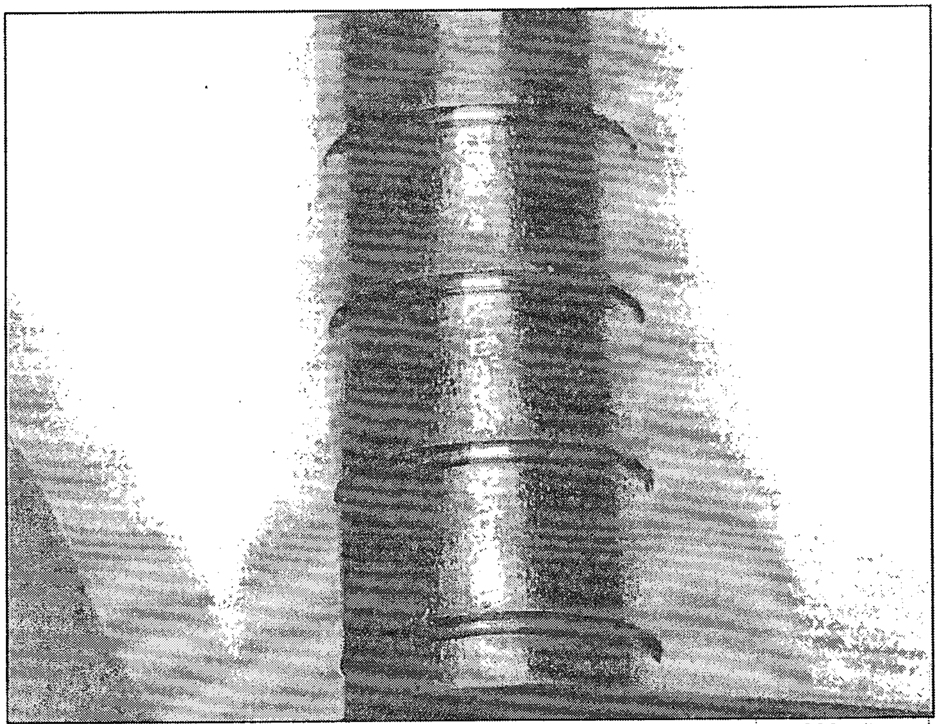
Upper image: Wear pattern on the inner diameter surface of the Hayes PRV sleeve. With the exception of the left band, the width of the wear rings corresponded to that of the spool lands (the wider band on the left is attributed to abrasive wear at the spool end interface as the valve opened and closed). *Lower image:* Erosive wear on one of the window "ligments".



FotoNo: 0408A00244

Figure 5

Aligning of the wear pattern on the sleeve inner diameter to the spool lands for the Hayes PRV showing that the wear on the sleeve was produced when the valve was in the open position (reference - rightmost line is inboard of spool seating surface).



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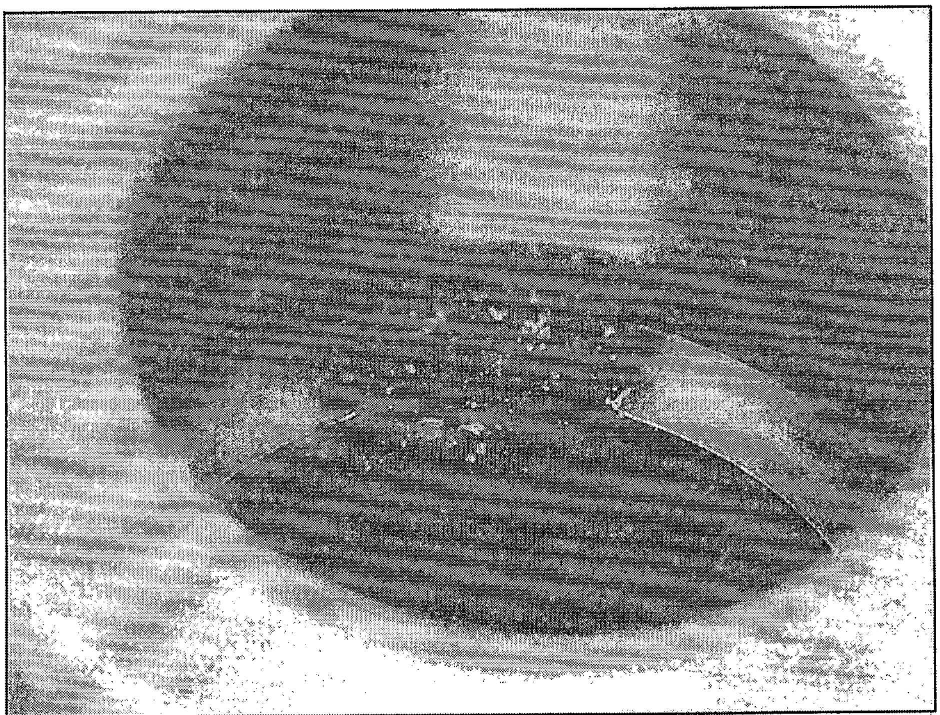
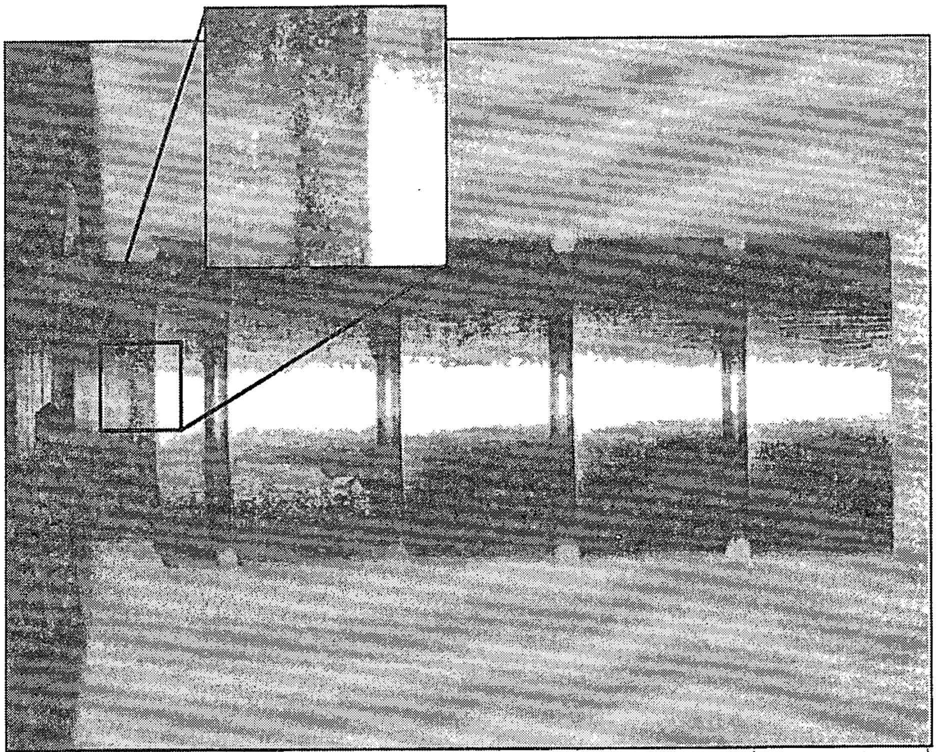


FotoNo: 0408A00166, 13.8 : 1 100 mils

Figure 6

Silt-like debris on the mating diameters of the Carson PRV.



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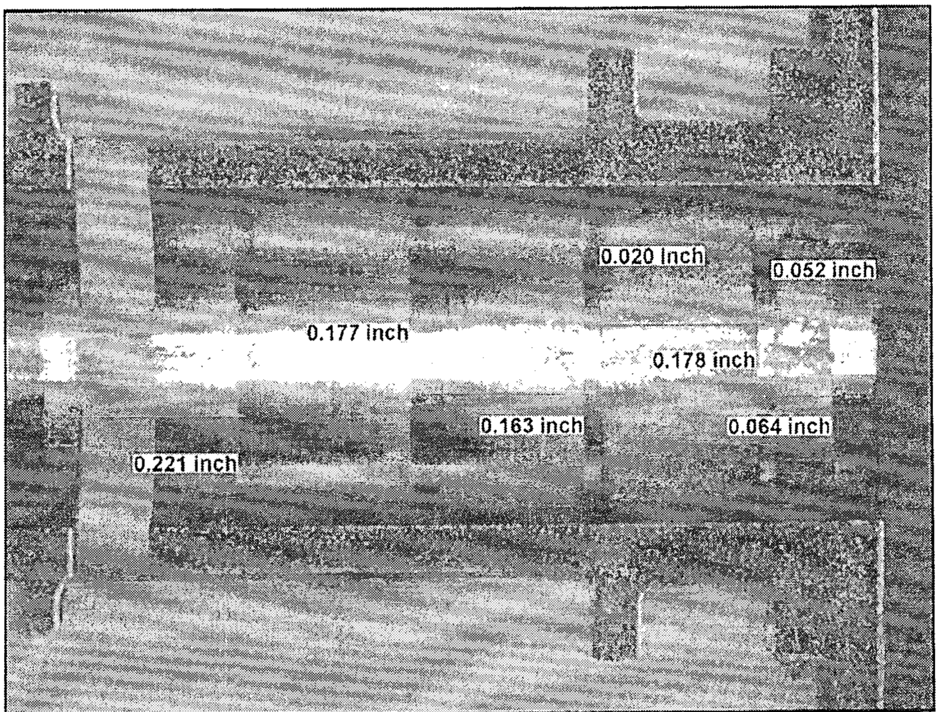
200 mils



FotoNo: 0408A00316, 5.2 : 1

200 mils

Figure 7

Close-up views of the spool and sectioned sleeve from the Carson PRV showing the overall wear pattern, as well as the contamination that had collected on the spool (highlighted area in upper image).

Figure 8

EDS spectrum obtained for contamination collected from the Carson PRV spool.

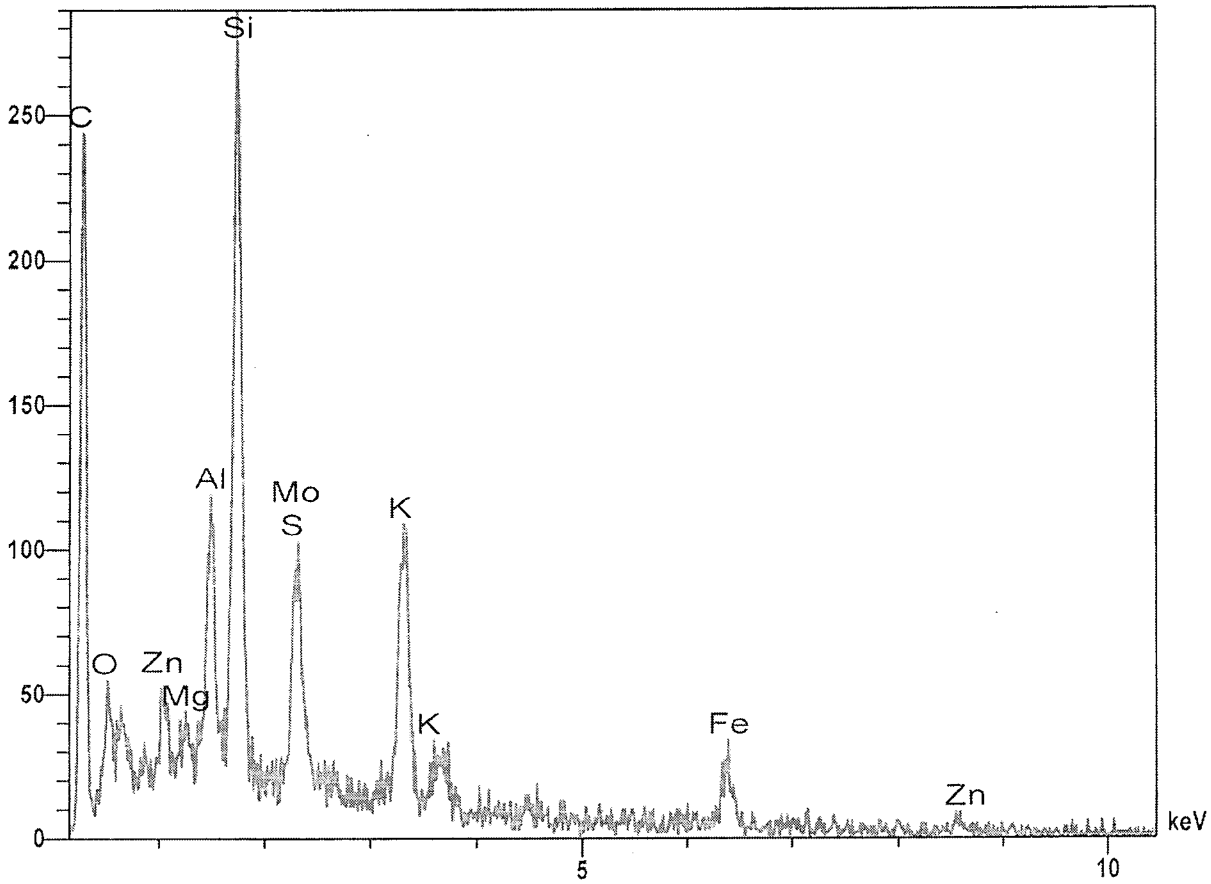
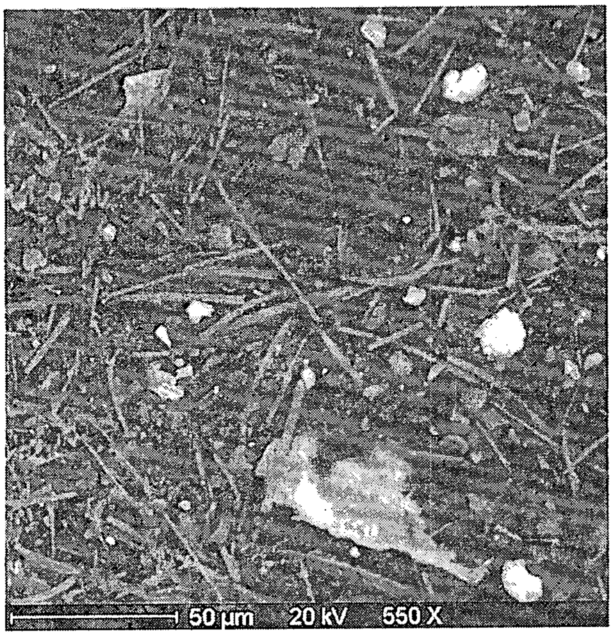
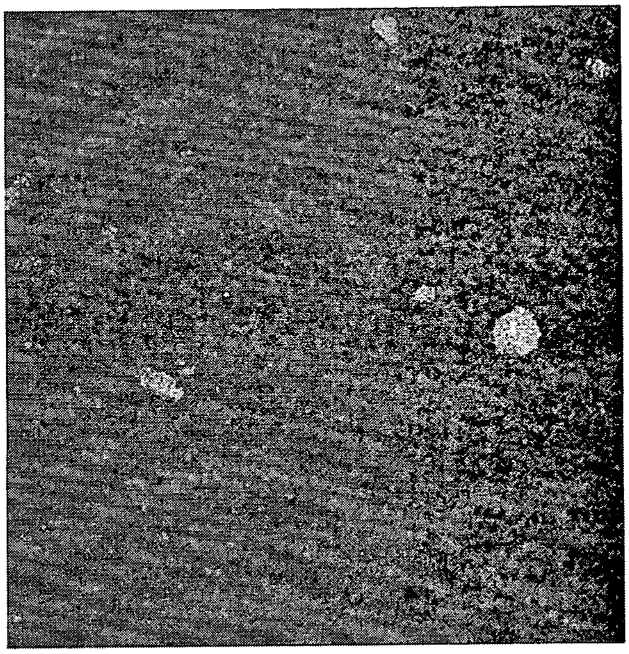


Figure 8 – cont.

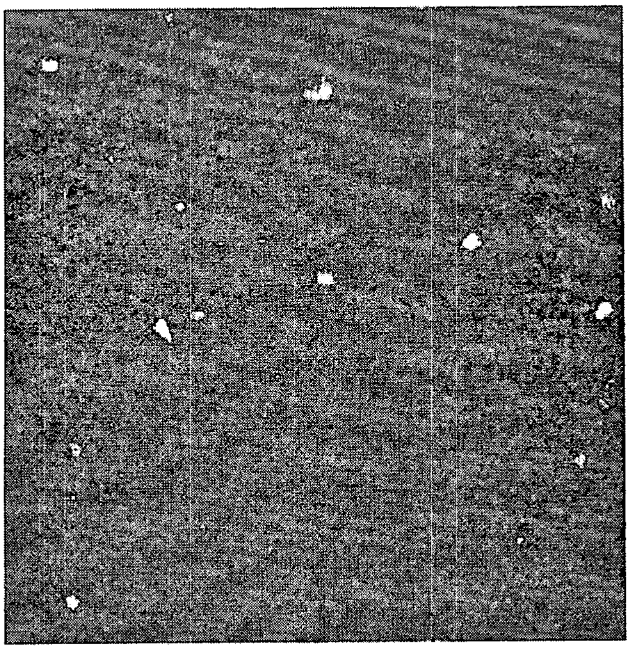
Back-scattered electron image of debris and associated elemental distribution maps.



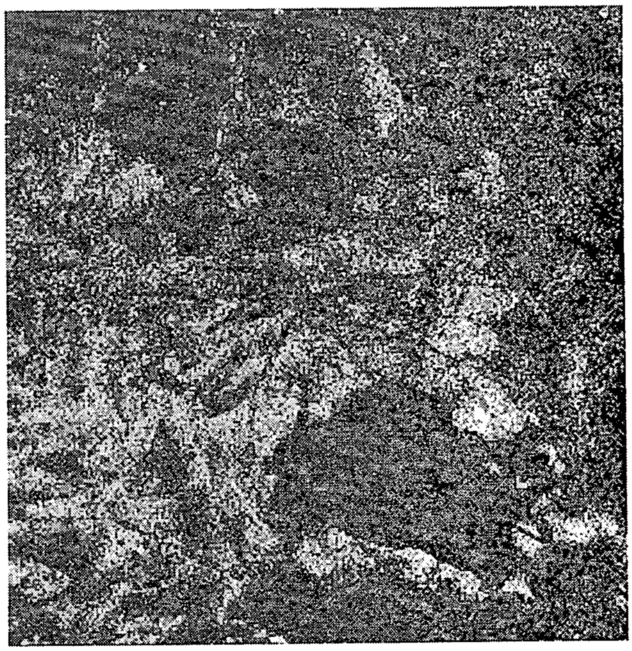
B.S.E.



Iron

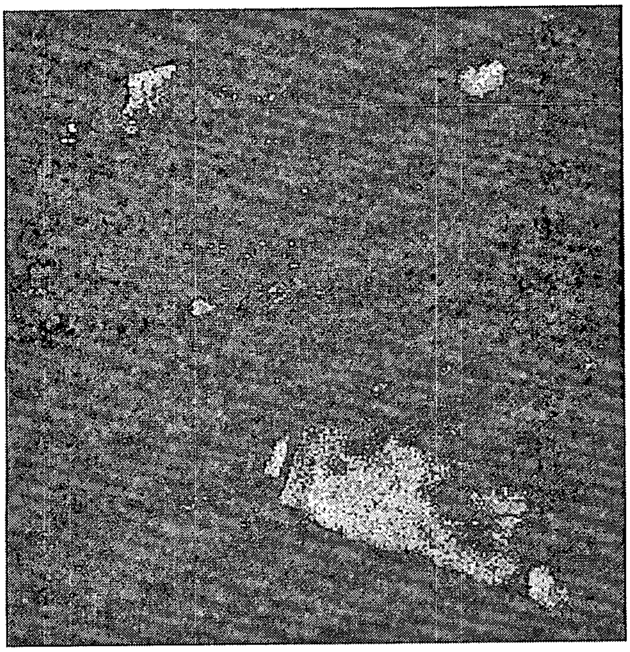


Zinc

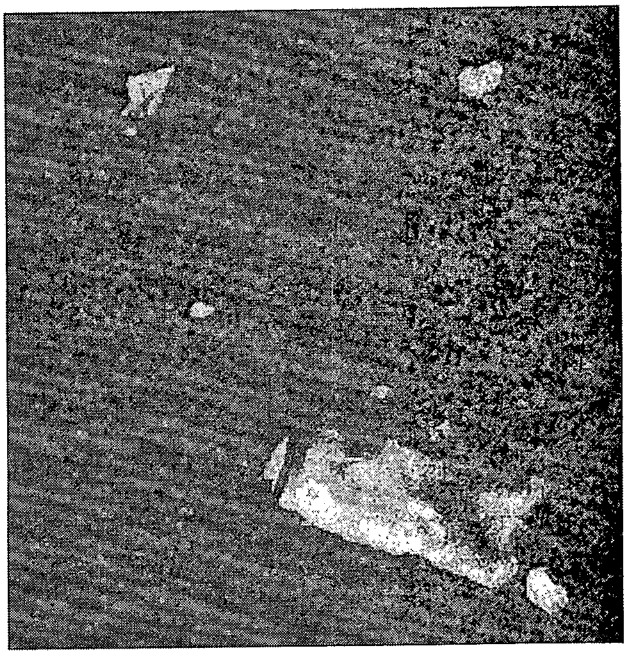


Potassium

Figure 8 – cont.
Additional elemental distribution maps.

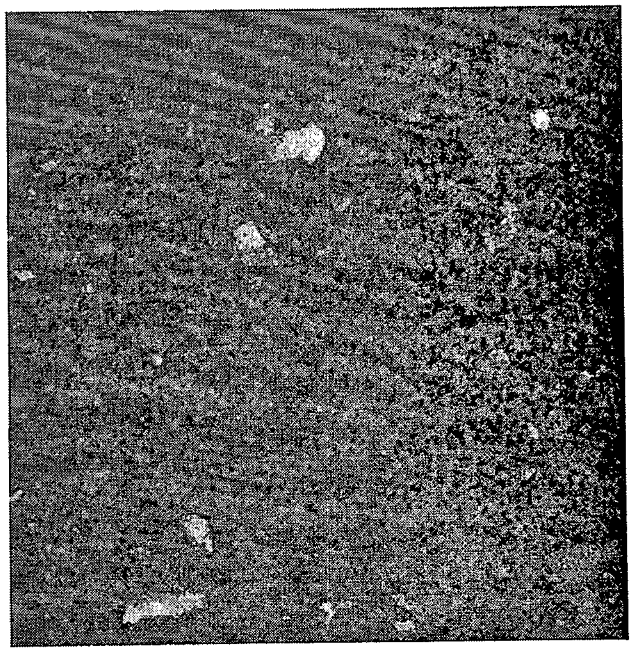


Molybdenum



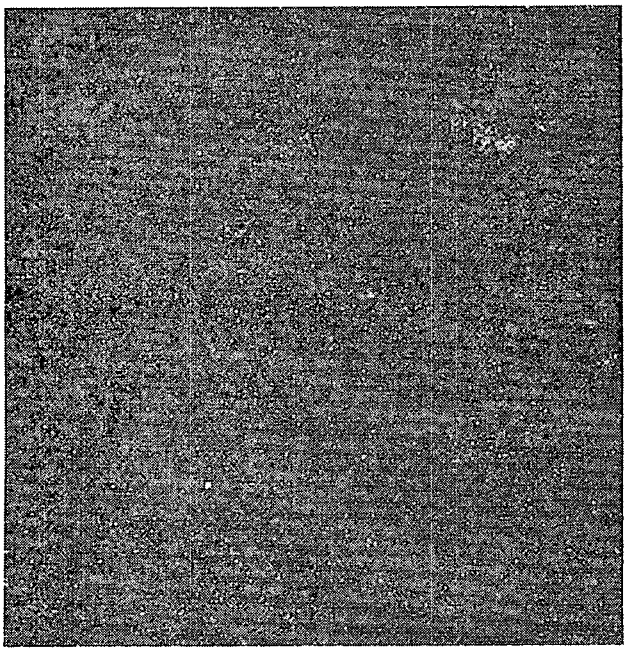
Sulfur

Silicon



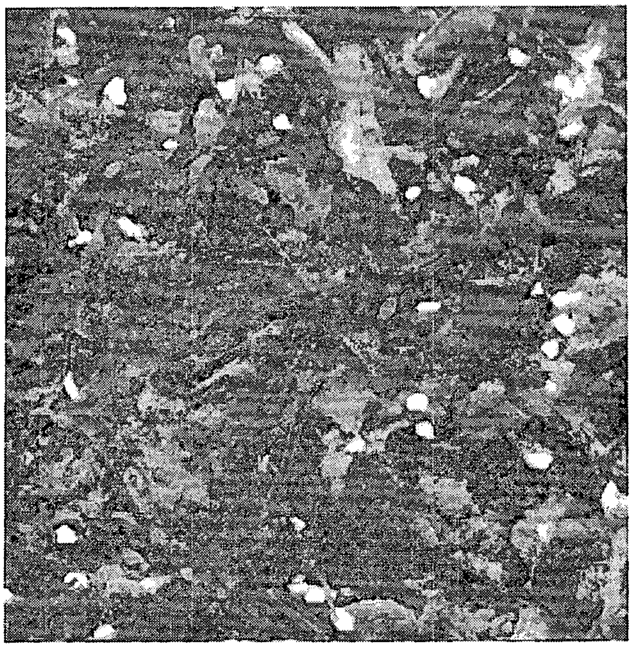
Aluminum

Figure 8 – cont.
Additional elemental distribution maps.



Magnesium

Oxygen



Carbon