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in the DOING IT COLD

OPERATORS IN COLD CLIMATES FACE CONSIDERABLE CHALLENGES WHEN TRYING TO ENSURE THEIR HELICOPTERS WILL CONTINUE TO WORK WHEN THINGS GET FRIGID.

by Gary Watson

Now Sam McGee was from Tennessee,
where the cotton blooms and blows.
Why he left his home in the South
to roam 'round the Pole, God only knows.
He was always cold, but the land of
gold seemed to hold him like a spell;
Though he'd often say in his homely
way that "he'd sooner live in hell."

In 1907, Canadian poet Robert Service got it correct in his poem *The Cremation of Sam McGee* when describing the bone-numbing cold and mental anguish that accompanies extremely cold weather.

When you've worked in temperatures below minus 40 degrees, it is difficult to describe the experience to those who live in warm climates. For example, try telling someone in Florida that metal will start to change properties in temperatures below -55 C (-67 F) and that items on a helicopter will break or cease to function simply because they are outside the original design temperature specifications that were established in locations such as Arizona, Texas or the south of France — their eyes will glaze over in disbelief. The final blow comes when you tell them that minus 40 seems like t-shirt weather after a day at -55 or -60 C. These temperatures are incomprehensible unless you have experienced them.

*On a Christmas Day we were mushing
our way over the Dawson trail.
Talk of your cold! through the parka's
fold it stabbed like a driven nail.
If our eyes we'd close then the lashes
froze till sometimes we couldn't see;
It wasn't much fun but the only one to
whimper was Sam McGee.*

The Klondike Gold Rush in Canada's Yukon Territory — the setting for *The Cremation of Sam McGee* — was the world's last great gold rush. Its lure motivated prospectors to endure harsh temperatures. In Service's poem, Sam McGee succumbs to cold and despair, but not before the narrator promises to honor Sam's last request: to be cremated. After hauling Sam's corpse along the snowy trail, the narrator cremates him in a derelict boat on Lake LeBerge — only to find his ghost "looking cool and calm in the heart of the furnace roar"; happy and warm for the first time since leaving Tennessee.

A century later, in Northern Canada and Alaska, "black gold," natural gas, base metals and even diamonds draw

modern prospectors to the same cold climate. Today's prospector, though, is definitely better equipped — with GPS receivers, satellite phones and a far more efficient mode of transportation: the helicopter. But, unlike the husky and malamute dog teams of old, the helicopter is not genetically suited to the extreme cold.

In designing helicopters to operate in moderate to hot temperatures, aircraft manufacturers have made maximum cooling of components and the cabin a priority. And while all helicopters have specifications for operation at lower temperatures, this doesn't mean they're 100 percent suitable for extreme cold-weather operation. As such, over the past 60 years, helicopter operators in the "Great White North" (a.k.a. Canada) have developed special modifications, equipment and procedures.

COLD-WEATHER CONCERNS

To operate in extremely cold weather, helicopters have several unique requirements. The first is to be capable of starting without any internal damage; the second is to be able to keep running; and the third is to be maintained in a condition so requirements 1 and 2 can be met. Operating out of a hangar is the ideal solution for starting helicopters on a cold day, but this is not always an option when winter contracts entail medevac duties, or supporting a seismic crew or an exploration project.

In many cases, a helicopter's low-end operating temperature is determined by the ability to keep engine oil within acceptable limits. The Sikorsky S-61, for instance, shows -40 C on its performance charts, but minimum allowable oil temperature is -54 C. In the past, operators would keep flying until they were absolutely unable to function. In today's world, the cutoff temperature for flying is more frequently based on passenger and crew safety than helicopter capability.

For Era Helicopters in Anchorage, Alaska, that cutoff temperature is minus 40 degrees, according to Doug Jager, quality assurance supervisor. Era operates Eurocopter AS 350s, Bell 212s and 412s, and AgustaWestland AW139s in support of the oil and gas industry. With the luxury of working from a warm hangar, Era has been able to ensure that its helicopters are not cold-soaked prior to flight. As a result, the company has not done anything specific to its fleet beyond incorporating the manufacturer options for cold-weather operations.

When a helicopter sits outside in the winter, it becomes

Cold-weather operations can take a toll on helicopters and personnel alike. **Graham Harrop Illustration**

cold-soaked: different metals in its components shrink at different rates, oil thickens and battery capacity is greatly reduced. The colder it is, the greater these effects. To reduce the chance of damage, engines require pre-heating before starting. Originally, this was carried out using external heaters, in-car warmers or even charcoal heaters. These haphazard methods occasionally resulted in the helicopter becoming part of the heat source (i.e., it caught fire). Fortunately, specific pre-heating products are now available for most helicopter models, and operators have a variety of certified products to attach to the engine, battery and transmission.

Pre-heating is critical, because even if you escape component damage when starting up a cold-soaked engine, other issues can arise later. Said Dirk Ellis, systems engineering manager at Tanis Aircraft Products: "I have seen a number of engines blowout filter oil seals and hydraulic lines due to congealed oil. The latest was an emergency medical service helicopter — thankfully a twin The engine's oil filter seal blew out while en route to pick up a patient. The pilot was performing a walk-around while the patient was being loaded and noticed his approach track was trailed in oil. Fortunately, this leg of the flight had only been eight minutes." Ellis pointed out that sometimes the best thing that can happen if you have not pre-heated a cold-soaked engine is that it does not start.

The thing to remember when pre-heating cold-soaked helicopter systems is that doing it properly takes time — but it increases safety and saves time and money later.

some insight on starting helicopters in cold weather, we asked Charlie Hoeller, Trans North's director of maintenance, to share his tactics.

Said Hoeller: "We try to keep them in the hangar, if possible, and try to have all our winter contracts work from these locations. We pay particular attention to door seals and have replaced most of our Janitrols with bleed-air heating systems: they keep the helicopter warm, are lighter and [have] very low maintenance. If we have to leave the helicopter outside, we ensure it is completely enclosed with covers. Prior to starting, we will run an EC 200 heater [from Cantherm] for half an hour to warm up the engine and transmission. On the initial start, the pilot will shut the engine down partway through the cycle, wait five minutes, then restart The second start will be a complete sequence with less chance of oil starvation or other cold-temperature damage." Waiting those five minutes allows the initial engine heat to warm up the oil and other components.

When it comes to heaters, Herman Nelson is a favored name among engineers/mechanics. With its worldwide market, Aerotech Herman Nelson is the largest portable combustion heating company in the world. Another popular

Because they work from a warm hangar, Era Helicopters in Anchorage, Alaska, has not done anything specific to its fleet beyond incorporating the manufacturer options for cold-weather operations.

Era Photo

A WORD TO THE WISE

Trans North Helicopters in Whitehorse, Yukon, has been flying a wide variety of helicopters from its seven well-established bases since 1967. To say it is cold-weather wise would be an understatement. To give our readers



company, though, is Cantherm Distributors, which also builds heaters and has several small, light-weight units suitable for helicopter use.

Portable heaters provide huge amounts of hot air and make cold-weather operations possible. They are used everywhere when carrying out maintenance — usually with some type of shelter, but sometimes just jammed into a helicopter. (In the latter case, the trick is to make sure you keep moving the hose around.)

The first portable heaters I worked with many years ago used gasoline for both the combustion fuel and to run an often-cranky gas engine that provided the air movement. The fuel tank sat atop the combustion chamber, and, as the fire got going, the heat would radiate into the fuel tank, vaporizing the gas for better combustion. It still amazes me that only a few of these units caught fire or blew up. Modern versions mainly burn jet fuel or diesel, have a very reliable gas engine or use an electric motor, and are much safer and easier to start and operate.

The thing to remember when pre-heating cold-soaked helicopter systems is that doing it properly takes time — but it increases safety and saves time and money later. Said Ellis: “In order to decrease the chance of internal damage, all the systems of the helicopter’s drivetrain need to be thoroughly brought up to temperature, not just surface heated for a short period with forced air. Thermal stress in the C-section is a function of both peak temperature and time of exposure. Proper pre-heating reduces both and yields a second-order reduction. Any time you can reduce spool time, you, in turn, decrease stress on all the associated mechanical and electrical systems.”

PISTON PROBLEMS

Piston-engined helicopters are even more troublesome than turbines in the cold. And, while the early piston-powered Bells, Hillers and Sikorskys have been replaced by turbine models — which are easier to start when cold-soaked — the rising popularity of Robinsons have returned the piston engine to cold-weather operations.

Starting a piston engine in cold weather is particularly difficult: its slow cranking speed, combined with gasoline that has failed to atomize properly and a degraded battery, should be familiar to anyone who drives a car in a cold climate. Then, once the helicopter is in flight, the airflow will create other critical concerns.

Helicopter designers have gone to great lengths to ensure their products are well-ventilated, minimizing engine, transmission and other component temperatures. In northern climates, these features are the bane of cold-weather operations. Consider oil temperature: on the ground prior to takeoff it might have been within limits, but at

Why Pre-Heat

Starting a helicopter in the extreme cold is not a quick operation. A number of obvious and not-so-obvious bad things can happen when the helicopter is not properly pre-heated. By adding some type of supplemental heating, engine and hydraulic systems benefit, excessive wear and tear of components is reduced, and the workload on the engineer/mechanic is decreased. The benefits of pre-heating include:

1. Easier rotation for starting. (If the engine is piston-powered, the most obvious result of not pre-heating is the failure to turn over fast enough to start. For a gas turbine engine, it's a hung start and over temp.)
2. Improved fuel vaporization, resulting in a more uniform ignition flame in the cylinder, minimizing crank time.
3. A warm battery, particularly a lead-acid type, which will produce more cranking amps.
4. Better viscosity of engine oil, which will also allow easier starting, particularly with piston engines.
5. Having dissimilar metals within an engine better maintain their critical tolerances, reducing the possibility of internal damage that could escalate at a later date and result in a catastrophic failure.
6. A reduction in the possibility of higher-viscosity engine oil preventing proper oil circulation.
7. Minimizing the time required, once the engine is running, for a thorough warm-up of the helicopter prior to control checks. This reduces the chance of servo leaks or other hydraulic problems.

cruise speeds the engine usually produces less power, so less heat is available to keep the cabin warm and ensure engine and transmission oils stay at a safe operating temperature. On a gas turbine, this is not as significant because the turbine's constant r.p.m. ensures a fairly stable operating temperature. Piston engines, however, run at lower revolutions per minute, so the entire engine will start to cool. And, engine oil coolers will be working at extreme efficiencies, so the oil will start to thicken, causing reduced oil flow, or, eventually, oil that doesn't move at all. A means of bypassing the oil cooler or restricting the airflow to the cooler is critical in this situation.

In the past, operators used their creativity to keep piston helicopters warm. For instance, all cooling openings were plugged with pieces of foam or taped closed with duct tape, and additional temporary ducting was added to help keep the windshield clear. Recognizing there had to be more effective methods to winterize helicopters, some operators, maintenance organizations and suppliers developed and certified aircraft-specific winter kits, making

cold-weather operations safer and more efficient.

Airborne Energy Solutions in Whitecourt, Alta., is one operator that has developed cold-weather products for its ships, having become an expert on operating Robinsons in the cold. "We worked in conjunction with DART Aero to design and certify a baffle kit that attaches to the outside and limits airflow to the fan," said Rob Wharf, Airborne's director of maintenance. "The [R44] Raven II has two oil coolers; we developed an STC'd [supplemental type certified] blanking plate to completely cover the smaller cooler, and currently we are developing another hinged blanking plate that will allow the pilot to adjust the airflow to the larger oil cooler. We hope to test the product this winter and have it approved. We are constantly designing new products for the entire Robinson line to improve their operation in our climate."

Airborne has a cutoff temperature for operation of -25°C (-13°F), but occasionally will operate at -27°C . "We are extremely careful about cold-weather operations," said Wharf, "and ensure that we know where our helicopters are at all times. If the machine requires maintenance, we will fly it to one of our bases. If it is an AOG [aircraft on ground] situation, we will fly out shelters and heaters."

Other companies that can help include Tanis, which makes complete pre-heat systems for all piston helicopters, heating everything from avionics to hydraulics, including the tail rotor gearbox.

WARM, INSIDE AND OUT

Staying warm inside the aircraft is also a critical element of cold-weather operations. Larger helicopters are often equipped with a Janitrol, South Wind or C&D Airmotive combustion heater. Keeping the cabin and cockpit warm is necessary for crew and passenger comfort, windshield visibility and avionics operation. Cold feet and wind-

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AEROTECH HERMAN NELSON

The de facto world standard for portable heat for the aviation industry, with products ranging from large wheeled units to small portable ones ideal for helicopter operations. (Visit www.herman-nelson.com or call 1-877-884-2376.)

CANTHERM DISTRIBUTORS

Another source for portable heating products, including the lightweight EC 200 and EC 400, which are particularly popular with operators of smaller helicopters. (Visit www.canthermheaters.com or call 1-800-661-WARM.)

CANADA GOOSE

Parkas and other cold-weather clothing items that resist "stabbing" cold. (Visit www.canada-goose.com or call 1-888-668-0625.)

C&D ASSOCIATES

Builds the C&D Airmotive heater, a direct OEM replacement for original Janitrol or South Wind heating units. (Visit www.aircraftheater.com or call 1-269-695-7469.)

DART AEROSPACE

Sells a number of cover sets for almost every helicopter make and model, and heating kits for the Bell 206 series that improve cabin/cockpit air temperature and circulation. Also markets an oil-cooler intake baffle kit for the Robinson R44. (Visit www.dartaero.com or call 1-613-632-3336.)

GREEN MOUNTAIN AVIATION PRODUCTS

Makes custom-fitted helicopter covers. (Visit www.greenmountainaviation.com or call 1-877-435-4468.)

PARAVION TECHNOLOGY

Bleed air heater and defroster systems for Bell 206s and 407s, custom winter heater systems and snow deflectors. (Visit www.paravion.com or call 1-970-224-3898.)

SHENEY & CO. AVIATION COVERS

Offers a variety of helicopter covers for popular makes and models. (Visit www.sheneyco.com or call 1-888-9SHENEY.)

TANIS AIRCRAFT PRODUCTS

Builds a wide variety of preheat systems for almost every helicopter make and model, and has a broad selection of options depending on customers' specifications for engines, main gearboxes, accessory gearboxes, oil coolers and other components and systems. (Visit www.tanisaircraft.com or call 1-800-443-2136.)



In many cold-weather operations, pre-heating is critical.
Tanjie Cowan Photo

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shield icing seem to be the biggest challenge, so some new heating kits specifically address floor heat and windshield de-icing. Companies such as Paravion build very efficient bleed-air kits that keep the cabin warm without any excessive weight or performance issues.

Once a helicopter is back on the ground, or if it hasn't flown due to extreme temperatures, the engineers/mechanics take control and begin their day. If they're lucky, ground facilities will include a hangar or a large tent to enclose the entire helicopter. Unfortunately, this is not always the case and "snow-drift maintenance" becomes part of their challenge. Inspections and snag repairs must still be carried out, and the aircraft must be protected from the elements in order to carry out the next day's flying.

After all the appropriate covers are installed, routine maintenance begins. A variety of fabric shelters are

erected, depending on the helicopter's size and the budget of the operator. The battery is often removed and taken inside, and the engineer, eyes and nose running, fingers stiffening, body bundled up with every piece of clothing available, begins the complex and intricate tasks needed to ensure the aircraft is in prime operating condition in time for the pilot to borrow it the next day.

Operating and maintaining helicopters in extremely cold weather is not a job for the faint-hearted — or the warm-blooded Sam McGees of the world.

Gary Watson has decades of hands-on experience in both fixed and rotary-wing aviation maintenance. He currently teaches avionics and human factors at SAIT Polytechnic in Calgary, Alta., and can be reached at gary@verticalmag.com.

