BONNEVILLE
POWER ADMINISTRATION

# LEVEL 1 ACCIDENT INVESTIGATION REPORT

# OF AUGUST 17, 2004

# FATAL AIRCRAFT ACCIDENT

# ON THE

# GRAND COULEE-BELL NO. 6

# 500 kV LINE

**FINAL REPORT**

**OCTOBER 1, 2004**

## TABLE OF CONTENTS

## SUMMARY

## INTRODUCTION

On August 17, 2004, at approximately 0940, a Bonneville Power Administration (BPA) pilot was killed in the crash of a Bell 206BIII helicopter while stringing "sock line" to enable the subsequent stringing of new conductors and static wire on the Grand Coulee-Bell #6 500-kV line between tower 84/2 and BPA's Bell Substation in Mead, Washington. (See Appendix 7, Site Map.)

On August 17, 2004, Terry Esvelt, BPA Senior Vice President, Employee & Business Resources, appointed a Level I Accident Investigation Board (AIB) to investigate the helicopter accident in accordance with Delegation Order No. 0204-161, signed by the Secretary of Energy on October 7, 1996, and with BPA Manual Chapter 181, "Accident Investigation and Reporting".

## ACCIDENT DESCRIPTION

On Tuesday, August 17, with the Spokane TLM Foreman III acting as overall job supervisor, a crew was present to string "sock line" onto the final two spans of the Grand Coulee #6 500-kV line into Bell Substation. Sock lines would later be used by the line crew to pull in the heavier phase conductors and overhead ground wire. A helicopter was requested so that the sock lines could be passed over nine normally energized lines that crossed under the new Grand Coulee-Bell #6 line. The helicopter would fly the sock lines to the substation dead-end bay where linemen in the structure would secure them.

At 0700, the aircraft landed near tower 84/2 located west of Bell Substation. The pilot shut down the aircraft and attached a 25-foot long line with a 31-lb. ballast weight and a remote hook to the aircraft's belly hook. The remote hook would then be connected to the sock line.

After a crew tailboard meeting and helicopter equipment examination, the helicopter operation began at approximately 0850 with three conductor sock-line pulls from a triple-drum puller/tensioner in the power-payout mode, in which the line is reeled out at a speed set by the operator's hydraulic controls. This mode was chosen to increase control and avoid making contact with normally energized lines beneath the pull. The three pulls went smoothly except for a momentary tug on the first sock line pulled that resolved itself. At approximately 0935, the pilot maneuvered the aircraft to a position above the substation dead-end bay structure to initiate the remaining static-wire sock-line pulls. The operation would now involve a different puller/tensioner, a single-drum machine with different operating characteristics. The crew had expected the pilot to land before the static-line pulls and was not prepared. A crewmember in the tower scrambled up to the goat peak to connect the sock line to the helicopter long line. Then the aircraft began to move backward in a westerly direction when the lineman in the tower noticed that the equipment operator was readjusting his radio speaker and was not ready. The lineman radioed the pilot to hold the pull. The pull continued when communication was re-established.

The aircraft had traveled approximately 700 feet from the puller/tensioner when a snag occurred on the reel. The snag caused the sock line to double back onto the reel for 36 feet. This line reversal, along with the opposing motion of the helicopter, removed all slack from the sock line and the aircraft's 25-foot long line and rocked the aircraft back on its tail. The resulting jolt may have unplugged the power source to the remote-hook release, preventing the pilot from jettisoning the sock line remotely (the pilot's primary method of releasing the load). With the sock line taut and the aircraft now heading westward, physical evidence indicates that the aircraft's belly hook was pulled aft and the long line electrical/solenoid release mechanism jammed against the belly-hook attachment frame and became inoperable (the second option for releasing the load). The aircraft quickly lost altitude and collided with the de-energized Kaiser 13.8-kV power line below before crashing to the ground.

Crewmembers immediately called 911, rushed to the accident scene and provided excellent emergency response. Using their training, experience and knowledge of the hazards, they responded quickly to shut off the fuel switch, extinguish a small fire, winch the helicopter upright to extricate the pilot and start two-person CPR. Unfortunately, the pilot had sustained fatal injuries.

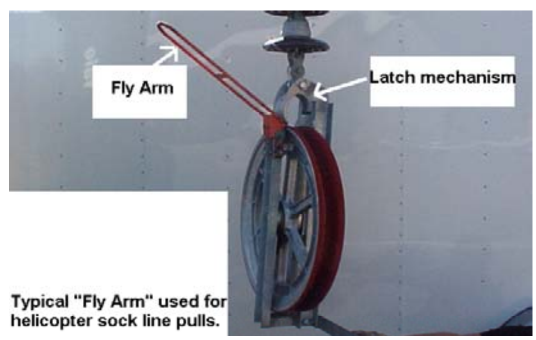
## FACTS

The job involved TLM crews stringing new conductor on the final two spans of the newly constructed Grand Coulee-Bell #6 500 kV line going into the Bell Substation. The rest of the 84-mile line was being constructed by a contractor as part of BPA's infrastructure reinforcement project. The job plan for these two spans began several months before the accident. Since the job's manpower needs exceeded the capacity of the Spokane-based Bell TLM line crew, the Foreman III supplemented the crew with employees from BPA line crews headquartered in Kalispell, Montana and Ellensburg, Washington. On May 17, 2004 the Spokane TLM Foreman III requested a helicopter from BPA Aircraft Services for the job. Sometime in mid-July the BPA Chief Helicopter Pilot decided to use the Spokane-based aircraft and pilot for this operation.

**August 12, 2004**

Witnesses stated that the Spokane helicopter pilot met with the Bell line crew to discuss the sock-line pull. At the meeting the pilot and ground crew looked at the triple-drum puller/tensioner that would be used for the sock-line pull. The pilot discussed with the crew the direction and sequence in which he would pull the sock lines from the triple-drum puller/tensioner.

During the briefing, the pilot indicated to the crew that he would be using a 50-foot long line (with a 31-lb. weighted ball, and remote cargo hook), which would be attached to the aircraft's cargo hook. The pilot expressed concern to the crew and later to the Chief Helicopter Pilot about setting the sock line into the traveler without fly arms installed. The fly arms could be used only on the two outside conductors of tower 84/3 because the other three lines had to be passed through the structure. The crew informed the pilot that they would be in the tower anyway and could assist in placing the sock lines in the travelers.



Typical "Fly Arm" used for helicopter sock line pulls.

The triple-drum operator and the pilot discussed the operation of the puller/tensioners and whether to free-wheel or power pay out the sock line. The pilot had been told by the BPA Chief Helicopter Pilot that as long as the line would come off the reel at a fast walking pace, it would be adequate for the operation. The Chief Helicopter Pilot later testified that he intended the reel to be freewheeling and assumed the pilot understood. The equipment operator paid out the sock line under power from the triple-drum puller/tensioner as the pilot walked with it at a fast pace. As a result of this test, the pilot was satisfied with the speed of power payout. However, this test was not performed on the TSE puller/tensioner used for the static sock-line pull. The initial decision to power payout rather than free-wheel the puller/tensioner was based on the fact that the sock line would be passing over a number of energized power lines. It was believed that the power-payout method allowed the puller/tensioner operator to maintain better control of the sock line with the equipment available for this job. This would prevent the sock line from drooping onto the energized lines. Based on discussions with experienced linemen and outside helicopter operators, the practice of paying out under power while pulling sock lines over energized lines with a helicopter is not uncommon in the industry. However, some operators, utilities and jurisdictions exclusively require freewheeling rather than power payout when using a helicopter.

**August 16, 2004 (Day Before the Accident)**

The pilot and TLM crewmembers attended an in-depth briefing of the work at a “tailboard” meeting. This included status of normally energized lines and equipment, Clearances and Hold Orders, electrical safety, communication channels and procedures, hardware, and technical specifications. Job assignments, work procedures and equipment locations were also discussed. Most of this information was contained in packets that were handed out. In addition, the pilot and crewmembers physically walked the job site.

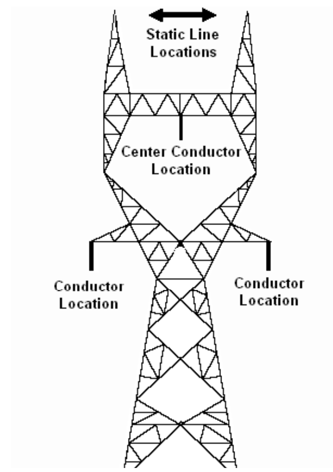
The BPA Foreman III in charge of the job gave the helicopter safety briefing that mainly covered ground crew safety. This included approaching the helicopter while it is on the ground, loose equipment precautions, and cautions on static discharge from the helicopter’s remote cargo hook. The pilot was present and agreed with the content of the briefing. There was no testimony to indicate that topics such as how to respond to emergency situations like sock-line hang-ups, other hazards specific to Class C loads[1], or other detailed helicopter operational procedures were discussed by the pilot at the general meeting. However, individual conversations between the pilot and the equipment operators and the pilot and the linemen designated as signalmen did take place, at which time some of these issues were discussed.

Testimony from many of the witnesses who had attended the August 16th tailboard meeting indicates the pilot had concerns about the job and was nervous about the sock-line pull. However, statements from other witnesses indicate that the pilot was not concerned about the work and that he expressed no nervousness about the operation. These include testimony from a contractor helicopter pilot who had been pulling sock line on the contractor-built portion of the same line, another BPA helicopter pilot with whom the pilot talked on the day before the job, and the mechanic who worked with the pilot setting up the long line and testing the emergency release on the morning of the accident. These conflicting statements and a lack of any testimony that the pilot had expressed specific concerns to any witness made it impossible for the Board to lend credence to suggestions relating to the pilot’s demeanor and attitude regarding the job. In addition, the Chief Helicopter Pilot, Aviation Safety Manager and Aircraft Services Manager testified that the pilot had not expressed any concerns to them regarding the job.

[1] Class C rotorcraft-load combination means one in which the external load is jettisonable and remains in contact with land or water during the rotorcraft operation

**August 17, 2004**

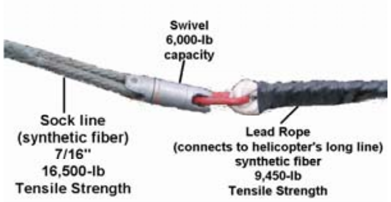
That Tuesday, with the Spokane Transmission Line Maintenance (TLM) Foreman III acting as overall job supervisor, a combined Spokane and Ellensburg, Washington, and Kalispell, Montana TLM line crew was present to string "sock line" on the final two spans of the Grand Coulee-Bell #6 500-kV line into Bell Substation. The sock line is a small, light rope unwound from a ground-based rope puller/tensioner machine that was intended to be strung through travelers mounted on towers 84/2 and 84/3 and the Bell Substation dead-end bay structure. Sock lines would later be used by the line crew to pull in the heavier phase conductors and overhead static lines. A helicopter was requested so that the sock lines could be passed safely over nine normally energized lines that crossed under the new Grand Coulee-Bell #6 line. The first part of the work plan for the three conductor positions involved pulling sock line from the triple-drum puller situated west of tower 84/2 through 84/2 and 84/3 and terminating at the substation dead-end bay structure. Linemen would be positioned in each tower to thread the sock lines through the travelers on each tower. The helicopter would then fly the sock lines to the substation dead-end bay where linemen in the structure would secure them. The second part of the job entailed stringing sock lines for pulling the two overhead static lines from the substation bay west to tower 84/2. Each of these sock lines would be pulled from a separate single-drum puller/tensioner. One lineman in each structure would be equipped with a radio and designated as signalman for communicating with the pilot and the equipment operators.




On August 17, 2004, at approximately 0655, aircraft N34698, a BPA Bell 206B III helicopter, departed Spokane International Airport (KGEG) enroute to Mead, Washington to pull the sock-line. This was a Class C rotorcraft external-load operation. The sole occupant on board the aircraft was the pilot-in-command (PIC).

At 0700, the aircraft landed near tower 84/2 located west of Bell Substation. The pilot shut down the aircraft and attached a 25' longline (a ½" steel cable, 21000 lbs. tensile strength) with a 31-lb. ballast and remote hook, to the aircraft's belly hook. The photo at right depicts BPA's helicopter rigging (the helicopter is not pulling sock line in depiction).

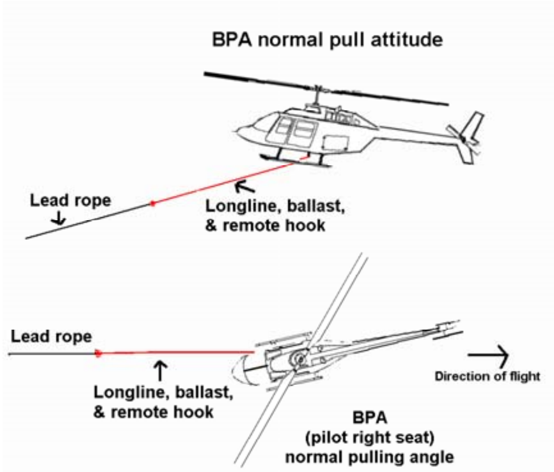

The remote hook would then be connected to the sock line lead rope (a 3/4" synthetic fiber, 9450 lbs. tensile strength). The lead rope is attached to a swivel connected to the sock line (Example, TSE sock line 7/16" synthetic fiber, 16500 lbs. tensile strength). See photo at left.




The pilot remained at the landing site while the line crewmembers attended a brief tailboard meeting in the Bell District "Bull Room". The Foreman III reiterated the high points of the previous day's detailed tailboard meeting and included the direction and sequence of the sock-line pulls. After the tailboard meeting, the pilot and the Spokane heavy mobile equipment mechanic (HMEM) physically checked the range of motion in all directions on the helicopter's cargo hook (belly hook), with the longline attached, to ensure that it would not interfere with the electrical connection to the remote cargo hook. The pilot and a lineman then tested the remote hook to ensure that it operated electrically and mechanically, but the pilot did not wrap tape around the remote cargo hook's electrical connection at the aircraft.

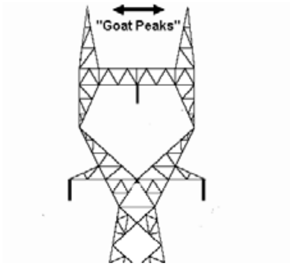
The pilot and an equipment operator discussed the operation of using the triple-drum puller/tensioner with the helicopter. The triple-drum puller/tensioner was located on the west end of the job and would be used for pulling sock line into the conductor location.

The BPA Aircraft Service's technique for pulling sock line with a Bell 206B, with the pilot flying from the right seat, is to position the aircraft with the nose 15 degrees to the left of the centerline of the pull and then fly rearwards. This puts the aircraft attitude slightly nose up.




A single-drum TSE puller/tensioner (see below) was positioned 258 feet east of the substation dead-end bay. In preparation for the static-line pull, a lineman and the equipment operator were preparing to remove a pin from the puller/tensioner that would allow the machine to operate in the free-wheel mode.

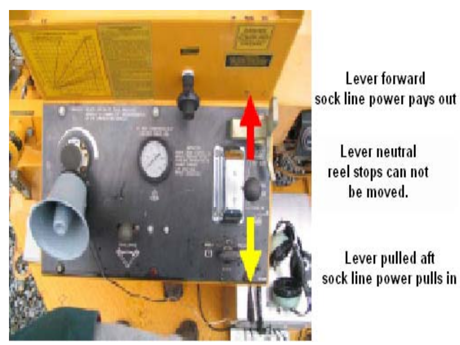

In the free-wheel mode, the reel is disengaged from the hydraulic drive system of the puller/tensioner, allowing the sock line to be manually pulled off the reel. At this time, the designated signalman at this end of the job (east end) informed crewmembers that the pilot wanted the puller/tensioner in the power-payout mode where, the reel is connected to the hydraulic drive and the sock line is paid out by the machine's motored drive. In this mode the speed of payout is dependent on the speed set by the operator's hydraulic controls. The ground crew then walked the sock line off as the operator power paid it out to establish the adequacy of the payout speed. The ground crew pulled the sock line out three (3) times the distance to the substation dead-end bay, approximately 700 feet. While walking out the sock line, a ground crew member experienced a tug on the line that spun him around and pulled him back towards the TSE puller. The equipment operator told the ground crewman he had a "snag" in the line, causing it to double back and pull in onto the reel. Such a snag is not uncommon in the use of puller/tensioner equipment and when not using a helicopter is not considered a safety hazard. The operator stopped the pull and reversed the reel to the position of the snag to jerk it free. The crew then fed the sock line through the traveler in the "goat peak," or top peak, on the dead-end bay structure. At this point, they realized they had pulled out too much slack sock line and had to reel in between 100 to 150 feet.



The helicopter operation began at approximately 0850 with the three conductor sock-line pulls from the triple-drum puller in the power-payout mode. Sock lines were fed from the reels directly to the traveler in the tower without passing through the level wind, a guide sitting on the front of the tensioner, manually controlled by the operator, that allows the line to be reeled in evenly onto the reel. At the beginning of the first pull there was a momentary tug on the helicopter, prompting the pilot to ask, "What was that?" The equipment operator and the linemen in the tower determined that all was clear, so the pull continued. The rest of this pull and the next two were uneventful and went "smoothly." Then the plan was to start with the south static position at the substation dead-end bay. The sock line would be pulled toward the West. At approximately 0935, the pilot maneuvered the aircraft to a position above the substation dead-end bay structure to initiate the static-sock-line pulls. Several crewmembers, including the Foreman III, were surprised, since they had expected the pilot to land after the first three pulls to discuss and coordinate the next two pulls, although this was not discussed at any tailboard meeting. The crew at the substation dead-end bay was still completing its work from the first three pulls and was not quite ready for the static pulls. As the helicopter hovered above the substation dead-end bay, an apprentice lineman in that structure scrambled to the goat peak. He positioned himself to connect the sock line to the helicopter's longline. After hooking the sock line to the longline remote hook, the apprentice climbed down from the goat peak to a safe position while the helicopter hovered above the tower. At this point, the helicopter was approximately 140 feet above ground level (AGL) and 25 feet above the substation dead-end bay.

The aircraft then began to move backward in a westerly direction while the lineman on the ground fed the line through his hands, holding tension until the slack on the ground, approximately 100 feet, was removed. In the meantime, the lineman in the tower noticed that the equipment operator was not ready to go because he was readjusting his radio speaker. The lineman radioed to the pilot to hold the pull. After communication was re-established between the equipment operator, the lineman in the tower and the helicopter pilot, the pull was continued.

The aircraft had traveled approximately 700 feet from the puller/tensioner when a snag on the reel occurred. The snag caused the sock line to double back onto the reel. Instead of paying out toward the helicopter, even though the reel rotation was in the proper direction, the line was being pulled in. The reel operator sensed the machine lugging down and then noted the snag. He immediately attempted to shift the power lever to neutral, but he overshot the neutral detent (lever stop position) and went into reverse. At the same time he radioed, "Hold the pull."

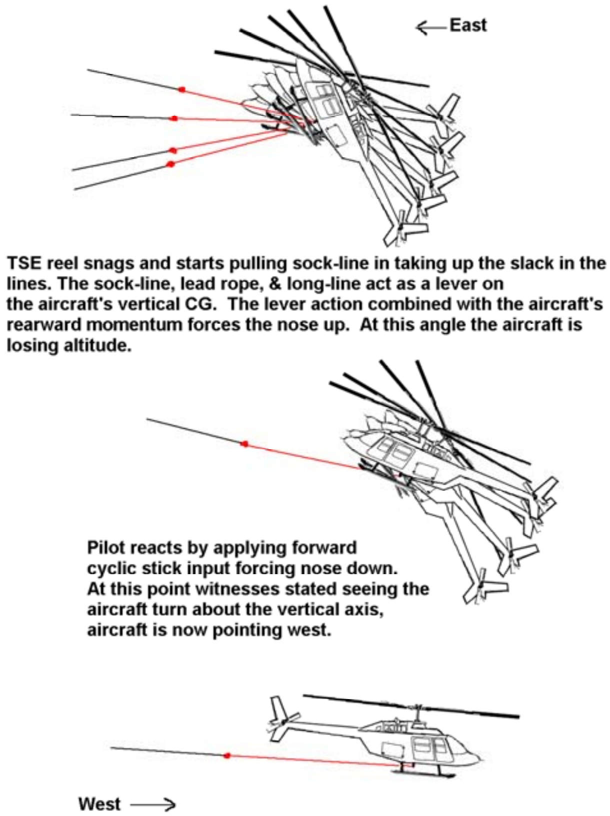




TSE puller/tensioner
as found by the AIB
on August 17, 2004

Evidence indicates that for approximately six seconds, the reel machine had pulled about 36 feet of sock line back onto the reel. Then, when the TSE reel operator shifted the lever through neutral to reverse, the rope once again snagged and doubled back on itself, pulling in an additional 9 ft. 7 in. of sock line, before the TSE was shut down. (The Accident Investigation Board (AIB) believes the last 9 ft. 7 in. of rope was reeled in after the helicopter's longline was cut by the Kaiser 13.8-kV overhead static line.) This was the condition in which the AIB found the equipment, see photo at left.

The aircraft was moving at the same speed that the line was paying out, (approximately 4.0 miles per hour), in rearward flight (westerly direction), when the first snag occurred and the puller/tensioner began pulling the sock line back in. The puller/tensioner was then pulling line back onto the reel at approximately 4.0 mph. Subsequent analysis indicates that it likely took almost two reverse wraps to develop enough friction to hold the line fast on the reel. Then two additional wraps were reeled in the same direction. These reverse wraps, along with the opposite motion of the helicopter, removed all the slack from the sock line and the aircraft's 25-foot longline, causing a sudden jolt that rocked the aircraft back on its tail (see drawing to right). The longline acts as a lever along the helicopter's vertical axis therefore the nose-up motion was due to the helicopter's aerodynamics and not pilot input. This jolt more than likely unplugged the power source to the remote-hook release, preventing the pilot from jettisoning the sock line remotely (the pilot's primary method of releasing the load).



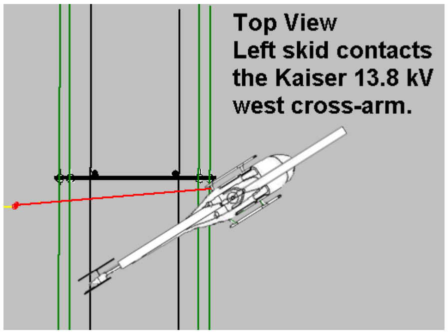


Witnesses reported that the aircraft then nosed down. The AIB determined through examination of the wreckage that the aircraft then turned about the mast centerline to the left. The nose of the aircraft was now heading westerly. At this point, the longline was taut against the belly of the aircraft, trailing directly aft, because the sock line was still attached to the longline as well as to the reel on the puller/tensioner.

Physical evidence indicates that when the aircraft's belly hook is pulled full aft, the manual release knob for the longline will jam against the belly-hook attachment frame rending the pilot's electrical release inoperable (the second option for releasing the load).


The aircraft was losing altitude when the left skid near the aft cross tube struck the upper wooden cross arm of the de-energized Kaiser 13.8-kV power line, see drawing next page. Physical evidence indicates that the longline was stretched across the west static wire of the Kaiser line.

Because the aircraft was still under power and producing thrust while still tethered by the sock line, the nose pitched forward vertically, virtually hinged at the static line. The static wire cut the longline




approximately five feet from the aircraft's cargo hook. The aircraft then caught the right cross tube on the second conductor of the Kaiser line, inverting the aircraft and tearing off the front cross tube and the left skid. At approximately 16 to 19 feet above the impact site, while the aircraft was inverted with the nose pointing north, the red main rotor blade struck the west pole of the Kaiser 13.8-kV line, shearing six feet off the end of the red blade (See Appendix 7, "Crash Sequence"). The impact destroyed the rotor system and the dynamic forces caused the airframe to rotate about its longitudinal axis approximately 90 degrees before slamming into the ground. The occupant's living space in the aircraft cabin was compressed approximately 40 to 50 percent. The pilot's shoulder harness was torn from its attachment points as the airframe compressed. The impact forces of the crash resulted in fatal injuries to the pilot (See Appendix 7, "Crash Sequence").

**Mishap Plan Execution**:

Realizing the aircraft had crashed, crewmembers immediately called 911. Records indicate that the 911 call was received at 0940. Employees immediately rushed to the accident scene. When a small fire in the aircraft's engine area started, the crew responded with fire extinguishers from the crew trucks. They initially tried reaching the pilot through the left forward cabin door, but decided instead to hook a winch line to the remaining portion of the aft cross tube on the left side. Using a winch from a truck along with other crewmembers on the right side of the aircraft, they raised the aircraft almost upright to gain access to the pilot and render first aid. The crews checked for a pulse when none was felt, a crewman administered CPR to the pilot until local fire and rescue units arrived. The crewman was then told to discontinue the CPR. BPA's Aviation Mishap Response Plan, dated 2002, was initiated by notifying the NTSB, DOE, and FAA.

**Weather:**

Spokane, Washington weather at the time of the accident as reported by the National Weather Service was 15,000 scattered, 20,000 broken, 27 degrees C, and winds 260 degrees at 7 knots.

**Autopsy and Toxicology Report:**

Based on the Spokane County Coroner's autopsy and toxicology findings, there was no sign of drugs or alcohol in the pilot's bloodstream, nor was any pre-existing medical condition discovered that would have contributed to the accident.

As with most accidents, no one person or management failure can be blamed. The numbering on each casual factor is not meant to represent a hierarchy, only the number of casual factors identified by the AIB. This accident was caused by multiple inadequacies in management processes, systems, and procedures that combined with human factors cumulatively led to the accident. As in any accident chain, one or more of the causal factors in this report, if corrected, might have prevented this accident. However, if the causal factors are not addressed in total, future accidents will occur.

**Probable Cause:**

To be issued by NTSB.

**Direct Cause:**

While the puller/tensioner was power paying out sock line for the helicopter, an unobserved snag occurred at the puller/tensioner reel, causing it to start pulling sock line back onto the reel and initiating the helicopter crash sequence.

**Root Causes:**

**(1) BPA management system procedures and processes did not require Aircraft Services to conduct a hazard assessment and risk analysis, or to develop mitigating controls for hazards associated with Class C rotorcraft-load combinations using the Bell 206-series helicopter with BPA puller/tensioner machines.**

Analysis/Discussion:

The elevated risk associated with Class C loads over routine flight operations was not adequately analyzed. For example, the mitigating effects of using different rigging combinations (e.g., longline lengths, ballast weight or fusable break-away link) were not considered. BPA should have been more proactive in establishing formal procedures for this type of operation, rather than relying only on pilot experience and FAA standards prescribed by 14 CFR Part 133 to ensure safety. The reliance on employee skill and experience without complementing these with a formal, written risk and hazard analysis contributed to this accident.

The unique differences and risks of using a Bell 206 with a belly-mounted hook for pulling sock line, compared to other types of helicopters, should have prompted BPA to perform a specific risk analysis for this work. (See Causal Factor 10.)

**(2) BPA did not require or have a formal coordinated work procedure (including a hazard assessment with energy source controls) between TLM and Aircraft Services to address helicopter external-load operations.**

Analysis/Discussion:

BPA’s corporate culture had accepted separate roles and responsibilities for TLM and Aircraft Services. Separate regulatory authorities (OSHA for TLM and FAA for Aircraft Services) oversee each organization. TLM believed Aircraft Services was responsible for the work during helicopter operations, and Aircraft Services believed TLM was responsible for the ground operation. The missing link in this job was integrating helicopter operations, risks and safety considerations into the work sequence that the Foreman III had developed for the job. The foreman made sure that linemen and ground crew were briefed on Clearances and Hold Orders for transmission lines that were to be crossed over during the five sock line pulls. The day before the job, he distributed to tailboard attendees a number of detailed charts and diagrams of all structures, as well as for existing transmission lines proximate to the five sock line pulls.

BPA's Accident Prevention Manual (APM) rule J-1 contains requirements for conducting a job hazard analysis. However, there is no requirement for a formal, coordinated analysis that integrates risks and hazards to Aircraft Services and TLM. The expert-based "can-do" attitude and culture of highly experienced and professional staff in TLM and Aircraft Services are BPA strengths. However, the culture should have included procedural and process requirements that had been based on a comprehensive risk assessment and approved by BPA management. The lack of a coordinated risk assessment, and detailed work procedure led to critical omissions in pilot or foreman prejob briefings. A detailed job-specific procedure for the static line pulls could have required rehearsal of each task, radio and hand-signal communication protocols, puller/tensioner tests, and detailed discussions between the pilot, dead-end bay crew and puller/tensioner equipment operator. This should have ensured that all east-end ground crew members, the puller operator and the pilot had discussed, understood and agreed upon expectations for the job sequence.

**Contributing Causal Factors:**

**(3) BPA did not have adequate procedures to ensure that pilots used standardized prejob briefings (tailboard meeting), communications protocols, phrases and sequence, preflight preparations, in-flight procedures and postflight briefing.**

Analysis/Discussion:

Witnesses stated that when the chief helicopter pilot had conducted previous external-load operations, he briefed crews on helicopter ground safety, in flight emergencies (flight and ground crew actions), ground crew emergency actions (sock line hang ups, etc.), and communications, including standard phraseology and radio discipline. The pilot on this job did not conduct as in-depth a briefing. The pilot did speak with the triple-drum operator and the crews working in the west section of the job and in tower 84/3, but did not address communications or in flight emergency procedures. The pilot never met with or discussed the pulling operation with the TSE single-reel operator. This led to confusion over what communications were expected from the pilot or responses to be given from the ground crew. However, the briefing requirements as outlined in the BPA Rotorcraft-Load Combination Flight Manual (Part 133) do not specify in detail all of the elements that should be covered.

The minimal communication during this job was due to a lack of communication standards. However, since neither the Part 135 nor Part 133 Operations manuals designate a person responsible for ensuring standardization, it is left up to each pilot to determine what is to be briefed with the ground crews during the operation as well as methods of conducting the operation.

**(4) The pilot's training and experience facilitated an environment where the pilot relied upon three independent cargo-hook release mechanisms, rather than assessing the failure modes and risks working with a puller/tensioner in the power-payout mode.**

Analysis/Discussion:

Interviews with experienced helicopter pilots involved with external-load work indicates that in most cases, hazard analysis is limited because of reliance on the pilot's ability to jettison the external load while in flight. Pilots generally give no consideration to the question "What if all three releases fail or become disabled." If thorough hazard-assessment and risk-management methodologies had been used, these potential failures would have been recognized and adequate controls established.

**(5) BPA did not have an adequate feedback and improvement process to report and evaluate near misses and incidents involving helicopters in previous transmission line work (Class B[2] and C external-load operations).**

Analysis/Discussion:

Witnesses recounted that on at least five different occasions while pulling sock line or landing spacers using a helicopter, a near miss occurred. Over the past several years these incidents included sock-line hang-ups in the towers, improper puller/tensioner operation, miscommunications (paying out under power when the pilot thought the reel was freewheeling), inadvertent jettison of the longline, and failure of the sock line to jettison from the remote hook. If these occurrences had been formally reported and thoroughly analyzed, many of the hazards that were overlooked prior to the accident would have been known, and mitigating controls could have been established. These precursor events should have led to critical evaluations of the suitability of equipment or equipment changes, engineering controls, administrative controls or revised practices to preclude their recurrence.

6. **(6) Not all energy sources were recognized and adequate energy source controls were not put in place.**

Analysis/Discussion:

Awareness of hazards and energy sources involved in this type of work is normally based on using the free-wheel mode of operation. When it was decided that the crew would be using the power-payout method to maintain increased control when crossing over normally energized lines, no one recognized that this added an energy source that required additional mitigation. The only concern was that the power payout was of sufficient speed to keep up with the helicopter. Since the major focus of the job-hazard analysis was based on crossing over the nine normally energized lines, it diverted attention from other potential hazards. If the hazard from this energy source (the reel) had been recognized, energy source controls could have been put in place that might have helped mitigate the additional hazard. These might have included the following:

[2] Class B rotorcraft-load combination means one in which the external load is jettisonable and is lifted free of land or water during the rotorcraft operation.

1) Dedicated reel tender equipped with a radio and authority to stop the pull.
2) A different type of sock line that is more rigid and less susceptible to forming snags and doubling back on the reel.
3) Fuse Link--a properly engineered breakaway link--inserted in the sock line/longline designed to break just before enough horizontal force could be applied to put the helicopter into an uncontrollable flight situation.
4) Helicopter rigging with a longer longline and heavier ballast weight (headache ball).

Other operators use some of theses methods to mitigate the hazards of unexpected horizontal pull on the longline.

It is the Board's observation that the APM J-1 requirement to discuss energy source controls is not generally recognized or understood by most work groups. Most employees surveyed think this term refers solely to controlling electrical sources with devices such as breakers or switches, or to "Lock Out/Tag Out"(LOTO) requirements only. Any unexpected release of energy, i.e. mechanical, electrical, hydraulic, pneumatic, or any other source that can injure employees or impact a work process should be considered in a job hazard analysis.

**(7) Aircraft Services based its Rotorcraft-Load Combination Flight Manual on 14 CFR Part 133, which contains only the minimum requirements.**

Analysis/Discussion:

Inadequate FAA Policies: Interviews with other companies conducting external-load operations (Class C loads) indicate that Aircraft Service's Rotorcraft-load Combination Flight Manual varies little from the other operators. Part 133.47 (c) (3) requires the manual to contain "*Any other information essential for safe operation with external loads*." None of the operators interviewed had addressed Class C loads in detail in their Rotorcraft-load Combination Flight Manual even though the FAA had approved these manuals. Although BPA's pilots and operations met all of the FAA standards, the accident still occurred.

In 1964 when 14 CFR Part 133 was enacted, the FAA stated, *"Several proposed provisions have been deleted that dealt with <u>cable angle limits, maximum tow loads, and related requirements, for Class C (formerly Class IV) rotorcraft-load combinations</u>. The Agency believes that too little is known about rotorcraft towing operations to justify adoption of these provisions at this time. The need for such provisions will be studied further as service experience accumulates."* No further studies have been published even though the use of helicopters in supporting the utility industry has expanded significantly since then.

Inadequate Oversight by the FAA: The FAA renewed BPA's Part 133 External Load Operating certificate and Rotorcraft-load Combination Flight Manual in May 2004, three (3) months prior to the accident. The FAA did not conduct a base inspection, observe operations, review pilot records, inspect the aircraft, or inquire about the adequacy of the Rotorcraft-load Combination Flight Manual compared to actual operations. Instead, the FAA used a letter from BPA Aircraft Services as the basis for renewal. Had the FAA completed a proper base inspection, the deficiencies of the Class C portion of the 133 manual might have been noted.

**(8) The DOE's Office of Aviation Management did not emphasize to BPA the importance of "Opportunity for Improvement" contained in the 2003 audit report.**

Analysis/Discussion:

The DOE's Office of Aviation Management (OAM) has conducted two aviation program audits using DOE Order 440.2B, Aviation Management and Safety, published in November 2002 as a basis for the review. In DOE O 440.2B section 4, "Requirements," subsection a. states, *"Each DOE field element and independent operating entity that has responsibility for assigned Federal aircraft (see Attachment 2, Definitions) or uses commercial aviation services (CAS; see Attachment 2, Definitions) must develop and publish an aviation implementation plan (AIP; see Attachment 2, Definitions) detailing the standards, operating parameters, airworthiness criteria, security procedures and safety systems of its planned aviation operations. As a minimum, the AIP will address all applicable requirements of this Order and other related requirements established by DOE policy."*

The OAM concluded in the 2002 audit that the Aircraft Services Operations Manual did not address the requirements of the order. Aircraft Services acted upon the recommendation and worked with OAM to develop an operation manual that met the requirements of the order.

During the November 2003 audit the OAM concluded there were "Opportunities for Improvement" in implementing the requirements of the aviation order, but did not make them "findings." Section 18, "Aviation Safety," of the OAM 2003 audit report states, "*The Helicopter Chief Pilot should evaluate the need for a formal mission plan for each external load operation using the Integrated Safety Management principles in order to document the risk management process for these types of missions*." In section 18, Aviation Safety of the same audit report states, ". . . . *However, we found that the program relies on pilot and maintenance technician experience, rather than on formal documented processes, to maintain safe operations. For example, instead of standard accepted aviation risk assessment and countermeasures policies, informal processes are used to ensure safe operations. While these informal processes have been effective, they might not enhance further program improvements as effectively as the industry standard methodologies. Additionally, the existence or effectiveness of these informal practices might be difficult to validate or substantiate in a post-incident audit or investigation. The ASD [Aircraft Services] can actively involve more of its personnel in its aviation safety efforts, and more effectively document its existing practices by incorporating them into the recommended methodologies. . .*"

The two "findings" that were reported to BPA in 2003 were acted upon in a timely manner. If the OAM had placed greater emphasis and importance on implementing the "opportunities for improvement" or had reported the weaknesses as "findings," BPA Aircraft Services most likely would have acted upon the recommendation, which might have prevented the accident.

**(9) The TLM crew at the substation end of the job was not ready for the static pulls to begin when the helicopter hovered above the dead-end bay, ready to pull the sock line.**

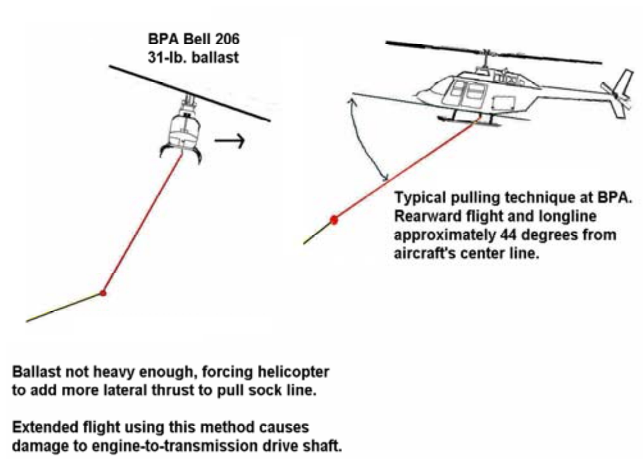
Analysis/Discussion:

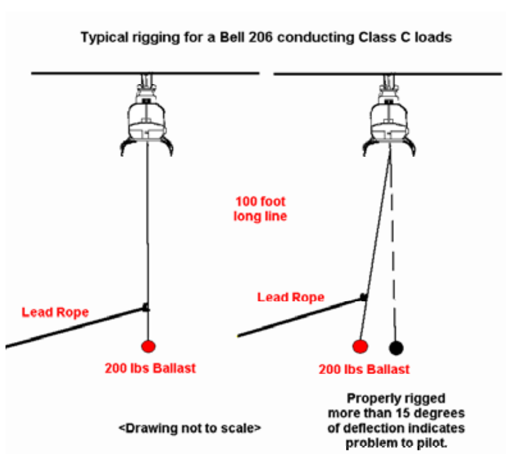
After the last of the three conductor pulls, the helicopter immediately positioned above the dead-end bay structure to start the first static line pull. Testimony indicated that some of the crew was surprised that the pilot did not land first to discuss this end of the job. The TLM crew had not completed securing the conductor sock lines. As a result, the crew divided their attention between completing the rigging for the conductor sock lines and starting the static line pulls. At the same time, the equipment operator was repositioning the radio speaker and was not fully prepared when the helicopter began pulling slack. There was no communication to the pilot or to the foreman to stop the job despite all crewmembers have stop-work authority.

**(10) The rigging used by BPA for Class C loads was not consistent with most other operators using the Bell 206-series helicopters.**

Analysis/Discussion:

"Load rigging methods can have a broad impact on the Center of Gravity and flight dynamics of the load.[3]" BPA typically uses 25 to 150 feet of longline, a 31-lb. ballast weight, and a 14-lb. remote cargo hook. Total weight of the ballast, remote hook and shackles together was 45 pounds. BPA's use of this equipment limited the operation of the Bell 206 aircraft during sock line pulls to rearward flight. The reason for flying rearward is that the ballast weight is not heavy enough to maintain a 90 + or – 15 degree angle between the helicopter's horizontal centerline and the longline (see picture below).




Based on witness testimony of the sock line pull, the BPA aircraft would appear to have a 10-degree nose up attitude with the longline at or about 44 degrees to the helicopter horizontal centerline. (Refer to previous drawing.) BPA's Class C load procedures were developed in-house based on previous pilot experience. BPA Aircraft Services did not seek input from other Bell 206 operators in the utility industry on their methods and practices. The Board concluded that BPA developed its Class C external-load operational techniques for pulling sock line without benefit of knowledge from the rest of the industry with regard to rigging equipment selection, operating experience and best practices for Class C external-load operations using a Bell 206 aircraft. This information would have been important in any risk analysis or hazard assessment of sock line pulling.

[3]Helicopter Association International, Utilities Patrol and Construction Committee, Power line Construction & Maintenance Guidelines, 1998.

The AIB conducted surveys and interviews with other North American operators utilizing helicopters equipped with belly-mounted cargo hooks to determine what rigging they use when conducting Class C loads (Sock line pulling). The responses were that they have learned through trial and error, near misses, and operating experience to use heavy ballast when pulling sock line with a belly mounted cargo hook, regardless of the make or model of helicopter. The least amount of ballast weight recommended for use on the end of the longline was 150 pounds--and most operators recommended 200 to 300 pounds. The length of longline recommended ranged from 50 to 100 feet. One operator told the AI Board that when they used a shorter longline length an even heavier ballast weight was used--for example, 20-foot longline and 600-pound ballast weight.

The operators use the ballast weight's momentum to pull the sock line and the pilot maneuvers the helicopter to control the ballast. By using proper rigging, this allows the helicopter to maintain a level attitude and gives the pilot the option to pull side ways, forwards, or rearwards, although most of the operators pull sideways. In addition, because the heavy ballast allows the Bell 206 to maintain a level attitude during flight, the aircraft can be flown sideways without imposing excessive wear on the transmission-to-engine drive shaft. Another factor is safety. The longer the longline and the heavier the ballast, the more warning pilots have of an impending shock load caused by a snag and the earlier they can respond. BPA's rigging method, although used for years without major incident, did not allow enough time for the pilot to feel the snag and react. The use of a longer longline and heavier ballast has the added advantage of making practical the addition of a breakaway fuse-link ahead of the sock line. This device provides an automatic fail-safe that is not dependent on the pilot or the helicopter systems.

**(11) The triple-drum puller/tensioner machine that was used at the west end for the conductor sock lines was different than the two single-drum machines that were used at the east end. No one recognized that the differences in the puller/tensioners were significant enough to discuss in detail.**

Analysis/Discussion:

The pilot along with an equipment operator had tested the triple-drum puller/tensioner in the power-payout mode to ensure that the speed of the payout met with the pilot's approval. It was not tested in the free-wheel mode. The two single-drum puller/tensioners were not tested or observed operating by the pilot. Had the pilot personally conducted the tests on the single-drum puller/tensioners, he might have observed the tendency of the rope to snag and double back on the reel. This could have influenced the decision to power pay out rather than free wheel.

**(12) The TSE puller/tensioner was being used in the power-payout mode rather than the free-wheel mode.**

Analysis/Discussion:

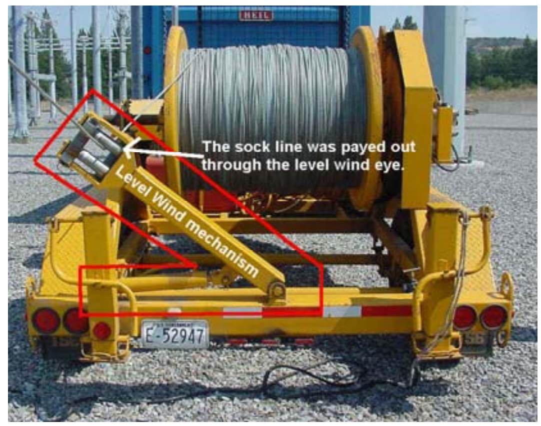
In the free-wheel mode when a snag occurs, at worst, the reel stops. In the power-payout mode when a snag occurs, the line can double back on the reel and begin to pull back in. Testimony indicates that the common mode when using a helicopter is to operate in the free wheel mode. This tendency to snag and reel back in using the power-payout mode was known by some TLM crewmembers, but was not recognized as a potential hazard to a helicopter.

The AIB believes it is possible that the problem of snagging and reeling back in was not encountered on the triple-drum during the first three pulls of this job because of the larger diameter of rope and from not using the level wind.

**(13) Use of the level wind on the TSE puller/tensioner during pay out increased the likelihood of creating a snag and restricted the operator's ability to see and react to it.**

Analysis/Discussion:

Use of the level wind in payout mode (power or free wheel) restricts the operator's view of the sock line where it comes off the reel. This also gives the operator another control to manage because the level wind is manually operated, distracting his attention from the sock line and reel. The level wind in the pay out mode adds another point of suspension and friction to the sock line increasing the possibility of a snag reversing the direction of the sock line.




**(14) The TSE puller/tensioner equipment operator used a hand-held microphone and external speaker for the radio instead of the headset, boom microphone and footswitch.**

Analysis/Discussion:

According to testimony of the equipment operator, the headphones for the radio on the TSE puller/tensioner worked intermittently and had a lot of static interference. Therefore, he did not use the headphones. He chose to position an external speaker on the control panel of the TSE. Under these conditions, he had to use the hand-held microphone with a push-to-talk button. He was holding the microphone in his left hand and controlling the level-wind lever with the same hand. This increased his task load and might have increased his reaction time communicating with the pilot and controling the TSE.

**(15) The 7/16" Spectron 12 line is prone to forming snags and doubling back on to the reel when used on a puller/tensioner.**

Analysis/Discussion:

Testimony indicated that incidents had occurred in the past when using the 7/16" Spectron line in non helicopter pulling operations. These incidents could be adequately dealt with when pulling with a capstan or all-terrain vehicle and thus were treated as a nuisance rather than a safety hazard by the line crew. This rope is extremely limp and tends to double back on the reel easily. Other sock lines that do not exhibit this tendency are available.

**(16) For unknown reasons an accepted practice of wrapping electrical tape around the remote hook's male/female electrical connection prior to flight was not followed.**

Analysis/Discussion:

Witness statements and physical evidence indicate that the remote cargo hook's male/female electrical connection at the belly of the aircraft was not secured by wrapping electrical tape around the connection. There is no written requirement in the BPA Aircraft Services External Load Manual to perform this task. However, experienced pilots conducting external-load operations (Class B & C) take this precaution to prevent inadvertent disconnect of the electric power connection for the remote cargo hook.

This provided the opportunity for the remote hook's electrical release to become disabled during the initial jolt or pull when the sock line reversed direction.

**(17) There was no aircraft mechanic on site to act as a Safety Watcher for the operation of the helicopter.**

Analysis/Discussion:

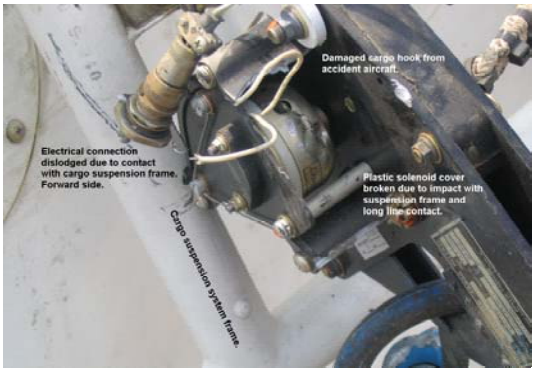
BPA's Rotorcraft-Load Combination Flight Manual Part 133 states: "Aircraft maintenance personnel will be safety watchers during all [external load] flight operations." Testimony indicates that BPA Aircraft Services decided not to send a mechanic due to the brevity of this job. Had an aircraft mechanic experienced in external load operations been present on the job site, he would have likely taped the electrical connection to the remote hook release or brought it to the pilot's attention.

**(18) Inadequate design of the helicopter's cargo suspension system, Bell Kit number 206-706-335, provides a working condition that under certain circumstances can damage or restrict the electrical and mechanical releases for the helicopter's belly hook."**

Analysis/Discussion:

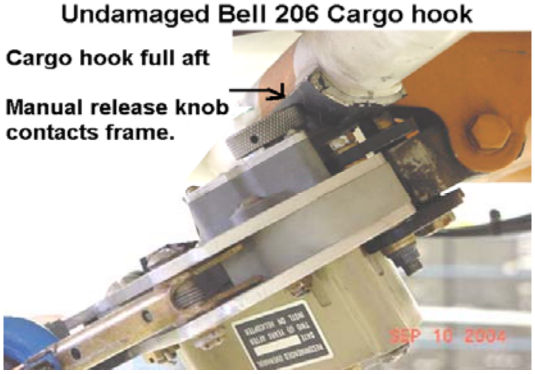
The Bell 206 Cargo Suspension system, Bell Kit 206-706-335, includes the following: a 1500-lb. capacity cargo hook manufactured by Breeze Eastern, Corp., part number SP 4232-5 model 2A15E; Bell Helicopter suspension system frame; quick-disconnect pilot's mechanical release cable; electrical connection; and associated hardware (see photos next page). In order to determine why the pilot did not jettison the external load, a post-accident analysis of two Bell 206 BIII helicopter's cargo suspension systems was completed. When the manufacturer-supplied kit is installed, the forward side of the cargo hook has a plastic housing where a cannon plug is mounted for the cargo hook's release solenoid. This cannon plug, when connected to the aircraft's cannon plug, completes the electrical system, enabling the pilot to electrically release the load in-flight from inside the cabin. On the aft side of the cargo hook is another plastic housing where a manual release knob attaches to a shaft that, when turned by hand, trips the cargo release mechanism. On the upper part of the aft housing is a mechanical release cable that, when

connected, goes to the T-handle near the pilot's collective stick to enable the pilot to manually release the load during flight from inside the cabin see picture above.

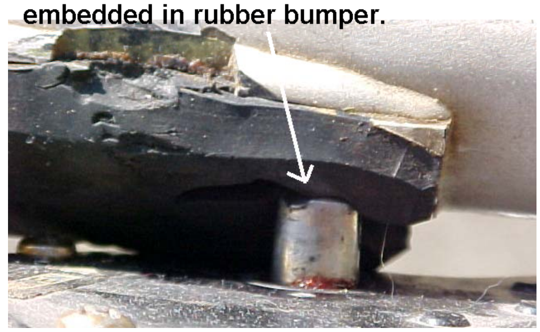



The postaccident investigation and analysis revealed that when the belly cargo hook is pulled full forward, the plastic housing encasing the electrical release connection and solenoid contacts the cargo suspension frame. This contact can--and in the case of the accident helicopter, did--cause damage to the housing where the cannon plug is located. When the belly hook is pulled full aft, the manual release knob contacts the frame. On the accident helicopter, the force was great enough to force the knob off in flight.

**Undamaged Bell 206 Cargo hook**




**Close-up of manual release knob shaft embedded in rubber bumper.**

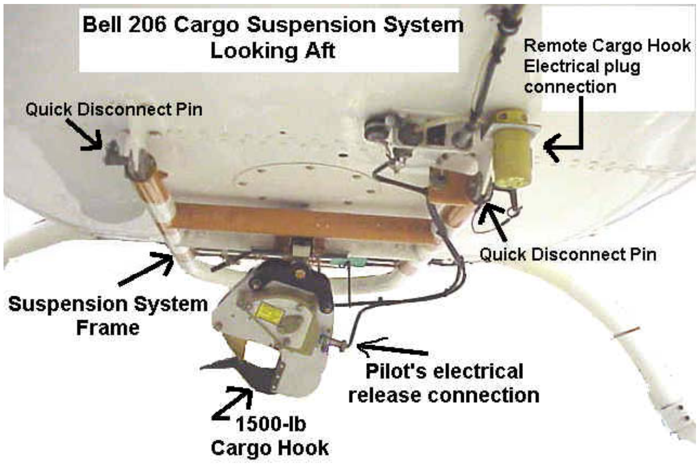


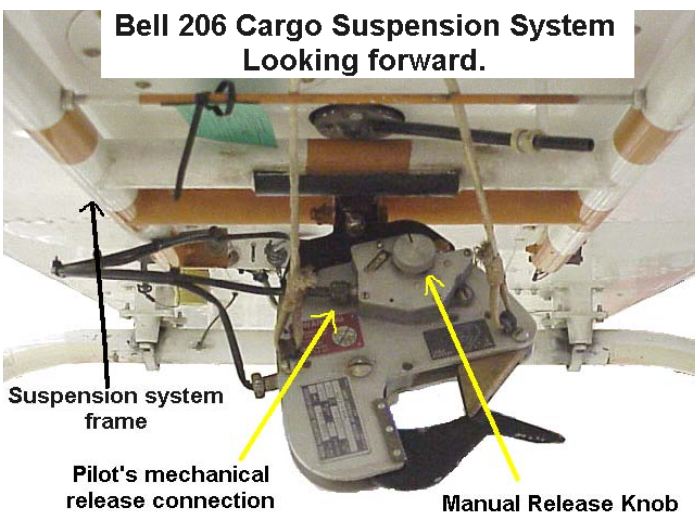

This allowed the exposed shaft where the knob is mounted to become embedded in a rubber bumper mounted on the suspension frame. Tests were done with the accident helicopter's cargo hook in the full aft position with the shaft embedded in the rubber bumper. The test proved that the electric solenoid could not open the hook. The same tests were conducted on a flyable Bell 206BIII's cargo suspension system, except with the manual release knob installed, and the results were identical. However, the manual release connected to the T-handle would work under the same conditions.

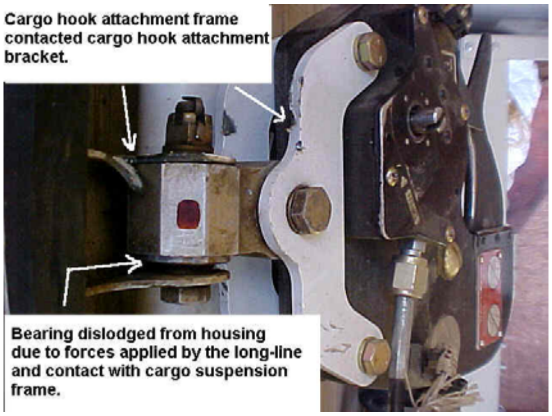
The Bell Long Ranger-series helicopter has a different cargo suspension system design (belly hook) and is not susceptible to this problem.

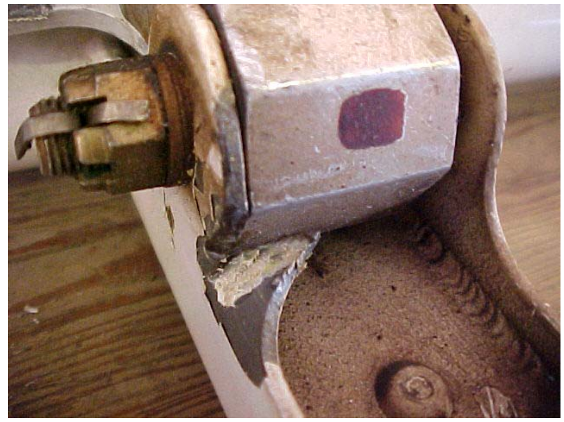
Given the position of the longline during the accident sequence, with the sock line still attached, it is the Accident Board's belief that the design flaw prevented the pilot from electrically releasing the load. Examination of technical service bulletins and airworthiness directives found no mention or warning related to this potential problem.

The Board could not determine why the pilot did not release the load manually, but accident analysis led the Board to believe that the pilot had, at most, three to four seconds to go through his entire sequence during the accident before the ship impacted. Allowing for normal reaction times and the disabling of the first two safety releases by the impacts to the suspension frame, it is highly unlikely that the pilot had enough time to use the manual load release T-Handle while attempting to recover control of the aircraft.

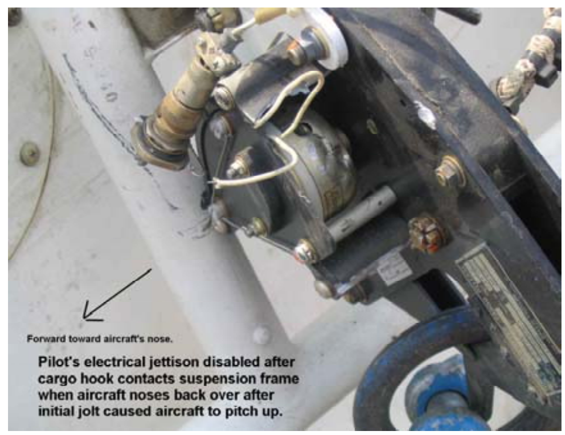


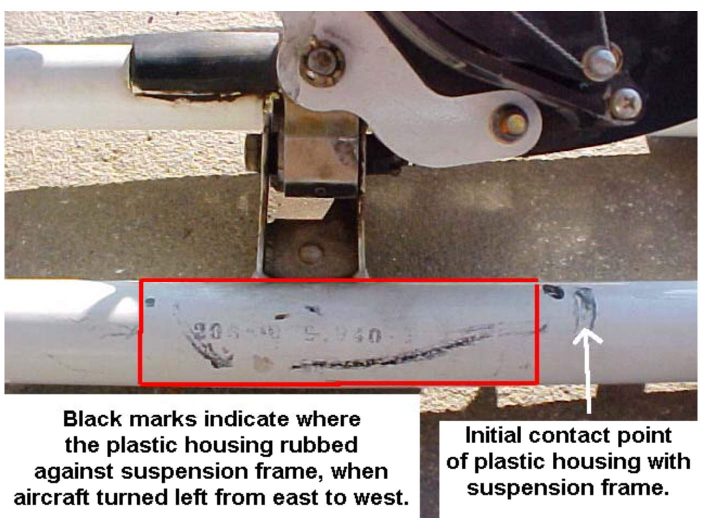




Cargo hook attachment frame contacted cargo hook attachment bracket.
Bearing dislodged from housing due to forces applied by the long-line and contact with cargo suspension frame.




Position of aircraft's cargo hook after aircraft turned west.


Forward toward aircraft's nose.
Pilot's electrical jettison disabled after cargo hook contacts suspension frame when aircraft noses back over after initial jolt caused aircraft to pitch up.


Black marks indicate where the plastic housing rubbed against suspension frame, when aircraft turned left from east to west.
Initial contact point of plastic housing with suspension frame.

| FINDINGS | RECOMMENDATIONS |
|---|---|
| **Management Systems** | |
| **(1)** BPA management system procedures and processes did not require Aircraft Services to conduct a hazard assessment and risk analysis, or to develop mitigating controls for hazards associated with Class C Rotorcraft-Load Combinations using the Bell 206 series helicopter with BPA puller/tensioner machines. | That BPA management direct Aircraft Services to conduct a hazard assessment and risk analysis to develop mitigating controls to address the hazards of Bell 206 Part 133 Class C Load operations, to include the following:<br>1. Examination of industry standards and best practices<br>2. Consider using an FAA Designated Engineering Representative to examine the required rigging for Class C helicopter load operations |
| **(2)** BPA did not require or have a formal coordinated work procedure (including a hazard assessment with energy source controls) between TLM and Aircraft Services to address helicopter external-load operations. | That BPA management establish a requirement and direct TLM and Aircraft Services to develop formal coordinated work procedures for helicopter external-load operations. This should include developing guidelines (and checklists as necessary) for designing and planning the work and selecting the proper helicopter rigging configuration and compatible ground equipment. |
| **(3)** BPA did not have adequate procedures to ensure that external-load helicopter pilots used standardized prejob briefings (tailboard meeting), communications protocols, preflight preparations, in-flight procedures and postflight briefing. | That BPA management direct Aircraft Services to establish procedures that outline prejob briefings, communications protocol, preflight preparations, in-flight procedures and postflight briefings. In addition, Aircraft Services shall ensure that the external-load pilots are trained on these procedures. |
| **(4)** The pilot's training and experience facilitated an environment where the pilot relied upon three independent cargo-hook release mechanisms, rather than assessing the failure modes and risks working with a puller/tensioner in the power payout mode. | That Aircraft Services conduct a failure modes and effects analysis and establish engineering and administrative controls such as a fusible link. |
| **(5)** BPA did not have an adequate feedback and improvement process to report and evaluate near misses and incidents involving helicopters in previous transmission line work (Class B and C external-load operations). | That BPA management establish requirements to report all incidents and near misses associated with helicopter external-load operations and inform affected BPA employees of these incidents, corrective actions and lessons learned. |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| **(6)** Not all energy sources were recognized and adequate energy source controls were not put in place. | That BPA define “energy sources” and “energy source controls” cited in APM J-1, "Job Briefing", and incorporate these definitions in the APM. BPA should ensure that all employees are made aware of and understand these definitions. |
| **(7)** Aircraft Services based its Rotorcraft-Load Combination Flight Manual on 14 CFR Part 133, which contains only the minimum requirements. | That BPA Aircraft Services contact the FAA’s Portland Flight Standard District Office and request a review of Aircraft Service’s external-load operations and procedures. |
| **(8)** The DOE’s Office of Aviation Management did not emphasize to BPA the importance of “Opportunity for Improvement” contained in the 2003 audit report. | That BPA meet with the OAM to review, amend, and clarify the terms and methodology used during the OAM annual audits of Aircraft Services. That BPA direct Aircraft Services to implement a formal job/mission plan for each type of external-load operation using the DOE Integrated Safety Management principles. Aircraft Services should also ensure that a formal corrective action and tracking process be developed to address recommendations from outside audit reports. The corrective action process should include a progress report to BPA’s senior management on the recommendations. |
| **Job Execution** | |
| **(9)** The TLM crew at the substation end of the job was not ready for the static pulls to begin when the helicopter hovered above the dead-end bay, ready to pull the sock line. | That BPA management review, revise as necessary, and re-emphasize to all BPA employees its requirements and guidance for stopping or pausing work until current tasks are completed. Anticipated stoppages or pauses in the work sequence should be included in the job plan as well as discussed in the pre-job briefing (tailboard meeting). |
| **(10)** The rigging used by BPA for Class C loads was not consistent with the rigging used by most other operators who use the Bell 206-series helicopters. | That BPA management direct Aircraft Services to contact other operators using the same type of aircraft to learn from their experiences, understand their methods of rigging for external-load operations and incorporate those that apply. |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| **TSE Puller/Tensioner** | |
| **(11)** The triple-drum puller/tensioner machine that was used at the west end for the conductor sock lines was different than the two single-drum puller/tensioners that were used at the east end. No one recognized that the differences in the puller/tensioners were significant enough to discuss in detail. | That BPA management establish a work planning requirement and guidance that addresses the need for detailed discussions between the helicopter pilot and equipment operator of each and every puller/tensioner to be used regarding performance characteristics, potential malfunctions or problems observed in the past, or any other information about the machine that could affect helicopter safety. Specific puller/tensioners shall be designated for helicopter use. However, whenever other puller/tensioners are being considered for use with a helicopter, their use and operation should be assessed for safety and workability before the operation begins. This assessment should include hands-on practice that would also incorporate the helicopter. |
| **(12)** The TSE puller/tensioner was being used in the power-payout mode rather than the free-wheel mode. | That BPA management direct that the puller/tensioner shall be used in the free-wheel mode while using a helicopter for pulling sock line and shall utilize a braking system that can achieve the necessary tension to maintain needed control of the sock line. |
| **(13)** Use of the level wind on the TSE puller/tensioner during pay out increased the likelihood of creating a snag and restricted the operator's ability to see the snag and react to it. | That BPA ensure through training and education that the level wind will not be used in the pay out mode. |
| **(14)** The TSE puller/tensioner equipment operator used a hand-held microphone and external speaker for the radio instead of the installed headset, boom microphone and footswitch. | That BPA management establish requirements and direct implementation of processes to confirm that all communications systems, are operable before starting the job. Additionally, BPA work procedures should call for stopping the job if any system or component that could adversely affect safety becomes degraded. |
| **Rope** | |
| **(15)** The 7/16" Spectron 12 line is prone to forming snags and doubling back on to the reel when used on a puller/tensioner. | That BPA shall explore the use of other sock line options when using the helicopter for wire-stringing operations. |

| FINDINGS | RECOMMENDATIONS |
|---|---|
| **Helicopter** | |
| **(16)** For unknown reasons, an accepted practice of wrapping electrical tape around the remote hook's male/female electrical connection prior to flight was not followed. | That Aircraft Services establish in its CFR 14 Part 133 Class C Rotorcraft-Load Combinations Manual all of the preflight procedures including taping the remote hook electrical connection. |
| **(17)** There was no aircraft mechanic on site to act as a Safety Watcher for the operation of the helicopter. | Aircraft Services shall review and revise the Rotorcraft-Load Combination Manual to clarify its requirement for aircraft maintenance personnel to be on site as a Safety Watcher for any helicopter external-load operation, regardless of its duration. |
| **(18)** Inadequate design of the helicopter's cargo suspension system, Bell Kit number 206-706-335, provides a working condition that under certain circumstances can damage or restrict the electrical and mechanical releases for the helicopter's belly hook. | That BPA prohibit the use of helicopters with cargo suspension system Bell Kit number 206-706-355 from conducting external-load operations. The Bell Long Ranger-series helicopter has a different cargo suspension system design (belly hook) and is not susceptible to this problem. NOTE: The NTSB representative on the AIB is notifying the manufacturer and the FAA of the deficiency of this kit. |

DOE F 1325.8e Electronic Form Approved by CILR – 09/26/2001
(8-89)

United States Government — Department of Energy

# memorandum

Bonneville Power Administration

DATE: August 17, 2004

REPLY TO ATTN OF: CF/CSB-2

SUBJECT: Level 1 Accident Investigation Board

TO: Terry Esvelt, Senior Vice President, Employee & Business Resources – C-4

This memorandum is to confirm the appointment of the individuals listed below to Bonneville Power Administration's Level 1 Accident Investigation Board. The purpose of the Board is to investigate a fatality that occurred on August 17, 2004.

| | |
|---|---|
| Randy Melzer | Deputy Regional Manager, Transmission Business Line, Board Chairperson. |
| Al Major | Aircraft Pilot, Transmission Business Line, Board Member |
| Barry Peckham | Lineman Foreman III, Transmission Business Line, Board Member |
| Don Swanson | Lineman Foreman III, Transmission Business Line, Board Member |
| Joseph Daisa | Electronics Engineer, Transmission Business Line, Board Member |
| Sid Millman | Occupational Safety & Health Manager, Employee & Business Resources, Board Member |
| Ed Blackwood | Director, Office of Regulatory Liaison, DOE Board Member |

The accident shall be thoroughly investigated and a report prepared in a manner consistent with BPA's Manual Chapter 181. During the investigation, the team shall review the accident site, equipment, work procedures, management systems, and other elements that are possible factors in the accident. Bonneville's final report shall include the facts, analysis of facts and conclusions with findings and recommendations. The report shall be forwarded by memorandum to within 30 calendar days.

Ralph Fair
Safety Manager
Employee & Business Resources

---

**SIGNATURES**

---

**Randall W. Melzer**
Accident Investigation Board Chairperson
BPA Deputy Regional Manager, Redmond
Transmission Business Line
DOE-trained Accident Investigator

**Sid Millman**
Accident Investigation Board Member
BPA Occupational Safety & Health Manager
Employee and Business Resources, Vancouver
DOE-trained Accident Investigator

**Edward B. Blackwood**
Accident Investigation Board Member
Director-Regulatory Liaison, Washington, D.C.
DOE Office of Environment, Safety & Health
DOE-trained Accident Investigator

**Barry D. Peckham**
Accident Investigation Board Member
BPA Lineman FM III, Ellensburg
Transmission Business Line
DOE-trained Accident Investigator

**Randy L. Stewart**
NTSB Party Member
Senior Aviation Policy Officer
DOE Office of Aviation Mgt., Washington, D.C.
NTSB/FAA-trained Accident Investigator

**Donald W. Swanson**
Accident Investigation Board Member
BPA Lineman FM III, Ross
Transmission Business Line
DOE-trained Accident Investigator

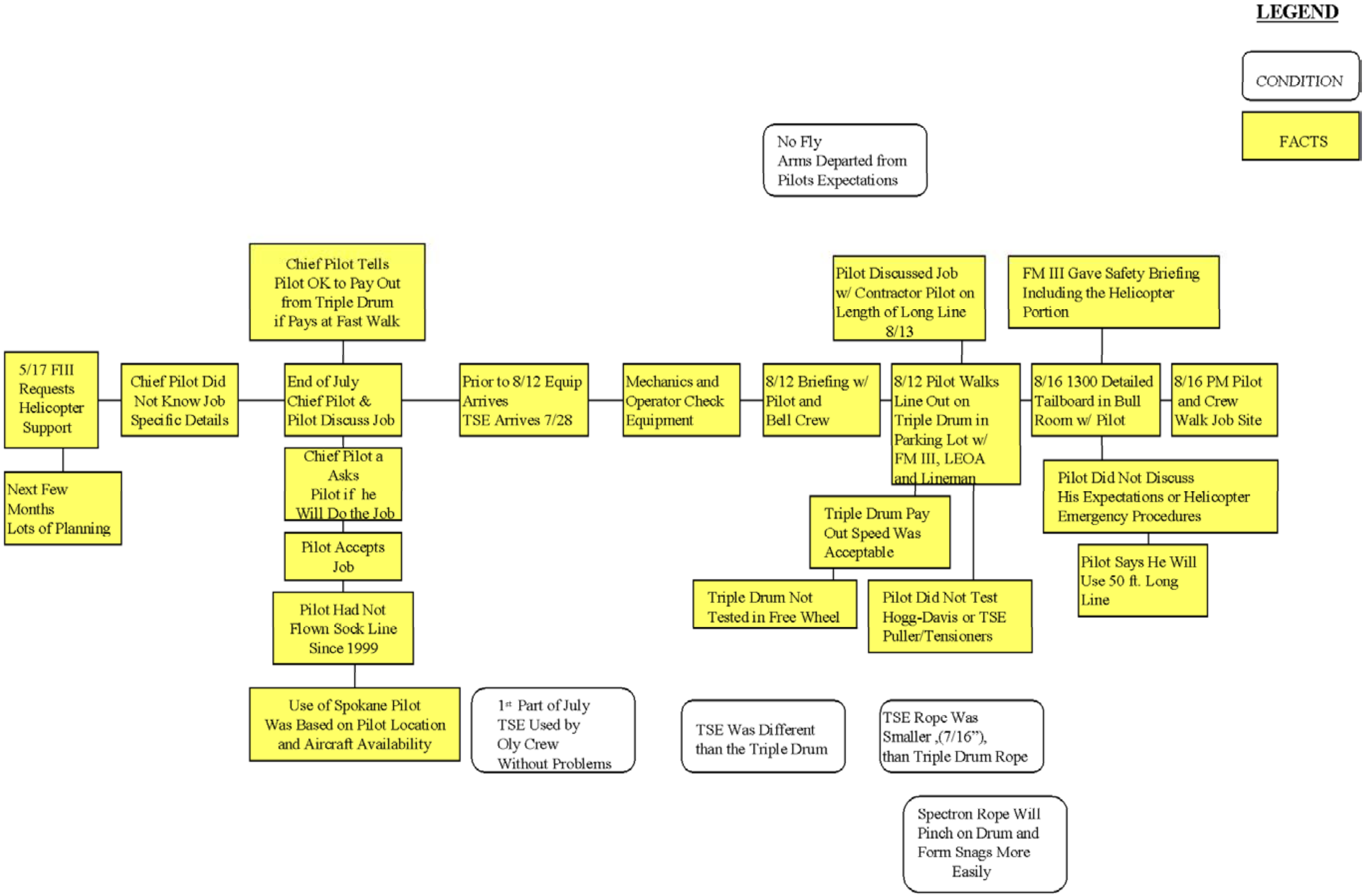
**Albert A. Major, II**
Accident Investigation Board Member
BPA Aviation Safety Manager, Portland
Transmission Business Line
NTSB-trained Accident Investigator

**Joseph N. Daisa**
Accident Investigation Board Member
BPA Electronics Engineer, Olympia
Transmission Business Line
DOE-trained Accident Investigator

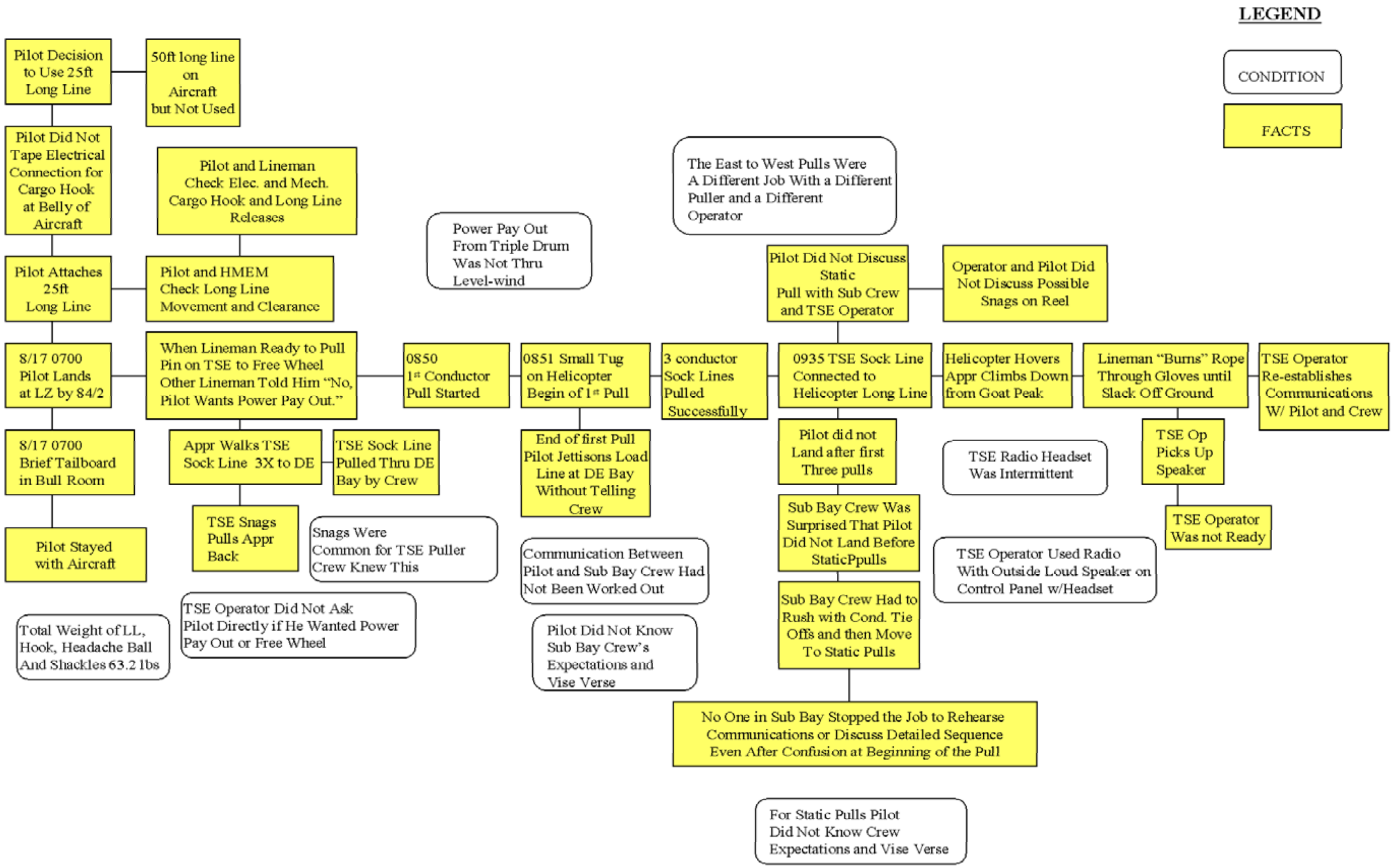
## BOARD MEMBERS, ADVISORS, AND STAFF

| | |
|---|---|
| Chairperson | Randall Melzer, BPA, TFR/Redmond |
| Member | Edward Blackwood, DOE, Washington, D.C. |
| Member | Albert Major, II, BPA, TC/Hangar |
| Member | Donald Swanson, BPA, TFOP/LMT |
| Member | Barry Peckham, BPA, TFSK/Ellensburg |
| Member | Sid Millman, BPA, CF/CSB-2 |
| Member | Joseph Daisa, BPA, TFOC/Olympia |
| Technical Advisor | Randy Stewart, DOE, Washington, D.C. |
| Technical Advisor | Wayne Noonan, BPA, TC/Hangar |
| Technical Writer | Stuart Sandler, Contractor |

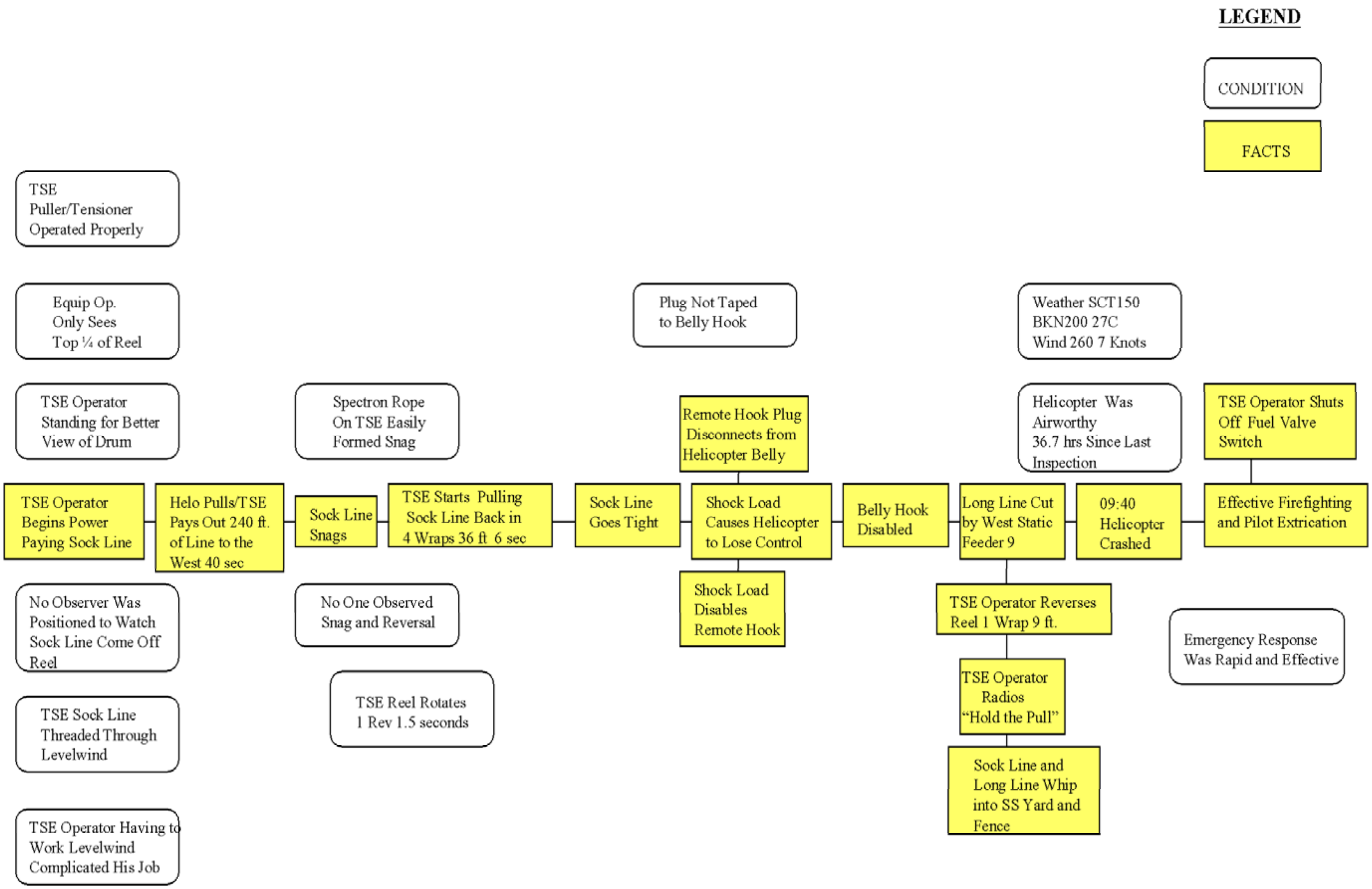
## Appendix 1 Event Time Line Pg 1



## Appendix 1 Event Time Line Pg 2



## Appendix 1 Event Time Line Pg 3



**Operator History and Certifications:**

Bonneville Power Administration (BPA) is part of the Department of Energy and owns seven aircraft. Two King Air 200s, three Bell 206BIIIs, one Bell 206LIII, and one Bell 206L4. BPA has been operating helicopters and airplanes since the 1940s. BPA initiated the first use of helicopters to patrol power lines in 1947, using a contracted Bell 47 model helicopter. Prior to this accident, BPA had experienced only one fatal airplane accident in 1982. The BPA fleet of aircraft on average accumulates 2700 flight hours annually. The accident aircraft (Bell 206BIII) has averaged approximately 340 flight hours annually.

BPA received an Air Carrier Certificate in 1994, issued under the provisions of 14 CFR Chapter 1, Part 119 to conduct 14 CFR Part 135 on-demand passenger and cargo air transportation services from the Federal Aviation Administration (FAA). In addition, BPA holds a Rotorcraft External Load Operating Certificate (Part 133) and Commercial Agricultural Aircraft Operator Certificate (Part 137). The Part 133 Certificate authorizes BPA to conduct Class A[4], B[5], and C[6] rotorcraft-load combinations. The Part 133 certificate after initial issuance is renewed every two years. BPA's Part 133 certificate number is B4SL670EW and was reissued in March 2004. Under the Federal law governing BPA aircraft operations, none of the operating certificates are required, but BPA's management has been proactive in complying with the same rules as those of any "civil aircraft[7]" conducting similar operations. In addition, the commercial certificates involve the FAA in the oversight of the aircraft operation which benefits the program with additional oversight that most public aircraft operators do not have.

**Pilot History:**

The pilot, at the time of the accident, had accumulated 21,803.2 pilot-in-command (PIC) hours of flight with 16,000 of those flight hours in the Bell 206 series aircraft over a 36-year career. His recent flight experience includes: flying time last 30 days=33.8 PIC flight hours; 90 days=116.3 PIC; 180 days= 253.9PIC; and 360 days= 359.2 PIC. There is no indication the pilot had flown any external-load operations in the previous 12 months. The accident pilot's records indicate his last Class C load operation occurred on May 6, 1999. The pilot, according to his company (BPA) flight records, had 4,000 PIC flight hours conducting external-load operations and 3,000 PIC flight hours conducting "vertical reference[8]" external-load operations.

At the time of the accident, the pilot held an Airline Transport Pilot rating (ATP) with a Rotorcraft-Helicopter BH 206 type rating and was limited to Commercial Instrument Privileges BH-206 VFR only. The pilot's ATP certificate was issued by the FAA on 09-24-1984. The accident pilot's company flight records indicate that in June 28, 1996 BPA's Chief Helicopter Pilot observed the pilot conducting a Class C operation with 50', 100', and 150' longlines. The total flight time was 3.6 hours. The BPA Chief Pilot signed the qualification record for the pilot

[4] Class A rotorcraft-load combination means one in which the external load cannot move freely, cannot be jettisoned, and does not extend below the landing gear.
[5] Class B rotorcraft-load combination means one in which the external load is jettisonable and is lifted free of land or water during the rotorcraft operation.
[6] Class C rotorcraft-load combination means one in which the external load is jettisonable and remains in contact with land or water during the rotorcraft operation.
[7] Civil aircraft means aircraft other than public aircraft.
[8] Vertical reference external-load operations normally involve the use of a longline (cable) extending below the landing gear by 50', 100', 150' or more and the pilot controlling the line by visual reference through the cabin door special window.

to meet the requirements of Part 133.37 Crewmember training, currency, and testing requirements. The pilot's flight time records indicate that his last external load operation was in April 2003 and he flew 30.2 hours of PIC in a Bell206BIII. These external load operation were Class B loads.

Part 133.37 paragraph (c) states, "Notwithstanding the provisions of paragraph (b) [Class D loads] of this section, a person who has performed a rotorcraft external-load operation of the same class and in an aircraft of the same type within the past 12 calendar months need not undergo recurrent training". The rule, Part 133, only defines initial training in Part 133.23 and not recurrent training. However, the rule requires some sort of recurrent training to be conducted. The accident pilot had exceeded the 12-month requirement.

His medical certificate was a Class II, issued on 09-23-2003 and had a limitation for the pilot to possess corrective lenses for near vision. The physician that issued the medical certificate was Dr. Lantsberger, FAA license number11529-4.

The pilot was enrolled in a FAA and DOE approved Drug and Alcohol testing program. His most recent random sampling occurred 03-21-2002 and the results were negative.

It is clear the pilot was a very experienced, safe, and competent pilot. His Class B external-load experience was extensive and he had demonstrated his ability to conduct Class C load operations to the BPA Chief Pilot in 1996. His last Class C load was 1999 and the Board is unable to determine the pilot's total Class C load experience.

**Aircraft History:**

The Bell 206BIII, registration number N34698, serial number 4324, was manufactured in 1994 by Bell Helicopter Textron, Incorporated. The aircraft is a five place (1 Pilot + 4 passengers capacity) aircraft with a maximum gross weight on the landing gear of 3200 pounds, but the maximum gross weight for external-load operations is 3350 pounds.

The aircraft had a total time of 3859.3 hours and had flown 36.7 hours since its last inspection. The aircraft maintenance program is an FAA approved inspection program under the provisions of 14 CFR Chapter 1 Part 135.419. The aircraft, including the engine, was maintained in accordance with 14 CFR Chapter 1, Parts, 21, 43, 91.409 (e) and (f) (2), Part 135.411 (a) (1), 135.419, and 135.421. The Rolls Royce turbo-shaft engine serial number CAE-296031 had 3761.9 total time and 262.6 since last overhaul. All life-limited component parts, airframe and engine inspections, and emergency equipment inspections were current and no discrepancies were open at the time of the accident. The aircraft, including the engine, were airworthy and safe for operation prior to the accident. There is no indication that any component, part, or accessory of the airframe or engine failed initiating the accident.

The civil Bell 206 series helicopter has been produced since 1966. Operators who used the aircraft back in the 1960s and 1970s for sock line pulling found that the aircraft had to be flown rearwards, because flying sideways caused damage to the engine-to-main transmission drive shaft. Since the transmission is not rigid on the airframe and the transmission floats in the direction of the thrust, this places the drive shaft in an extreme angle to the engine drive and causes excessive wear in a relatively short time. The Bell 206 has been used by many operators to pull sock line successfully.

**Appendix 3 Accident Photos**

Front View. Looking westerly.

Aircraft was moved to extract pilot. The aircraft was pulled upright and tail end moved onto roadbed. This placed the nose heading ENE, original heading at impact 003 degrees.

Front View with crush angle.

Aft View. Looking easterly

Right Side View. Looking north.

Yellow line indicates actual impact. The impact was hard enough to create a small depression, which is visible underneath yellow line.

Left Side View. Looking south.

Red M/R blade struck upper cabin at left door post. Rescue workers pulled door off during extraction of pilot.

Right Side Close-up View. Looking north.

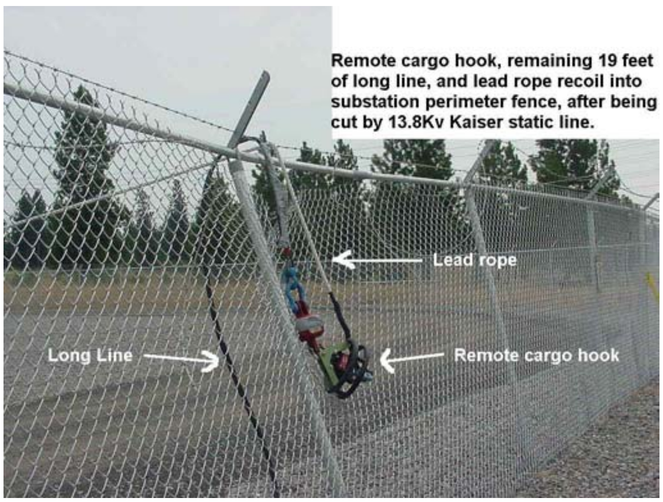
.

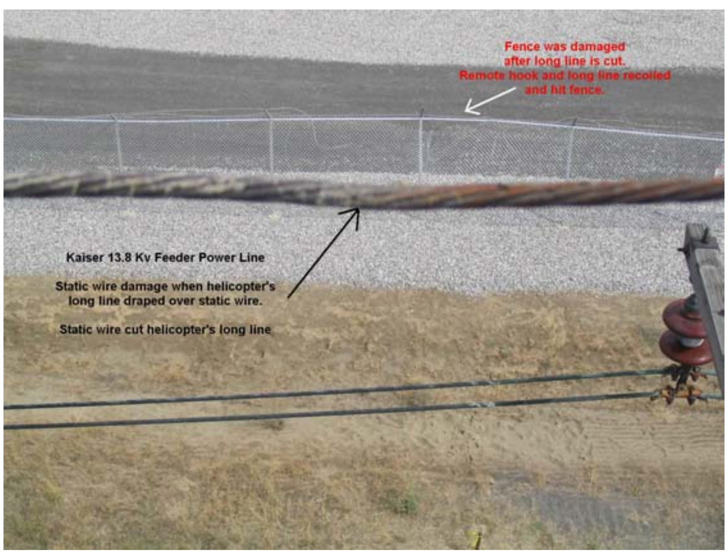
Right side close up shows extent of upper cabin crushing exposing pilot seat to ground impact.

Left front cross tube scuffing is where landing gear caught on second conductor of 13.8 Kv Kaiser Feeder power line.

Picture of 13.8 Kv Kaiser power line (second conductor) shows paint transfer from left cross tube and indications of direction as cross tube moved across before tearing loose from aircraft.

Close up picture of 13.8 Kv Kaiser power line (second conductor) showing paint transfer from left cross tube and indications of direction as cross tube moved across before tearing loose from aircraft.



Close up of left front cross tube showing scuffing and where landing gear caught and was torn out of aircraft's underside.

See next picture lower left.

13.8 Kv Kaiser Feeder power line west pole showing red M/R blade strike when aircraft was inverted.

Close up of red M/R blade strike looking due west. M/R was under full power when it struck pole.

Photo of red M/R blade with creosote transfer from pole strike.

Photo of red M/R blade showing where blade wrapped around pole prior to braking.

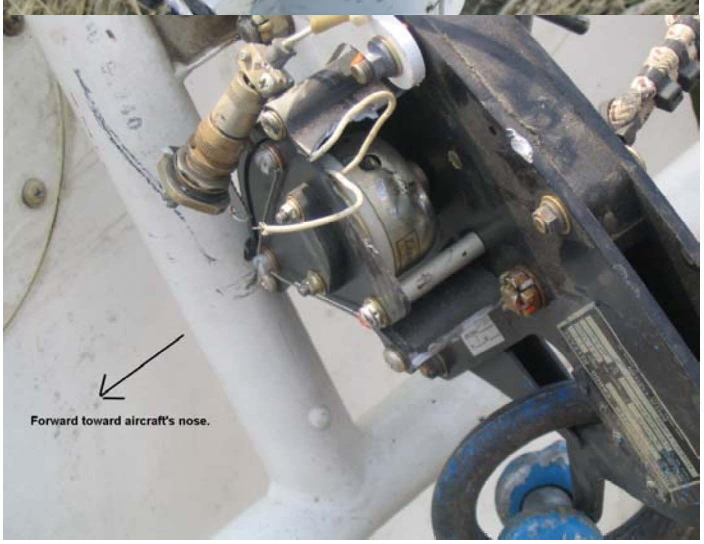

Red Main Rotor blade strike
Helicopter impact crater.
White Main Rotor Blade strike/impact


Mast paint removed by sand as mast penetrates into dirt during impact.

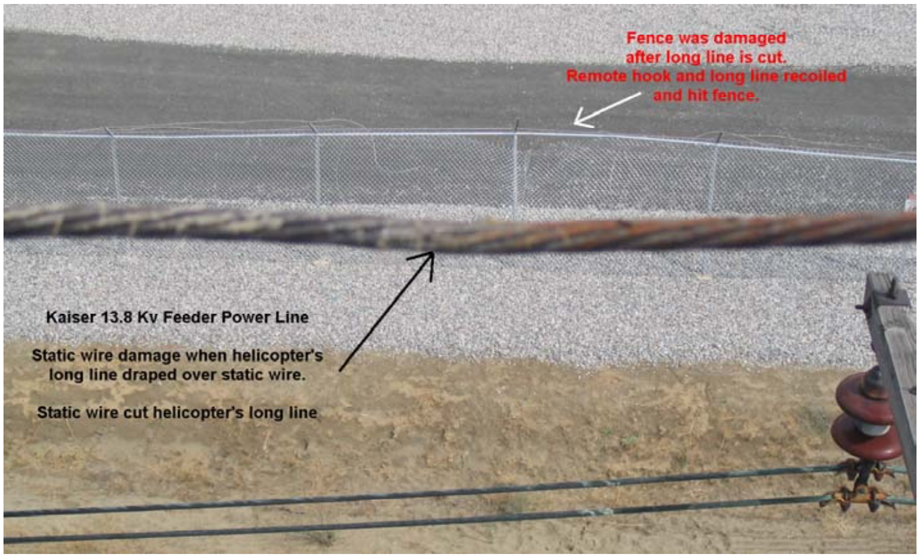
Below all parts of the main rotor system are placed next to each other. White blade is on left. White M/R blade tip was embedded in the dirt just forward of the cabin. (See wreckage map Appendix 4)

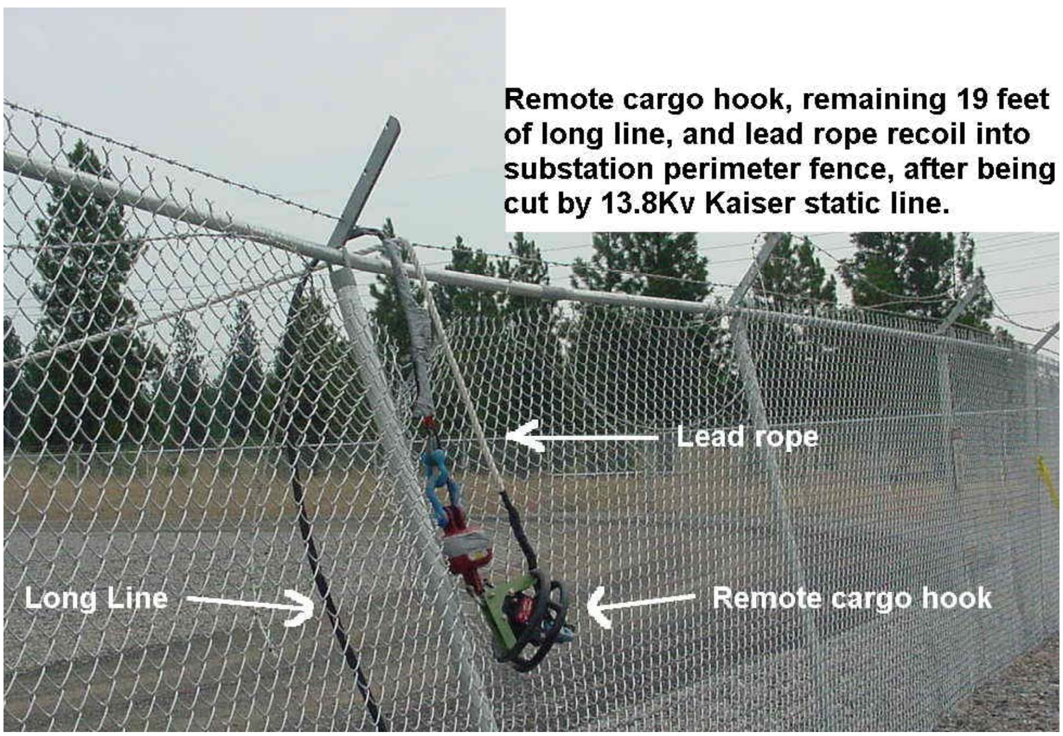

Forward cross tube, right side.

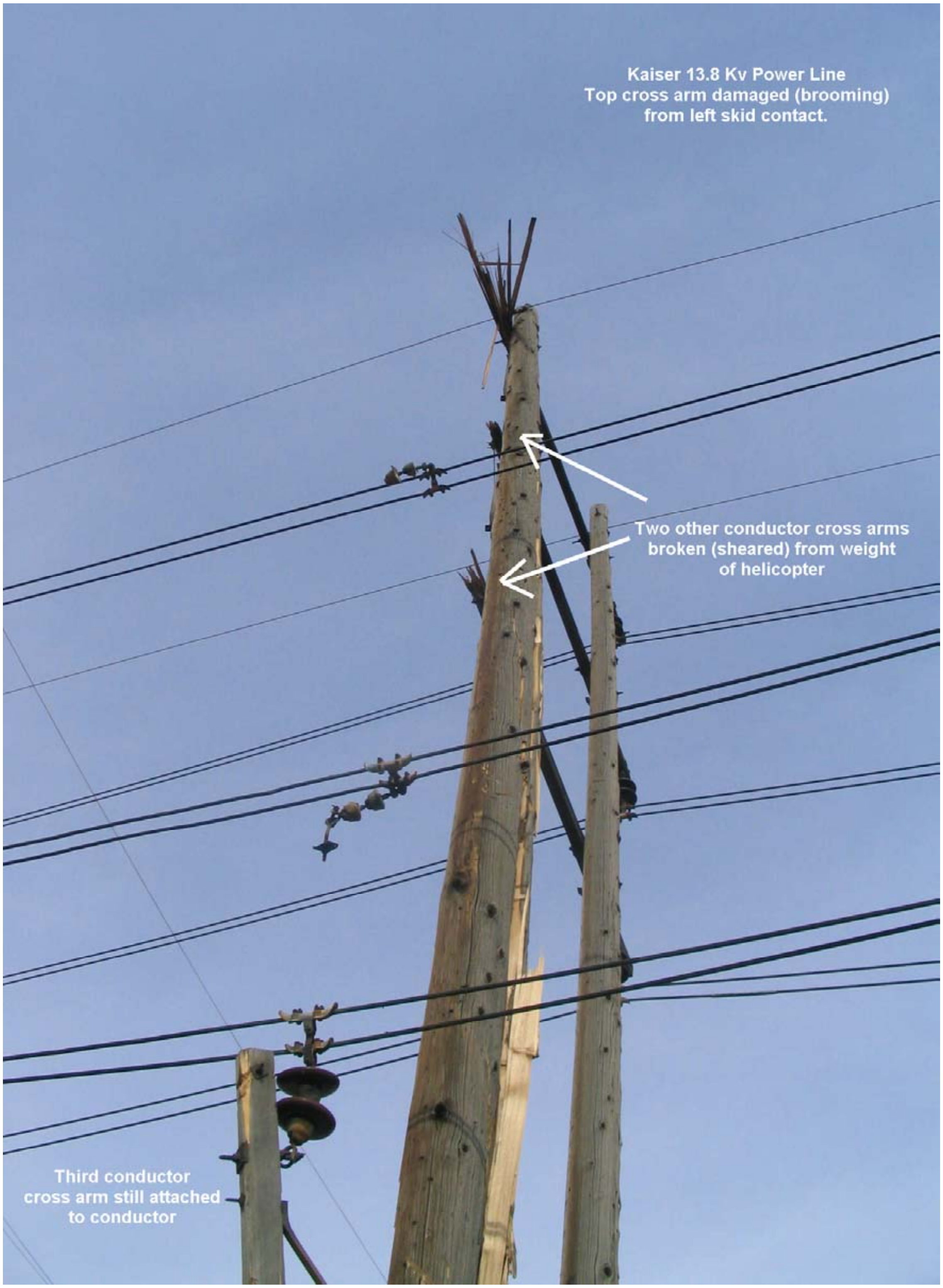

Forward cross tube, right side.



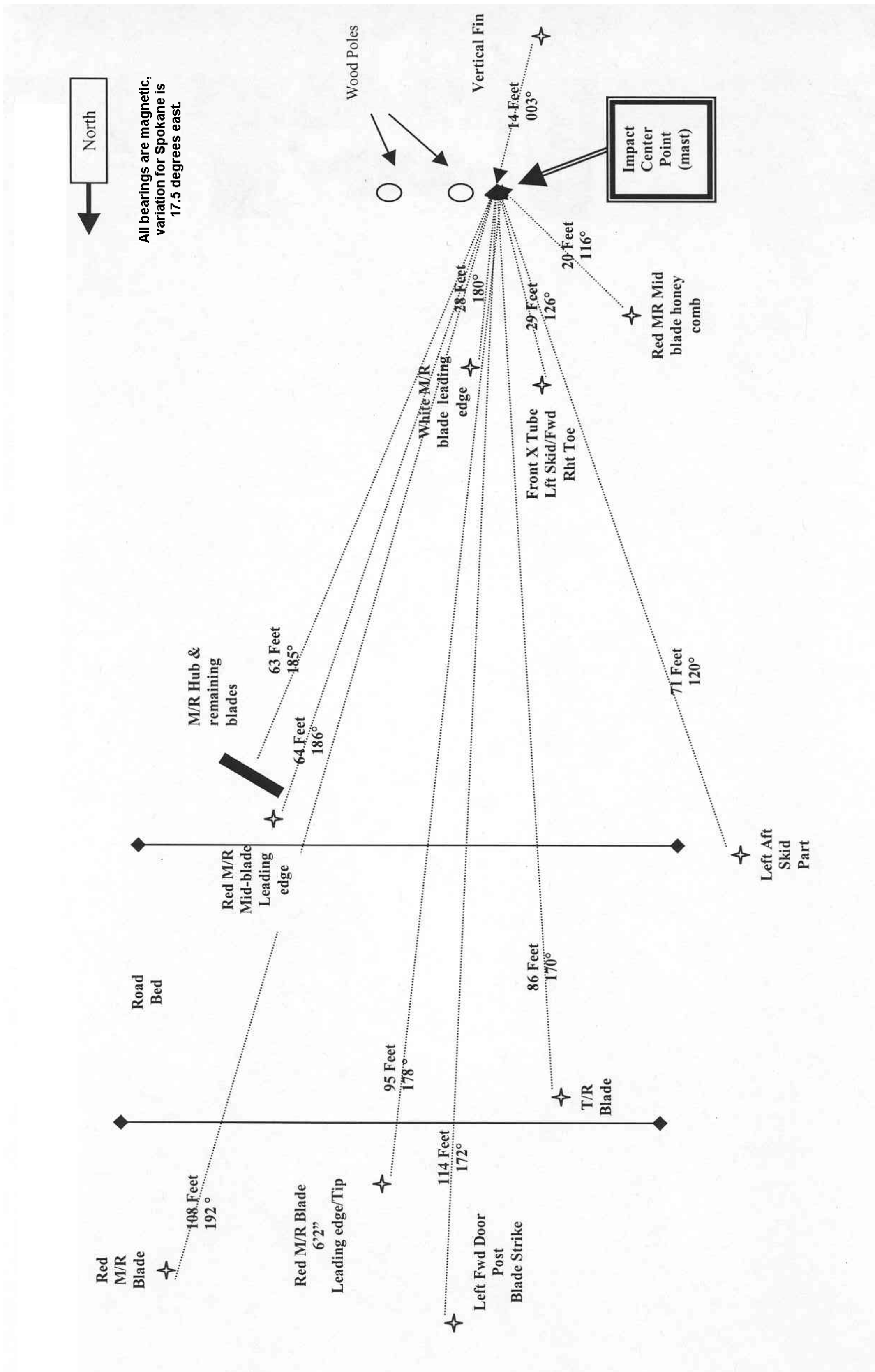

Aircraft's belly cargo hook. Pilot's electric release disabled due to contact with cargo suspension frame. Solenoid dents due to blue clevis bolt contact.


Fence was damaged
after long line is cut.
Remote hook and long line recoiled
and hit fence.
Kaiser 13.8 Kv Feeder Power Line
Static wire damage when helicopter's
long line draped over static wire.
Static wire cut helicopter's long line


Remote cargo hook, remaining 19 feet
of long line, and lead rope recoil into
substation perimeter fence, after being
cut by 13.8Kv Kaiser static line.
Lead rope
Long Line
Remote cargo hook


Kaiser 13.8 Kv Power Line
Top cross arm damaged (brooming)
from left skid contact.
Two other conductor cross arms
broken (sheared) from weight
of helicopter
Third conductor
cross arm still attached
to conductor

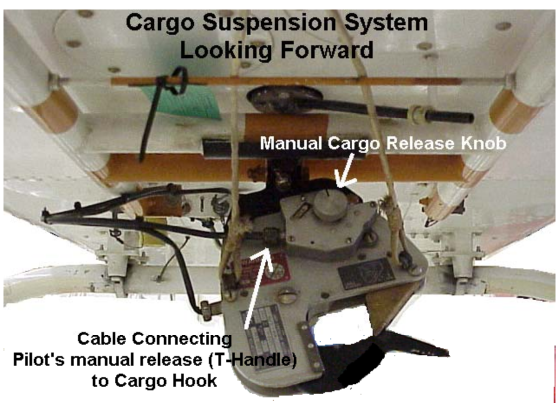
## Appendix 4 Wreckage Map (Scatter)

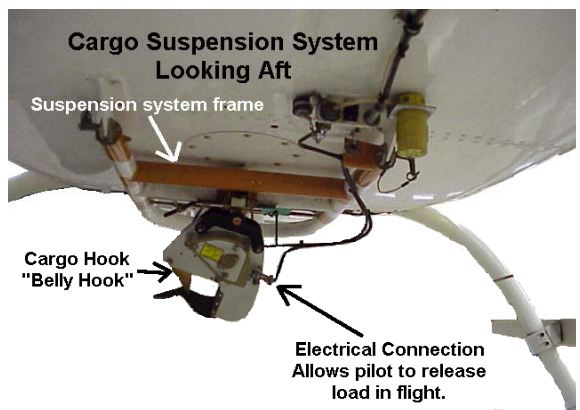


**Description of Aircraft External Load System:**

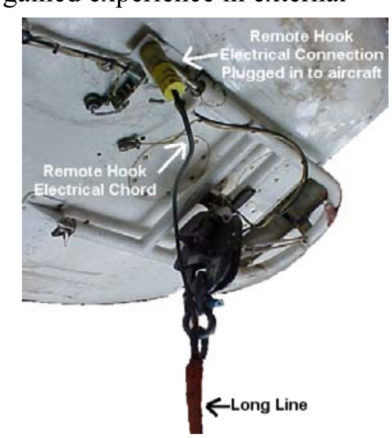
Most helicopters are equipped with a cargo suspension system for conducting external load operations. In some cases, the cargo suspension system is a permanent installation when the aircraft is manufactured. In other aircraft, such as the Bell 206, the factory supplied cargo suspension system can be removed and reinstalled by the pilot based on the mission need through the use of quick disconnect pins, electrical and cable quick connections. The aircraft's cargo suspension system is commonly referred to as the "belly hook."

The FAA aircraft design certification requirements for an external load system are found in 14 CFR Chapter 1, Part 27, section 27.865. The regulation requires the manufacturer to install a primary quick release to jettison the load during flight and a back-up quick release that are independent of each other. The primary release must be mounted on one of the primary aircraft controls (normally the pilot's cyclic control stick) and is electrically activated. The back-up release is mounted in way that it is readily accessible to the pilot. The back-up release is normally a mechanical system that includes a T-handle or pedal, a control cable, and mechanical linkage inside the cargo hook. When mechanical system is connected the pilot can pull a T-handle or push a pedal releasing the external load in flight. See photos below and on the next page.



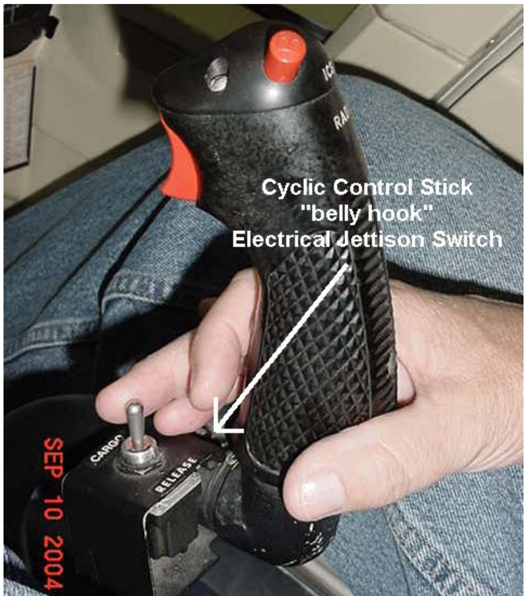




Over the years as helicopter work matured and helicopter operators gained experience in external load work and customers placed greater demands to conduct operations in mountainous terrain, jungles, and heavily wooded areas helicopter operators started using extension cables rather than hooking loads straight to the "belly hook." These cables are commonly referred to as "long-lines." Long-lines in use today reach lengths of 25 feet to 150 plus feet depending on the obstacles or benefits the pilot-in-command determines to accomplish the work. In order to release the cargo at the end of the long-line, operators attached another cargo hook to the end of the cable to give the pilot the ability to release the load in flight. This hook is commonly referred to as the "remote hook." The common practice is to attach an electrical cord extending from the remote hook to the underside of the aircraft where it is connected into the aircraft's electrical system using common three prong plugs. In accordance with FAA regulations this

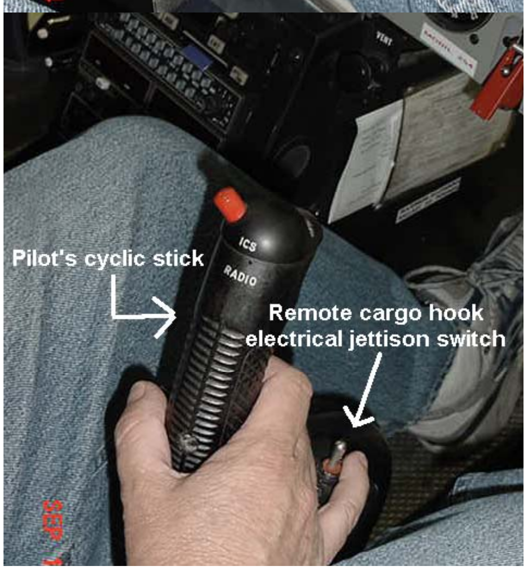


connection is required to provide a quick release of the cargo while in flight and the FAA must approve wiring to the pilot's control stick. However, unlike the FAA requirement to have a back-up release for the belly hook, no back-up quick release is required for the remote cargo hook.

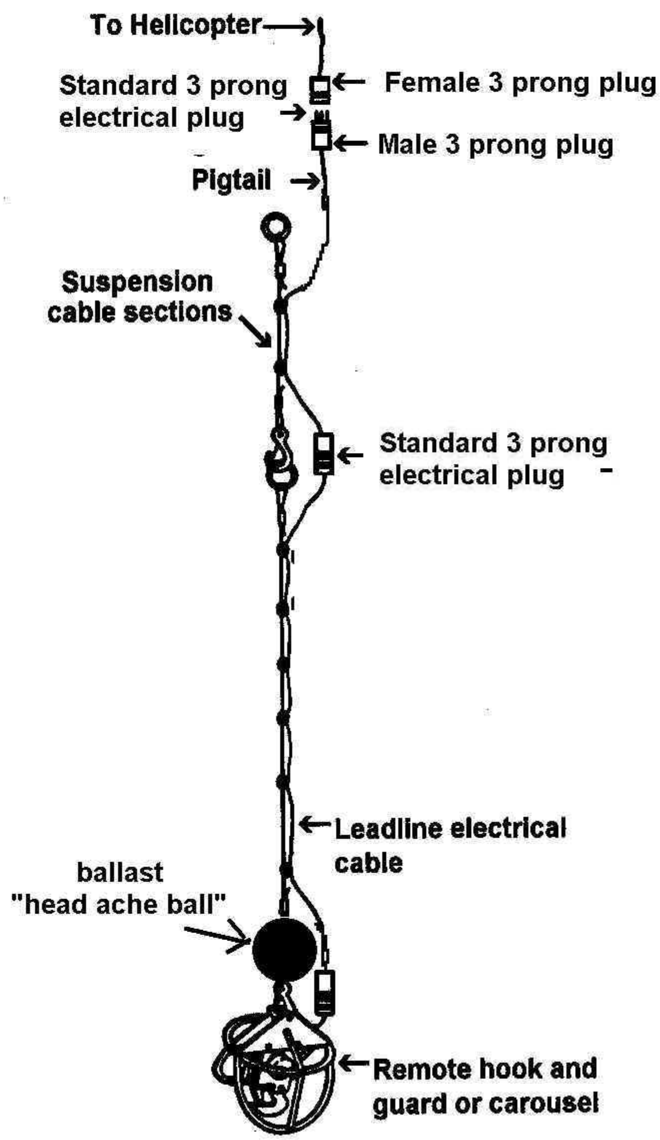
The following pictures depict external cargo releases and normal cargo suspension system in use in the Bell 206 today.



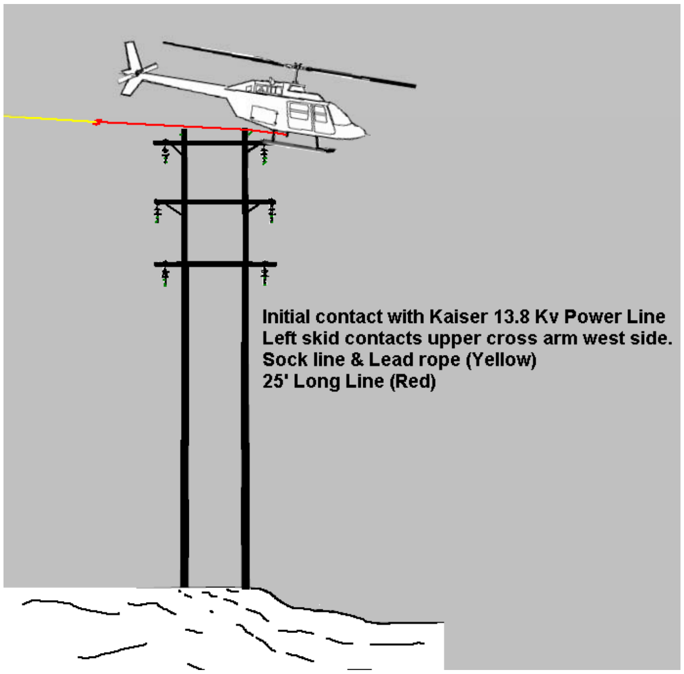


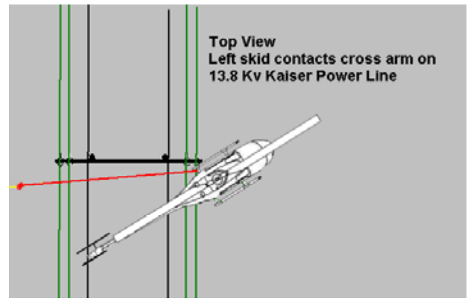


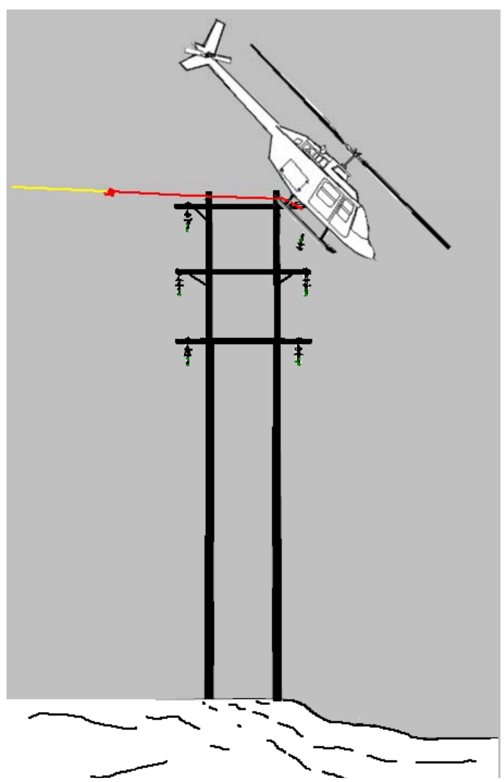

## Typical Longline/Remote Electric Hook Equipment Configuration

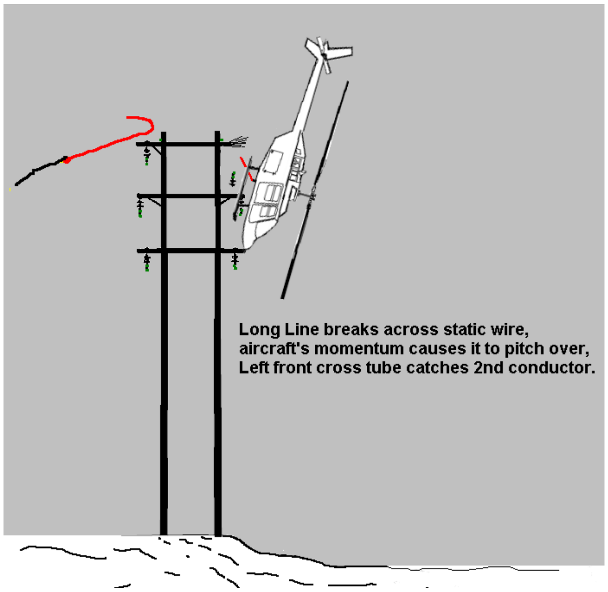


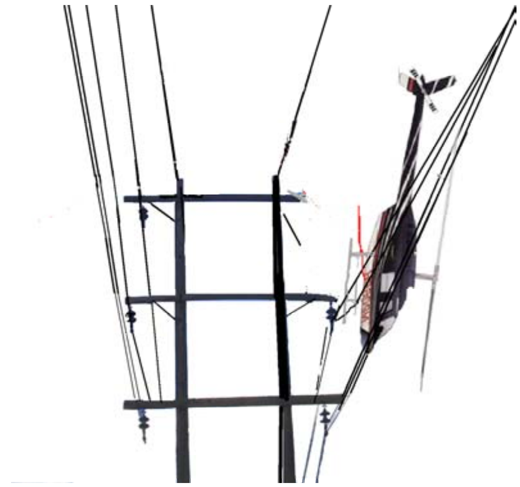
## Appendix 6 Crash Sequence

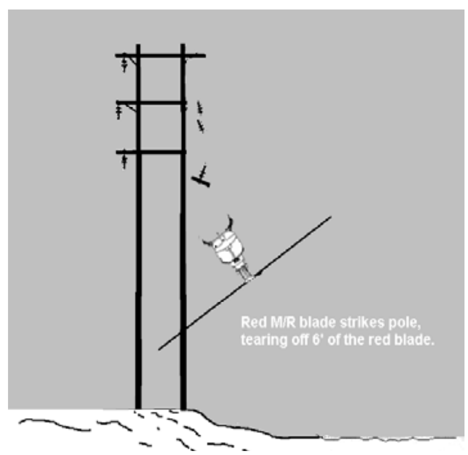


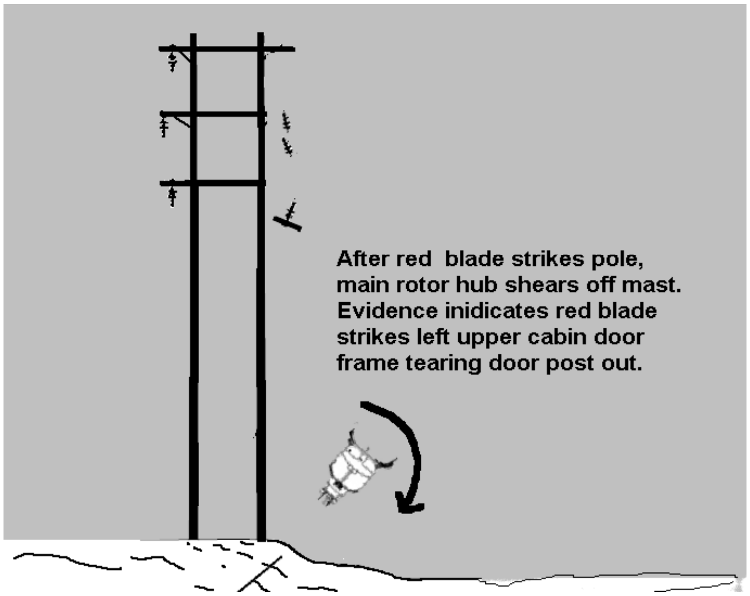



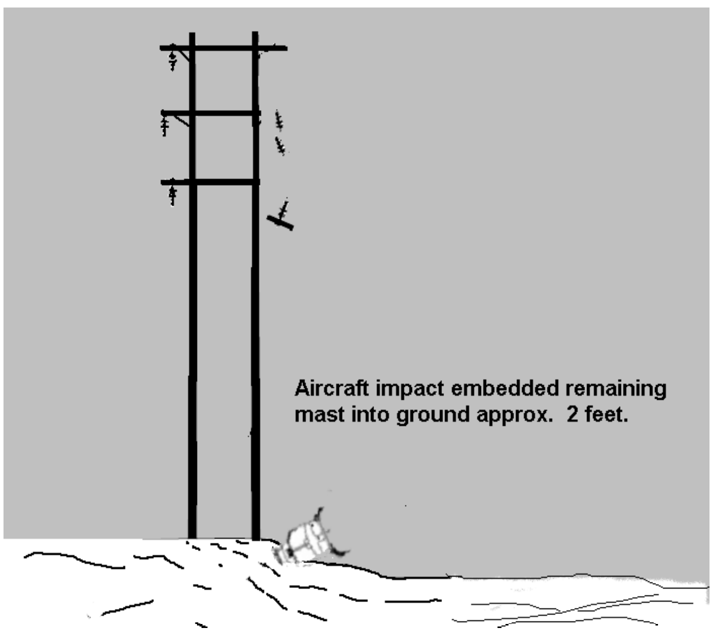




Long Line breaks across static wire,
aircraft's momentum causes it to pitch over,
Left front cross tube catches 2nd conductor.

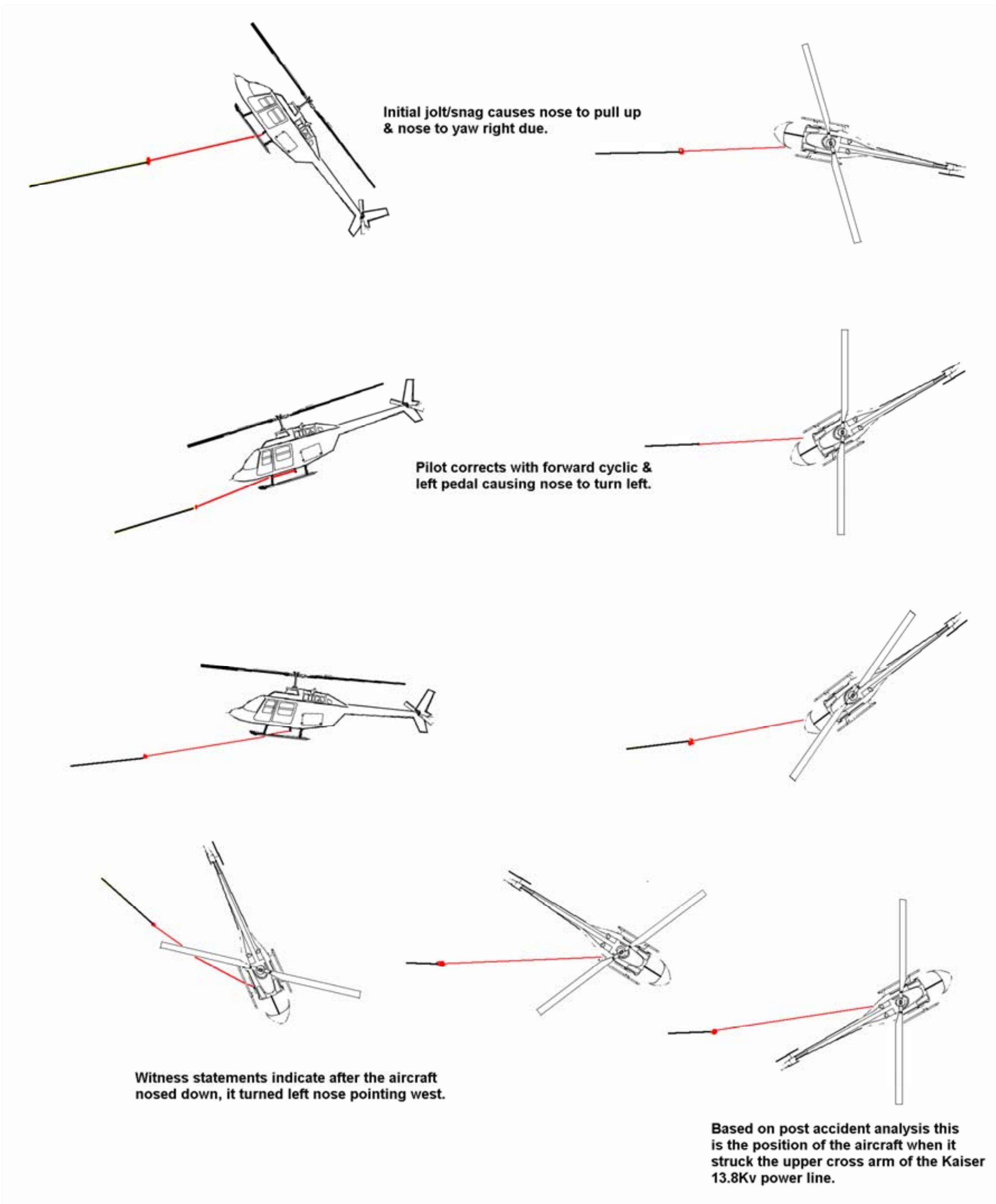



Red M/R blade strikes pole,
tearing off 6' of the red blade.

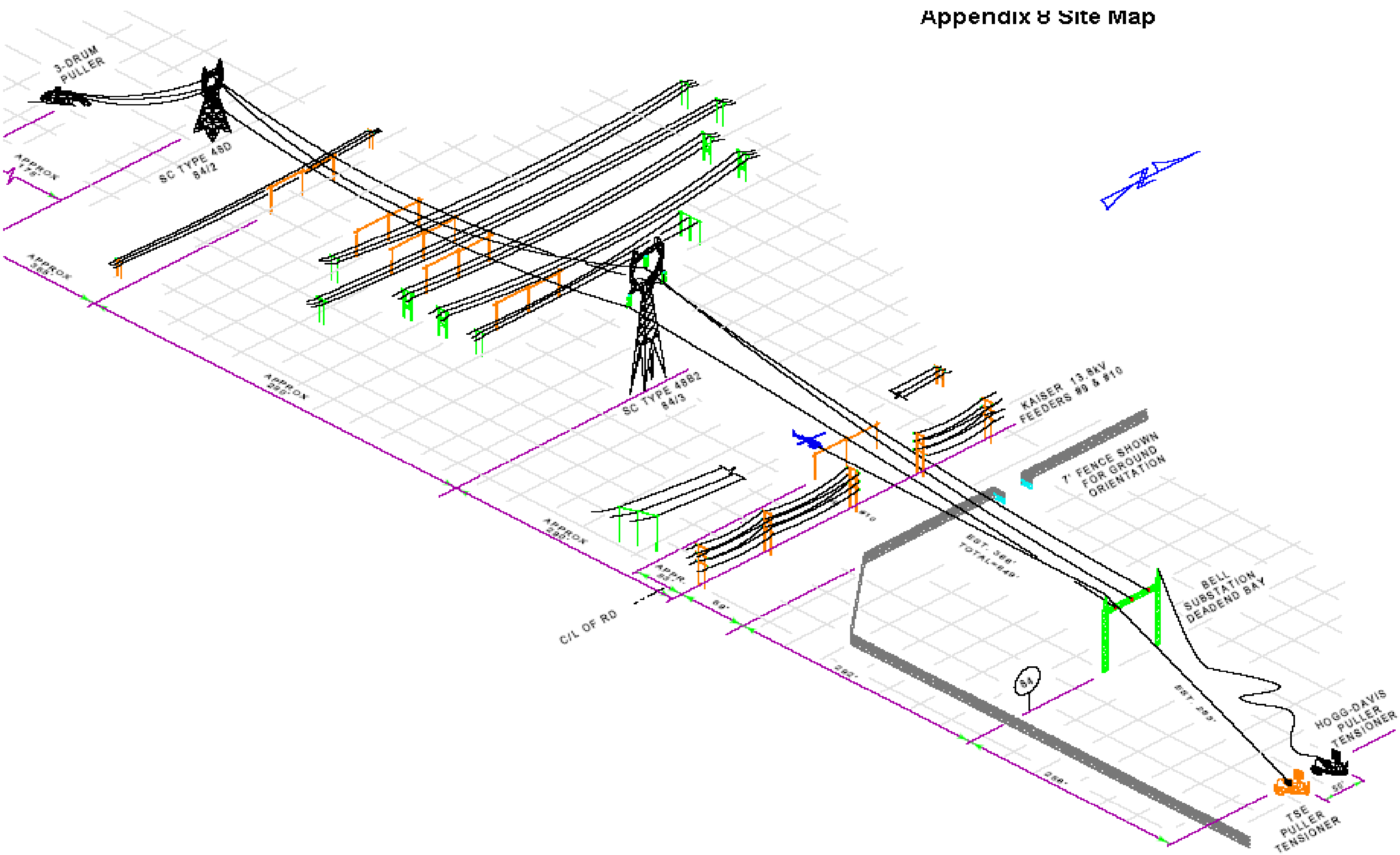

After red blade strikes pole,
main rotor hub shears off mast.
Evidence inidicates red blade
strikes left upper cabin door
frame tearing door post out.


Aircraft impact embedded remaining
mast into ground approx. 2 feet.


Crush Angle


Initial jolt/snag causes nose to pull up
& nose to yaw right due.
Pilot corrects with forward cyclic &
left pedal causing nose to turn left.
Witness statements indicate after the aircraft
nosed down, it turned left nose pointing west.
Based on post accident analysis this
is the position of the aircraft when it
struck the upper cross arm of the Kaiser
13.8Kv power line.

## Appendix 7 Site Map



**Appendix 8 BPA Rotorcraft-load Combination Flight Manual**

(34)

U.S. Department of Transportation
Federal Aviation Administration

EIVE
APR 26 2004
CRAFT
VICES

FLIGHT STANDARDS DISTRICT OFFICE
1800 NE 25th Ave., Suite 15
Hillsboro, Oregon 97124-5982
(800) 847-3806, Ext. 5560
FAX: (503) 681-5555
(503) 681-5560

May 3, 2004

Bonneville Aircraft Services - TC
Attn: Wayne B. Noonan
Chief Helicopter Pilot
Portland International Airport
9120 N.E. 47th Avenue
Portland, OR 97218

Dear Mr. Noonan:

Enclosed are your new External Load Operating Certificate and the List of Authorized Aircraft (LOA).

Please return any superseded certificate(s) and LOA(s) to my attention.

Sincerely,

JDMiller

Johnny D. Miller
Principal Operations Inspector

2 Encl:
1.FAA8430-21
2.LOA

I verify that this copy of the FAA 133 Manual is a copy of the original as provided by Wayne Noonan. 8/27/04 JOSEPH N. DAISA
Joseph N. Daisa

Witnessed by Randall W. Melzer
Randall W M 8/27/04

US Department of Transportation
Federal Aviation Administration

# Operating Certificate COPY

This certifies that

**BONNEVILLE AIRCRAFT SERVICES - TC**
**PORTLAND INTERNATIONAL AIRPORT**
**9120 NE 47TH AVENUE**
**PORTLAND, OREGON 97218**

has met the requirements of the Federal Aviation Act of 1958, as amended, and the rules, regulations, and standards prescribed therein, for the issuance of this certificate and is authorized to operate as an Air Operator and conduct

**ROTORCRAFT EXTERNAL-LOAD OPERATIONS**

in accordance with said Act and the rules, regulations, and standards;
**CLASS A, B, AND C LOADS ARE AUTHORIZED.**

This certificate is not transferable and, unless canceled, suspended, superseded, surrendered or revoked, shall continue in effect **UNTIL MAY 31, 2006.**

By Direction of the Administrator

LARRY S. BIRD
(Signature)

MANAGER, NM-FSDO-09
(Title)

Certificate number: B4SL670W

Effective Date: MAY 3, 2004

Issued at: NM09, HILLSBORO, OR

FAA Form 8430-21 (6-87)

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

**Flight Standards District Office**
1800 NE 25th Avenue, Suite 15
Hillsboro, OR 97124-5982
(800) 847-3806: Ext. 5560
FAX: (503) 681-5555
(503) 681-5560

**COPY**

May 3, 2004

Bonneville Aircraft Services – TC
Attn: Wayne B. Noonan
Chief Helicopter Pilot
P.O. Box 3621
9120 NE 47th Avenue
Portland, OR 97208-3621

Dear Mr. Noonan:

This letter authorizes the following rotorcraft to be operated in accordance with Title 14 of the Code of Federal Regulations (14CFR), Part 133, and the provisions and limitations of the attached operating certificate number B4SL670W.

| | | |
|---|---|---|
| **Bell 206L3** | **N3209G** | **Class A, B, and C** |
| **Bell 206B3** | **N6181A** | **Class A, B, and C** |
| **Bell 206B3** | **N34698** | **Class A, B, and C** |
| **Bell 206L4** | **N2064S** | **Class A, B, and C** |

Sincerely,

Johnny D. Miller
Principal Operations Inspector

Revision No. One

Date: October 1997

ED
99

## STANDARD PROCEDURES FOR FUEL QUANTITY PLANNING AND MONITORING (G.A.B. #97-03)

To allow for delays during the mission and completion of the mission with appropriate fuel reserve, the following procedures will be adhered to.

Note: FAR 91.151 requires a 20-minute VFR fuel reserve.

1. Refer to the attached engine rate of consumption chart during premission planning to assess the minimum and maximum rates of consumption for each mission. Note: Actual rates of consumption should be noted after each flight.

2. Determine minimum fuel required taking into consideration:

   A. Distance to and from airport or nurse truck,
   B. Unusable fuel,
   C. On station time estimate,
   D. VFR fuel reserve, and
   E. Possible delays which would extend flight time.

3. Monitoring procedures: 39

   A. Constant cross-check of fuel state during mission.

Note: Unusual attitudes during class "C" operations may result in erroneous fuel gauge readings and may cause fuel boost pump caution lights to illuminate.

   B. A predetermined refuel clock time will be noted prior to each flight. Recalculate refuel clock time if inadvertent shut down during mission occurs.

   C. If necessary, use ground support personnel as clock time reminder.

   d. Fuel quantity shall be verified upon completion of each fueling.

FAA APPROVED 1/23/98
INSPECTOR DATE
NM-FSDO-09

(h:data\manuals\revisions\fuelrev1.doc)

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |

(w:faa/rotorcraft/load.doc)

**250 SERIES**

**PERFORMANCE RATINGS**

**STANDARD, STATIC, SEA LEVEL CONDITIONS**

250 - C20 - B,J Fuel Flow Range 235 - 273 p.p.h.
206BIII Set at 235 p.p.h. = 361.5 h.p. (235 ÷ .65* = 361.5 h.p.)
1. 270 h.p. (85%) x .70* = 189 p.p.h ÷ 6.8 = 27.7 g.p.h.
2. 317 h.p. (100%) x .67* = 212.4 p.p.h. ÷ 6.8 = 31.2 g.p.h.
3. 348.7 h.p. (110%) x .66* = 233.6 p.p.h. ÷ 6.8 = 34.3 g.p.h.
4.2 h.p. per 1 PSI, 1 PSI = 1.3% TRQ
420 h.p. (132.5%) x .65* = 273.0 p.p.h. ÷ 6.8 = 40.1 G.P.h.

250 - C28B Fuel Flow Range 290 - 368 p.p.h.
206 L-1 Set at 290 p.p.h = 483.3. h.p. (290 ÷ .60* = 483.3 h.p.)
1. 370 h.p. (85%) x .66* = 244.2 p.p.h ÷ 6.8 = 35.9 g.p.h.
2. 435 h.p. (100%) x .62* = 269.7 p.p.h. ÷ 6.8 = 39.6 g.p.h.
3. 457 h.p. (105%) x .62* = 283.3 p.p.h. ÷ 6.8 = 41.69 g.p.h.
7.37 h.p. per 1 PSI, 1 PSI = 1.7% TRQ
550 h.p. (126.8%) x .59* = 329 p.p.h. ÷ 6.8 = 48.4 g.p.h.

250 - C30P
206 L-3 Set at 310 - 315**p.p.h = 500 h.p., 325 - 330***p.p.h. = 524 h.p.
F.F. - .62 = h.p., Fuel Flow Range 281 ÷ 450 p.p.h.
1. 370 h.p. (85%) x .65* = 242.7 p.p.h. ÷ 6.8 = 35.7 g.p.h.
2. 435 h.p. (100%) x .63* = 276.2 p.p.h. ÷ 6.8 = 40.6 g.p.h.
3. 457 h.p. (105%) x .62* = 283.3 p.p.h. ÷ 6.8 = 41.6 g.p.h.
4. 524 h.p. (120.5%) x .62* = 325 p.p.h. ÷ 6.8 = 47.7 g.p.h.
7 h.p. per 1 PSI, 1 PSI = 1.6% TRQ
700 h.p. (161%) x .59 = 413 p.p.h. ÷ 6.8 = 60.7 g.p.h.

* S.F.C. - SPECIFIC FUEL CONSUMPTION, PER HOUR, PER HOURSEPOWER
** NORMAL L-3 SETTING
*** HIGH POWER KIT FOR L-3
( ) TORQUE
6.8 JET A WEIGHT PER GALLON
ALL DATA COMPILED & INTERPOLATED FROM ALLISON TURBINE SCHOOL TRAINING MANUALS.

December 11, 1987

FAA APPROVED
1/23/98
INSPECTOR DATE
NM-FSDO-09

Bonneville Power Administration
Aircraft Services External Load Specialist
905 NE. 11[th] Avenue
P.O. Box 3621 Portland, OR 97208-3621

Revision No. 2
A. 1. Change to approve class "A" loads for N3209G

FAA APPROVED
ROTORCRAFT FLIGHT MANUAL
CHANGE FOR BELL MODEL 206L3-N3209G

FOR
EXTERNAL LOAD OPERATIONS ONLY
Reg. No. N3209G

This change shall be attached to the appropriate FAA approved Bell Model 206BIII-206LIII Basic Rotorcraft Flight Manual when Class "A" loads are to be flown on N3209G.

Revised text is indicated by a black vertical line.

This revision replaces all of page 5 of the BPA-R.L. C.F.M.

FAA Approved:

______________________

DATE:

______________________

INSPECTOR:

______________________

MM-FSDO-09

FAA APPROVED
[signature] 4/21/99
INSPECTOR DATE
NM-FSDO-09

h:data:manuals:longlinechgFAAapp.doc

APR-22-1999 14:53 503 681 5555 94% P.02

Bonneville Power Administration
Aircraft Services External Load Specialist
905 NE. 11th Avenue
P.O. Box 3621, Portland, OR 97208-3621

Revision No. 3

A. 1. Revise rotorcraft load combination flight manual cover sheet and revisions page to reflect the addition of Bell 206L4 Registration No. 2064S

2. Add N2064s L4 Class "A", "B", and "C" load specifications new page No. 7A

FAA APPROVED
ROTORCRAFT EXTERNAL LOAD COMBINATION MANUAL

FOR
EXTERNAL LOAD OPERATIONS ONLY
Reg. No. N2064S

FAA Approved:

---

7-30-99 DATE:

---

Martin G. Corson INSPECTOR:

---

NW MM-FSDO-09
mgc

# *TABLE OF CONTENTS*

## *SECTION ONE*



## *SECTION TWO*

3. RIGGING
   A. CLASS "A" LOADS
   B. CLASS "B" LOADS
   C. CLASS "C" LOADS
   D. CLASS "D" LOADS
4. IN FLIGHT
   A. CLASS "A" LOADS
   B. CLASS "B" LOADS
   C. CLASS "C" LOADS
   D. CLASS "D" LOADS
5. REQUIRED PLACARDS

## *SECTION THREE*

INFORMATION:

1. SAFETY AROUND HELICOPTERS AND EQUIPMENT
2. DEFINITIONS

## *APPENDIXES*

| | |
|---|---|
| APPENDIX ONE | CONGESTED AREA PLAN |
| APPENDIX TWO | SAFETY BRIEFING |
| APPENDIX THREE | OPERATIONS BRIEFING |
| APPENDIX FOUR | HAND SIGNALS |

## SECTION ONE

OPERATING LIMITATIONS:

In addition to the operating limitations set fourth in the approved rotorcraft flight manual, this aircraft will be operated in accordance with the following operating limitations.

1. No person shall operate this aircraft with an external load unless he holds an FAA external-load operator certificate and has an entry in his logbook or a letter of competency as required by FAR-133.31(d)(3). He must have a copy of the knowledge and skill test logbook endorsement or letter of competency in his possession during the operation.

2. No passengers will be carried during external load operations under any circumstances.

3. Operations shall not be conducted over congested areas unless approved by the FAA FSDO in accordance with a congested area plan developed in compliance with FAR 133.31(F)(1) and (2), (see sample plan in appendix one congested area plan).

4. A. No pilot may conduct external load operations unless all persons involved have received a safety of flight and ground operations briefing stating that all standard and special safety procedures will be adhered to as prescribed by FAA regulations and the BPA aircraft operations manual, (see appendix two, safety briefing).

B. The pilot-in-command will ensure that all persons are briefed before each flight on all operational procedures, (see appendix three safety briefing)).

5. The total weight of these aircraft and load combinations shall not exceed:

Make and model: Bell 206L3

N-number: 3209G

Empty weight: 2684 lbs.

Class A loads: maximum weight 200 lbs., per cargo rack—not to exceed 4,150 lbs. mgw.

Maximum forward airspeed: 130 kts

<u>NOTE</u>: Maximum load figures for 206L3 is derived using a 220 lb. pilot and 300 pounds of fuel.

Make and model: Bell 206L3

N-number: 3209G

Empty weight: 2684 lbs.

Class B load maximum weight: 1046 lbs. not to exceed mgw 4,250 lbs.

Maximum forward airspeed: 87 kts

Make and model: Bell 206L3

N-number: 3209G

Empty weight: 2684 lbs.

Class C load maximum weight: 1046 lbs. not to exceed mgw 4,250 lbs.

Maximum forward airspeed: 87 kts

FAA APPROVED
INSPECTOR 1/21/99 DATE
NM-FSDO-09

h:data:manuals:longlinechgFAAapp.doc

'2-1999 14:54 503 681 5555 95% P.03

<u>Note:</u> Extreme caution must be exercised when carrying class B external-loads, as controllability may be affected by the size, shape, and relative airspeed of the cargo.

Make and model: Bell 206B3

N-number: 6181A

Empty weight: 2071 lbs.

Class A load maximum weight: 709 lbs. not to exceed mgw 3,200 lbs.

Maximum forward airspeed over 3,000 lbs.: 122 kts

<u>Note:</u> Maximum load figures for 6181A are derived using a 220 lb. pilot and 30 gallons (200 lbs.) of fuel.

Make and model: Bell 206B3

N-number: 6181A

Empty weight: 2,071 lbs.

Class B load maximum weight: 709 lbs. not to exceed mgw 3,200 lbs.

Make and model: Bell 206B3

N-number: 6181A

Empty weight: 2,071 lbs.

Class C load maximum weight: 859 lbs. not to exceed mgw 3,350 lbs.

Make and model: Bell 206B3

N-number: N34698

Empty weight: 1,935 lbs.

Class A load maximum weight: 845 lbs. not to exceed mgw 3,200 lbs.

Maximum forward airspeed over 3,000 lbs.: 122 kts

Note: Maximum load figures for N34698 are derived using a 220 lb. pilot and 30 gallons (200 lbs.) of fuel.

Make and model: Bell 206B3
N-number: N34698
Empty weight: 1,935 lbs.
Class B load maximum weight: 845 lbs. not to exceed mgw 3,200 lbs.

Make and model: Bell 206B3
N-number: N34698
Empty weight: 1,935 lbs.
Class C load maximum weight: 995 lbs. not to exceed mgw 3,350 lbs.

FAA certificated maximum gross weights:
Bell 206L-3 external loads (up to 1,500 lbs.)
Bell 206B-3 external loads (up to 1,200 lbs.)

6. A copy of the external-load operating certificate and rotorcraft-load combination flight manual will be on this aircraft during all external-load operations.

7a. The total weight of this aircraft and load combinations shall not exceed:

Make and model: Bell 206 L4

N-number: 2064S

Empty weight: 2,610 lbs.

Class A loads: maximum weight 200 lbs., per cargo rack—not to exceed 4,450 lbs. mgw.

Maximum forward airspeed with cargo racks installed: 115 kts.

NOTE: Maximum load figures for 206 L4 is derived using a 220 lb. pilot and 300 lbs. of fuel.

Make and model: Bell 206 L4
N-number: 2064S
Empty weight: 2,610 lbs.
Class B load maximum weight: 1,420 lbs., not to exceed 4,450 lbs. mgw.
Maximum forward airspeed: 87 kts

Make and model: Bell 206 L4
N-number: 2064S
Empty weight: 2,610 lbs.
Class C load maximum weight: 1,420 lbs., not to exceed 4,450 lbs. mgw.
Maximum forward airspeed: 87 kts

w:faa:loadcombinations.doc

## SECTION TWO

I. LOAD COMBINATION INFORMATION

A. Oscillating Tendencies

If a load swings away to one side or another it will eventually come back, but with twice the swing. If the load is to continue swinging, it requires an offset pivot point, (the helicopter). If the pivot point moves over the top of the load as it swings, the load stops swinging. Light weight, high drag loads require a swivel connector between the cargo hook and the sling to prevent unstable oscillations in flight above 20 KIAS.

B. Ground Effect - In and Out

Refer to the flight manual performance section for proper IGE and OGE hover ceiling computations.

C. Density Altitude

For D. A. computations refer to D.A. chart in the performance section of the flight manual.

D. Electrical Activity

No class B or class C external load operations will be conducted in an electrical storm or when lightening is likely to hit the aircraft.

E. Strong or Gusty Winds

No external load operations will be conducted in winds stronger that the pilot is able to handle.

## II. OPERATING PROCEDURES

### A. Operator's Responsibility

The helicopter operator shall be responsible for the size, weight, and manner in which loads are connected to the aircraft. No load shall be made if the helicopter operator believes the lift or pull cannot safely be performed. The operator of the helicopter will freely exercise his prerogative and judgment as to safe operation of the helicopter and any associated operations.

### B. Cargo Hooks

All electrically operated cargo hooks shall have an electrical activating device which is designed and installed to prevent inadvertent operation. All hooks will be equipped with an emergency mechanical or manual release control. No electrical cargo hook shall be used unless prior to that days operation, the releases are tested and functioning properly.

### C. Emergency Conditions

All emergency procedures will be followed in accordance with the Bell 206B-3 and L-3 flight manuals and FAA regulations. In the event of electrical hook failure use the manual hook release to jettison the load during class B operations, or the cable during class C operations.

Note: It is critical to ascertain that the load or cable did detach from the aircraft during an emergency landing. A more vertical approach to landing will be required during an emergency landing if the load does not release to avoid loss of attitude control.

D. Hooking and Unhooking Loads

No person shall perform work under a hovering helicopter, provided, that qualified employees may function under such craft for that limited time necessary to guide, secure, hook or unhook the loads. When doing so at elevated positions, employees shall be assisted by a positive positioning guide system. When under hovering helicopters in other situations, the employee shall have a predetermined ingress and egress route in case of emergency. This complies with Washington State Safety Standards for Electrical Workers, Chapter WAC 296-45-6703(7).

E. Static Electricity Discharges

To minimize the effect of static discharge, the pilot should always ground the hook or longline prior to any ground personnel contact. Certain weather conditions such as blowing snow or dust will exacerbate the static discharge. In these cases it may be necessary to curtail the operation.

III. RIGGING

Note: Ropes and straps used for tying or securing loads together should only be used when attached to a 25 foot or longer steel long line with a weighted end. If unable to use a steel long line exercise extreme caution to avoid rope snap back in the event of breaking.

1. Class A Load

(a) Loads will be approved by the pilot. The pilot will assist and supervise the loading and distribution of all loads.

(b) The pilot will inspect and approve all attaching and securing devices used on class A loads.

(c) The pilot will assure proper securing of the load and check the weight and balance of the aircraft in accordance with the appropriate flight manual.

2. Class B. Loads

(a) The slings and attaching devices used for external loads shall be inspected each day before use.

(b) No sling shall be used unless it has a minimum tensil strength of four times the load weight.

(c) No sling shall be used unless upon inspection it is determined to be in good condition and capable of the work which is to be performed.

(d) Loads shall be properly slung so that there will not be slippage or shifting of the load and so that the load will not accidentally be dislodged from the aircraft.

(e) Use only an appropriately sized shackle or steel "O" ring as the last device on the end of the long line or sock line. Only it will be inserted into the a/c cargo hook.

Note: The pilot must be aware that interphase spacer operations, cross arm operations, airway lighting operations and any other BPA maintenance function may have unique rigging requirements not stated in this manual.

3. Class C Loads

Note: Refer to class B load rigging for class C applicability.

(a) A minimum of 25 foot steel long line, with electrical release hook attached, will be used for all sock line operations.

(b) All cables and cable end attaching devices will be inspected for serviceability.

(c) Each sock line or cable must have a shackle or carabineer attached to it to insure a smooth release from the long line hook.

(d) Check the reels the cable is to be pulled from and the condition of the cable reel brake.

Note: The pilot must be aware that some class C load operations may have unique rigging requirements not stated in this manual.

IV. IN FLIGHT PROCEDURES

A. Class "A" Loads:

Note: All standard FAA flight regulations and flight manual procedures will be followed during class "A" load operations.

1. In the event the securing devices become disconnected or loose, a precautionary landing is recommended as soon as possible.

B. Class "B" Loads:

1. The pilot will brief all involved personnel on the capabilities and limitations of the helicopter in reference to the operation being conducted.

2. Each flight will be conducted at an altitude and on a flight path that will allow a jettisonable load to be dropped, and the aircraft landed in an emergency without hazard to persons or property.

3. During flight operations, the transmission line maintenance (TLM) foreman will ensure that the pilot is notified of any adjacent line condition, i.e. energized or de-energized, and will ensure that no personnel will be located under the line section during flight operations or on any structure that a line cart is being positioned on by the helicopter. The TLM will provide adequate training of personnel in the operation maintenance and hook-up procedures of all external loads.

4. Communications shall be maintained between the air crew and ground crew at all times. The signal man shall have the sole function during loading and unloading of signaling and maintaining communication with the pilot.

5. In the event of loss of communication all flight operations will cease until communication is re-established.

6. In the event of electrical failure, use the manual release to drop the cargo load. If any difficulties arise during the flight and an emergency landing is necessary, release the load immediately.

7. All emergency procedures will be followed as set forth in the Bell 206B3/L3 flight manual and FAA regulations.

Note: Better directional control may be realized by avoiding relative winds from the right front quadrant while performing external cargo operations.

C. Class "C" Loads:

Note: Refer to part II of this section for class "C"" applicability.

"ATTENTION". Under no circumstances will class "C" load operations, i.e. sockline pulling, be conducted adjacent to or in the vicinity of energized transmission lines. Local distribution lines are exempt for crossing purposes ONLY when proper wooden "H" frame crossing structures are in place. During class "C"" flight operations the TLM foreman will ensure that the pilot is notified of the adjacent line conditions.

Note: Pulling sockline of a non-conductive nature (i.e., rope or other non-conductive material) is authorized while adjacent to or in the vicinity of energized transmission lines.

1. Prior to each days operations the pilot will conduct a visual flight to thoroughly survey the line and adjacent area for ground and aerial hazards. Remember wire, especially static wire, can become invisible during certain lighting conditions.

2. The pilot will designate the order in which wires will be pulled.

3. No other socklines, hardlines, staticlines, or conductor will be winded up while the helicopter is pulling line through the same structures.

4. Under no circumstances should the pilot hook to a line near the base of a tower with the line running through the traveler. Back travel of the line can pull it into the aircraft rotor system. Allow sufficient line distance from structure for possible back travel.

Note: Because unusual attitudes are common during class "C" operations, the pilot must pay particular attention to fuel state and fuel consumption.

D. Class "D" Loads: Not Authorized

1. A placard bearing the following statement and visible to all occupants will be placed in the he cockpit of these aircraft:

   "This aircraft is approved for class A, B, and C external load combinations."

2. A placard stating the maximum class "C" exteranl load will be placed on both sides of the aircraft near the hook mounting location. The maximum load allowed is: 206L-3 2,000 lbs. and 206B 1,500 lbs.

# SECTION THREE

## I. SAFETY AROUND HELICOPTERS AND EXTERNAL LOAD EQUIPMENT

A. Personal protective equipment when working on, under or in the vicinity of helicopters:

1. All employees shall wear hard hats which shall be secured on the employees head by a chin strap.

2. All employees shall wear eye protection to prevent dust or other substances from contacting the eyes.

B. Wearing apparel: No employee shall wear clothing which can be expected to flap or react in the down wash of a running helicopter.

C. Loose gear and objects: All loose gear, including lunch boxes, rope, cardboard, wire covers, and similar items shall be removed or secured before the helicopter is started or allowed to approach said area.

D. Designated employees may come within 50 feet of the aircraft when rotor blades are turning, but no closer, other that to enter the aircraft, to hook, to unhook the load or to perform other essential functions.

E. Approaching the helicopter: Whenever approaching or leaving a helicopter with blades rotating, all employees shall remain in full view or the pilot and remain in a crouched position if within 50 feet of the helicopter. No employee shall approach the rear of the helicopter. All employees when working within 50 feet of the helicopter are subject to the direction of the helicopter operator. No employee shall enter or leave the helicopter unless and until the place at which they enter or leave is large enough for the helicopter to land.

F. Fires: Open fires shall not be permitted in any area in which said fire will be affected by the down wash of the helicopter, nor shall any employee smoke in an area subject to helicopter down draft.

G. Know emergency procedures: Ground and flight personnel should fully agree to and understand all necessary actions to be taken by all concerned in the event of emergency. This prior planning is essential in avoiding injuries when emergencies do occur.

H. Rigger training: External load rigger training is possibly one of the most difficult and continually changing aspects of the helicopter external-load operation. A poorly rigged cargo net, crossarm or ISCH could result in a serious and costly accident. It is imperative that all riggers be thoroughly trained to meet the needs of each external-load operation. Since rigging requirements may vary several times in a single day, proper training is of the utmost importance.

## II. DEFINITIONS AND ACRONYMS

### A. Definitions

<u>Rotorcraft-Load Combinations</u> - the combination of a rotorcraft and an external load, including the external-load attaching means. Rotorcraft-load combinations are designated as Class A, class B Class C and Class D. FAA regulation part I.

<u>Class "A" Rotorcraft-Load Combination</u> - one in which the external load cannot move freely, cannot be jettisoned. and does not extend below the landing gear

<u>Class "B" Rotorcraft-Load Combination</u> - one in which the external load is jettison able and is lifted free of land or water during the rotorcraft operation.

<u>Class "C" Rotorcraft-Load Combination</u> - one in which the external load is jettison able and remains in contact with land or water during the rotorcraft operation.

<u>Class "D" Rotorcraft-Load Combination</u> - one in which the external load is other than a Class A, B or C and has been specifically approved by the Administrator for that operation.

### B. ACRONYMS

| | |
|---|---|
| ISCH | Interphase spacer cargo hook |
| FSDO | Flight Service District Office |

APPENDIX ONE

CONGESTED AREA

# CONGESTED AREA PLAN

Name, Address, and Telephone Number of Operator:

Name, Address, and Telephone Number of Contractor:

Rotorcraft I.D. Number N:.

Rotorcraft Make and Model:

Rotorcraft Air worthiness Category (Normal):

Pilot Name and Certificate Number:

Dates and Times Operation will Begin and Terminate:

Name, title and telephone number of appropriate official of the local area who has agreed to exclude unauthorized persons from the operational area, if applicable:

Copy of agreement attached:.

List of streets and/or roads that will be blocked during operation if applicable:

To and from routes of flight:

Appropriate air traffic control facilities coordination:

Description and weight of loads to be carried: i.e.

| | |
|---|---|
| Length of: | Weight: |
| Attaching Means: | Quantity: |
| Class of Load: | Hook and Cable: |

Building description, address and telephone number.

Narrative and pictorial description of pick-up site, route, delivery site, emergency landing sites, and plan for ceasing operations if unauthorized persons enter area.

Signature of company official.

Title:

Date:

APPENDIX TWO
SAFETY OF FLIGHT AND
GROUND OPERATIONS BRIEFING

# SAFETY OF FLIGHT AND GROUND OPERATIONS BRIEFING

* WIRE CROSSINGS:

The safety of flight and ground briefing will include all of the following, if appropriate to the operation.

1. Aircraft maintenance personnel will be safety watchers during all flight operations.
2. Describe in graphic detail the hazards of approaching, departing and working near a running helicopter, i.e.
   a. Approach and departure direction
   b. Steep terrain main rotor hazards
   c. Tail rotor hazards
   d. Loose articles
   e. Throwing material

3. The helicopter will be shut down and the refueling unit properly grounded prior to any refueling operation. "Hot Refueling" will be allowed only during emergency operations. The pilot will remain at the flight controls during hot refueling.

4. Smoking is strictly prohibited in and around the aircraft and the fueling apparatus during all flight operations.

5. Discuss appropriate hand signals, (refer to appendix IV).

6. Weather. Due to the unpredictable nature of the weather, the pilot-in-command will be the final (go-no-go) authority for daily flight operations.

7. Ropes and or straps. Under no circumstances will ropes or straps be used as a direct cargo hook up to the helicopter cargo hook. Refer to external load rigging procedures in section two.

8. Personal protective gear, i.e. hard hats and eye protection. Refer to section three safety around helicopters for specific equipment requirements.

9. Emergencies. Any person observing any unsafe flight or ground activities shall communicate said situation immediately to the pilot and safety watcher.

APPENDIX THREE

OPERATIONS BRIEFING

## OPERATIONS BRIEFING

WIRE CROSSINGS!

The operations briefing should be conducted in conjunction with the safety briefing.

1. Hand signals to be used during the operations if required, (see appendix IV).

2. Radio communication during flight operations.
   a. The aircraft will be equipped to allow direct communication among required crew on a discrete channel that will facilitate minimal radio interference.

   b. All non-essential radio transmissions will cease during flight operations to allow clear communications between the aircraft the designated safety watchers and the supervisor in charge. For class "C" external load operations radio communications must be established between the ground crew and the pilot of the helicopter. The brakeman on the reel vehicle must have clear radio communications with the pilot.

3. Procedures to reduce or eliminate the types of electrical hazards associated with class B and C external loads, (see safety section III).

4. Present the capabilities and limitations of the helicopter in reference to the operations being conducted.

23

APPENDIX FOUR
HAND SIGNALS

## HAND SIGNALS

1. The signals between the signal man and the operator of the aircraft shall be reviewed and understood for each procedure or job.

2. Should there occur a change in the hazards, method of performing the job, signals to be used, or other operating conditions during the course of any external load operation, a conference shall be held immediately, at which time all affected personnel will be advised of the changes.

24

**HAND SIGNALS NOT INCLUDED IN THIS REPORT**

**Department of Energy**

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

February 7, 2002

In reply refer to: TC-Hangar

Mr. Roger B. Phillips
Federal Aviation Administration
Flight Standards Districts Office
1800 NE 25th Avenue, Suite 15
Hillsboro, Oregon 97124

Dear Mr. Phillips:

Please replace Mr. Art Ashton, Director of Operations with Mr. Michael W.L. Asher, Aircraft Services Manager. This change is effective immediately.

We are also resubmitting Form 8710-4 for renewal at this time.

Sincerely,

Wayne B. Noonan
Chief Helicopter Pilot

SUBMITTED
2-7-02
TO ROGER

## DEFINITIONS, ACRONYMS, ABBREVIATIONS

**AIB:** Accident Investigation Board.

**APM:** Accident Prevention Manual.

**Attitude:** The orientation of an aircraft's axis relative to some reference line or plane, such as the horizon. The position of the rotorcraft or suspended load with reference to a horizontal position, such as nose up or nose down.

**Ballast:** Heavy material used on a rotorcraft cargo line to enhance stability.

**Belly hook:** A device attached or suspended from an aircraft that is used to connect an external load to the aircraft through direct coupling or by lead lines; this unit has both mechanical and electrical locking/unlocking means.

**CFR 14 Part 133 (Rotorcraft External Load Combination Operation Manual):** The F.A.A.-approved manual prepared or utilized by the aircraft operator designating each rotorcraft model's limitations, performance, and procedures for which the airworthiness of the rotorcraft has been demonstrated.

**Class B rotorcraft combination:** A load combination in which the external load is jettisonable and is lifted free of land or water during the rotorcraft operation.

**Class C rotorcraft combination:** A load combination in which the external load is jettisonable and remains in contact with land or water during the rotorcraft operation.

**Clearance:** Assurance given to a worker by a System Dispatcher or Substation Operator that (1) specified power system equipment or a transmission line is isolated from the power system, and (2) it will not be ordered energized from the power system until that worker reports the crew in the clear and the equipment or line ready for service and the Clearance is released.

**Dead-end tower:** The tower at which the conductor and OHGW are terminated.

**De-energized:** Free from any electric connection to a source of potential difference; not having potential different than that of ground. The term is used only with reference to current-carrying parts that are sometimes alive (energized). To state that a circuit has been de-energized means that the circuit has been disconnected from all intended electrical sources. However, it could become electrically charged through induction from energized circuits in proximity to it, particularly if the circuits are parallel.

**Energy source:** The supply point of energy providing force to a system, which may require control or mitigation to avoid injury or damage.

**Energy source controls:** Physical or administrative measures put in place to help avoid injury or damage from an unexpected release of power or force from any energy source--mechanical, electrical, hydraulic or pneumatic.

**External lift or load operation:** Any operation involving a rotorcraft carrying an external load.

**External load:** A jettisonable load that is suspended from the primary hook (s) or other rotorcraft load attachment points.

**FM I:** Foreman One.

**FM III:** Foreman Three.

**Fly arms:** Outrigger arms that guide the sock line into the throat area of the traveler with spring-loaded gates to contain the line.

**Fusible breakaway link:** A device between the aircraft and the sock line manufactured with a predetermined breakage point to prevent overstressing the airframe. Also known as "weak link."

**Guard structures:** A temporary structure built of poles and sometimes ropes and nets. That is used whenever conductors are being strung over power lines and road and railroad crossings, and is normally constructed to prevent the conductor from falling onto or into any of these facilities in the event of equipment failure, broken lines, loss of tension, etc.

**Hold Order:** Assurance given to a worker by a System Dispatcher or Substation Operator that if specified power system equipment or a transmission line is de-energized, it will not be energized until that worker reports the crew in the clear.

**Hot crossing:** Any energized transmission or distribution line, which passes under or over another transmission line.

**Job briefing:** A formal group meeting that must cover hazards associated with the job, work procedures, special precautions, energy source control, personal protective equipment, and Clearances, Work Permits and Hold Orders.

**Job Hazard Analysis & Job Briefing Information Sheet:** Regionally mandated worksheet in use by field personnel to document job briefings.

**Kilovolt (kV):** Equals 1000 volts.

**Longline with remote electric hook:** The longline/remote hook system consists of suspension cable sections, a remote cargo hook, a remote-hook guard and handgrip, appropriate matching hardware and electrical pigtail. The pilot is able to electrically release loads attached to the remote hook.

**Levelwind:** A hydraulically controlled arm on a rope puller/tensioner used to force a line laterally on a reel, under tension, while being pulled in. The level-wind pushes and pulls the rope back and forth as the reel is turned and the line is retrieved. This prevents line from piling up in one spot on the reel

**Normally energized:** High-voltage power system equipment is considered "Normally energized" if it is energized or could be energized by closing an isolating device.

**OHGW:** Overhead ground wire

**Overhead groundwire (lightning protection):** Multiple grounded wire or wires placed above phase conductors to intercept direct strikes, protecting phase conductors from direct strikes.

**Payout:** Dispensing or unrolling rope from a reel.

> **Power payout:** Dispensing rope from a reel under operator-regulated hydraulic power at whatever speed appropriate to the pull.
>
> **Free-wheel payout:** Dispensing rope from a reel without applying power. Reel movement is supplied from the rope being pulled by an external force, such as a helicopter.

**Pulling line:** A high-strength line, normally synthetic fiber or rope, used to pull conductor. However, on reconstruction jobs where a conductor is being replaced, the old conductor often serves as the pulling line for the new conductor. Then, the old conductor must be closely examined for any damage prior to the pulling operations.

**Puller/Tensioner:** A device designed to pull conductor during stringing operations. It is normally equipped with its own engine, which drives the drum(s) mechanically, hydraulically or through a combination of both. It may be equipped with synthetic fiber rope to be used as a pulling line. The pulling line is paid out from the unit pulled through travelers in the sag section and attached to the conductor. The conductor is then pulled in by winding the pulling line back onto the drum. This unit is sometimes used with synthetic fiber rope as a pilot line to pull heavier pulling lines across canyons, rivers, etc.

**Remote hook:** A means for releasing the external load from the aircraft. At the end of the cable is a remote electric hook, similar to the cargo hook on a helicopter. An electrical line runs the length of the cable and is plugged into the electrical system of the helicopter. The other end is plugged to the remote hook. The hook is self-cocking (that is, returning to the latched position after the electrical release signal is removed).

**Sag:** The amount of tension along a power line. The distance that the power line bows below a designated horizontal reference.

**Signalman:** Designated individual responsible for communication between the ground crew and pilot. A designated individual who through radio, intercom or standardized hand signals can direct the pilot-in-command when a load is being lifted or set in place.

**Snag:** Anything that impedes or prevents passage, such as a sudden impediment or obstruction preventing wire or rope from unrolling off a reel.

**Sock line:** A lightweight line, normally synthetic fiber rope, used on a puller to pull heavier pulling lines that, in turn, are used to pull the conductor. It is the first line pulled through in a stringing operation. Sock lines may be installed with the aid of finger lines or by helicopter when the insulators and travelers are hung. Also known as pilot line, finger line or lead line.

**Static charge:** Any electric charge at rest, most commonly created by friction between materials, that allows electrons to build up or become depleted when the materials are separated. The amount depends on the degree of friction, the composition and conductivity of the materials involved and the relative humidity of the environment.

**Static discharge:** The rapid release of electrons when a charged surface comes in contact or close proximity with a material that has a different electrical potential, causing a transfer of electrons between the two materials.

**Stringing:** The pulling of pilot lines, pulling lines and conductors over travelers supported on structures of overhead transmission lines. Quite often, the entire job of stringing conductors is referred to as stringing operations, beginning with the planning phase and terminating after the conductors have been installed in the suspension clamps

**Suspension tower:** A tower designed to support conductors strung along a virtually straight line with only small turning, descending or ascending angles. Approximately five suspension towers are used to a mile; tangent towers have no turn angle; angle towers have light or heavy turning abilities.

**Tailboard:** A term used to describe the crew briefing conducted prior to the beginning of the job. The tailboard is mandatory and must be attended by all workers, including the helicopter crew. Sometimes called “tailgate.”

**Tension stringing:** The use of pullers and tensioners to keep the conductor under tension and positive control during the stringing phase, thus keeping it clear of the earth and other obstacles that could cause damage.

**Tension:** A force tending to stretch or elongate. The condition of so being stretched, or tautness. A measure of such a force, as in "A tension on a cable of 50 pounds."

**Tensioning:** Pulling conductors to the correct sag so that proper ground clearance is maintained. Also insures that supporting structures are not overloaded under ice and wind.

**Terminal:** The equipment used to connect a line or transformer into a substation.

**TLM:** Transmission Line Maintenance.

**Tower ladder:** A ladder complete with hooks and safety chains attached to one end of the side rails. The ladder is suspended from the arm or bridge of a structure to enable workers to work at the conductor level to hang travelers, perform clipping operations, etc.

**Transmission:** In power system usage, the bulk transport of electricity from large generation centers over significant distances to interchanges with large industries and utility distribution networks.

**Traveler:** A sheave complete with suspension arm or frame used separately or in groups and suspended from structures to permit the stringing of conductors. These devices are sometimes bundled with a center drum or sheave and another traveler and are used to string more than one conductor simultaneously. For protection of conductors that should not be nicked or scratched, the sheaves are often coated with nonconductive or semiconductive neoprene or nonconductive urethane. Any one of these materials acts as a padding or a cushion for the conductor as it passes over the sheave.