



The NStar Chronicle

The Project North Star Association of Canada

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Editor's Notes

Roger Button

In this issue we are recognizing the completion of a very important step in the restoration of the North Star, namely, its Merlin engines, and our members who have volunteered with CASM to carry out the necessary work. This is a very informative issue and I am sure we will all learn a great deal. I was not aware, until putting this edition together, that the Merlin designation was in keeping with the custom of Rolls Royce to name its aircraft engines after birds of prey.

The article, "Four Merlins" provides the reader with a detailed history of the restoration of these engines. Due to its length, the article will be divided into two editions; starting with engines number one and two in this edition; and three and four in the next edition. We are fortunate to have members who have had lengthy involvement with this part of the project. Sadly one of those members passed away recently. Inside you will find a tribute to Tim Timmins by the President of our Association.

We look forward to receiving your comments and suggestions regarding this edition and for future editions whether good, bad or ugly. Please use my email address located on the back page.

Good reading.

PNSAC

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Notes from the President

Richard Lodge

As always, before I start to write the Notes from the President, I reread my previous Notes to remind myself of what I had previously said in order to set the record straight if necessary. As I write this at the beginning of September, I am now aware of the impact of the COVID-19 pandemic on the restoration schedule for the North Star and the operations of your Association.

Since March, restoration work on the aircraft has been suspended and the activities of the Association have been limited. We have, however, been keeping in touch with each other through the weekly Zoom meeting organized by the Museum's volunteer co-coordinator Cédric St.-Amour. This virtual meeting takes place every Thursday at 10 AM EST; it is open to all our volunteers and any other PNSAC members who would like to join in.

As previously reported, the North Star project reached a major milestone with the completion of the restoration of Engine #4 which was moved into the reserve hangar on a cold December 2019 morning.

Since we are unable to physically meet and there has been no restoration work carried out, we felt that a special issue of the NSTAR Chronicle devoted entirely to the 15 year restoration of all four of the Merlin engines would be of interest to members.

Understandably, with a project which has taken many years, the volunteers working on the engines have changed over time. Some have retired

or stopped volunteering and sadly, some have died. Earlier this year we asked Ted Devey to contribute a piece but before writing about his work, he passed away. Ted was involved with restoring all the engines and for several of the early years was the volunteer leading the restoration team. Ted was a great raconteur and our oldest volunteer at 93 years old. His recollections would have added considerably to the interest of this special issue of the NSTAR Chronicle.

After much consideration, the Museum has decided that volunteering cannot restart before January 2021. Until then we will continue with our regular Zoom meetings and will also organize a virtual Annual General Meeting for the Association. We will also continue to provide updates on the situation and much will depend upon how the different levels of government handle the ongoing recovery from the pandemic.

There is an old saying "That it is an ill wind that blows nobody any good." This is very true even of this pandemic. One of the very pleasant results is having conversations with PNSAC members who don't reside in the National Capital area and have sent membership renewals by mail. Where a renewal has been received and confirmation has been delayed as a result of the pandemic, I try to call a member on the telephone to explain what has happened and that the renewal has not been lost. As a result I have had many interesting phone calls with people whom I have never spoken to before. A definite bonus for me.

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Remembering Austin (Tim) Timmins 1928-2020

Richard Lodge



Austin (Tim) Timmins.

We were all very sorry to hear that our second President and also Life Member, Tim Timmins, had passed away on September 7th. Tim was a founding member of the Project North Star Association

of Canada and one of its original directors. He was an active member of the small group of aviation enthusiasts who worked for many months with the Canada Aviation & Space Museum to negotiate a groundbreaking arrangement to restore Canada's sole remaining North Star aircraft to a standard suitable for display in the Museum.

Tim became a dirty hands volunteer in the early years of the project and was involved in the often difficult and usually very dirty initial restoration work on the aircraft. He will have taken part in "bird nestling" when volunteers spent many hours removing years of bird nest debris from various parts of the aircraft.

Following the untimely death of our first President, Robert Holmgren in October 2007, Tim agreed to become our second President. He held this position until June 2000 during which time he was instrumental in helping the Association move from a fledgling operation to a respected part of the Aviation Museum's volunteer team.

Many of us will remember Tim's cheery smile and the long hours he spent talking to members of the public during the Museum's open days and public events. He always had anecdotes and stories to tell of his time in the RCAF as a navigator on the North Star.

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Conservator's Corner

Réjean Demers, AME—Conservator Special Project Manager Canada Aviation & Space Museum

When touring the shops in the Museum's Conservation wing, the engine shop is reserved for what is referred to as, the "Crown Jewel". Guests are lead through the corridor and the lights are flicked on to reveal a shining piece of aeronautical engineering and craftsmanship. The Merlin 622 engine, one of four such power plants, sits resplendent. Gasps and expressions of delight from guests are guaranteed to insight a prideful glance upon this piece of work by volunteers and staff alike. Appearing as if the engine had just been delivered from Bristol Aero Ltd. is an illusion. What is this strange magic? How can such beauty manifested though steel and aluminum

even exist? As any good sorcerer will tell, illusion is lost upon the dissolution of mystery. Yet this piece of work, a restoration of great effort, time and detail, cannot shed the cloak of timelessness so easily. The result of thousands of hours culminate through unrelenting intrigue, garnered by all who cast eyes upon the Merlin. These words simply scatter as embellishments to the enduring design and purpose, which cannot be hidden in all evidence of its greatness.

Referencing an Ottawa Citizen article dated Saturday Feb. 1st, 2003. We read of an effort to restore the Canadair North Star to a version of her "former self" as PNSAC founder Robert Holmgren put it. A sad, sorry state at the time. Destitute to serve as a bird house to the starlings. No mention of any spells enacted to summon the aviation gods or mojo hand placed upon the yoke to stir the spirits which have tilled the air. Yet today, she's a Hangar

Queen, patiently awaiting final installation of engine #4. Is this sorcery? No, simply the fourth iteration of the Project's labour of love; Rolls-Royce Merlin 622, Serial #309573. The task of accomplishing the finale to a four part, long haul repeat restoration of a power plant began in 2014. Looking back at power plant restoration cycles, we see the evolution of the Project North Star volunteer organization since the early 2000's. The forming of Engine Shop crews and the establishing of Crew Chiefs. The coordination of daily grunt work of condition recording, treatment and reassembly of components. Today, members of the project continue to develop ideas, adapting to new technology, finding different approaches and maintaining a solid work ethic. This spirit remains unchanged throughout difficult times and challenges we have encountered.

The Tech. log states: Engine installed on North Star 17515 on August 23rd, 1965 at airframe Total Time of 19845.45 Hrs. with 1121 hours remaining in #4 position (4th to the right). The engine had previously flown on 17514 until April 30th, 1965 when a broken intake valve #1 cylinder, "B" bank necessitated a repair. Flipping through pages, various signatures, authorities, stamps and markings show evidence of a storied service life going back to 1948. Engines are shared among power plant "skeletons" which in turn, are shared across the fleet. This was one of the major design features of the "Power Egg" as the promotional material of the day had put it, interchangeability and ease of maintenance. A glance at the log tells me this engine serial number served on North Stars 506, 510, 508 and 502 to name a few. The last remaining example of its type, North Star 17515 holds pieces of the past, belonging to aircraft that have long been gone. Like crew members who have also shared their time amongst a fleet that traveled all over the globe, with change-overs, turn-arounds and plenty of distance in-between.

One of the big pay-offs for members of Project North Star is the opportunity to display the work carried out by volunteers. Many occasions come to mind, such as Canada Day, Doors Open Ottawa and family visits to the Museum. One opportunity, of which I will always be grateful to have participated in, was such a moment. Myself and a few volunteers

met a retired employee of the aforementioned Bristol Aero Industries Ltd. who worked at the overhaul shops when this engine was undergoing acceptance runs in the early to mid-sixties. Quickly, job experience and familiarity with the object was brought forward. A quick look under the cowling to reveal preserved markings and decals, evidence of original repair shop work was pointed out. "I probably worked on that job" he said. I understood at this point, how someone's work, preserved in such a way, could be of intangible value. The history coming around full-circle before my eyes, as the gentleman pointed out the ROLLS-ROYCE cast upon the rocker covers, saying "it was one of my first jobs, painting on those red letters".

These records, object qualities, historic log entries and our treatment reports all add up. We string together these bits of information to form longer chains that communicate the history of an artifact. As focal points shift towards other areas of interest, or priorities, work carried out in the past helps maintain a continued relevance for others to pick-up where we left off. With such a long term project, setting the pace is just as important as taking a break now and then. Knowing that we had an impact and remembering the experiences we've shared can carry us through new challenges. It's a pleasure for me to observe a new volunteer work towards acquiring the skills that may be passed on to others, like an old wizard speaking to his young apprentice.

I encourage Project North Star members to communicate their interest in the project to the public. Generate their own records that may contribute to the history of the machine and the lives it affected. This newsletter, social media and other forms of reaching out to the public are excellent ways to remember one of Canada's great contributions to air transport. With the tools at our disposition, I would not hesitate to believe we can create many new and engaging experiences for the public to learn about the role this aircraft undertook while in service. Now, in continuation with a sense of national pride, the North Star remains an important platform for interpretation of the work carried out by dedicated volunteers supported by a museum that understands the value of such an artifact.

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Our Members

Readers of the Chronicle will know that this item usually refers to one of our members. This edition, however, salutes all of our members who worked as volunteers on the restoration of the North Star engines namely:

- Charles Baril
- John Corby (deceased)
- Ted Devey (deceased)
- Ed Hogan
- Peter Houston
- Ron Lemieux
- Richard Lodge
- Wib Neal
- Jim Riddoch
- Stan Rideout
- Ted Slack
- John Tasseron
- Bill Tate
- Tim Timmins (deceased)
- Giuseppe Zanetti

The following members have provided comments on their personal experiences.

Charles Baril

Working on all 4 Merlin engines has been an extremely rewarding experience that has taught me a lot about older technology, an appreciation for history involved (and those in the engine crew with that knowledge) and learning new skills and techniques. Although most of the parts were auxiliary systems, seeing them as part of the full engine gives a sense of accomplishment. It is very satisfying to see a part going from the dirty, oil covered, rusty part to newly refurbished one that looked like it was overhauled in an RCAF maintenance depot. It has been an honour to be part of this project and restoration of these pieces of history.

In particular I remember working on the lower cowling flaps. Trying to undo the inner skin was difficult due to longer rivets through the mounts for the flaps. It took several tries and a few extra holes, but it was done. Fixing those holes often meant using

original methods which was revealing and a commitment to historical methods.

I also recall the work on the filter ducts. The filter duct is the last stage of the air intake before the supercharger. During its cleaning, there was a starling nest on top of one filter. This caused a lot of corrosion damage that needed to be removed and treated. Yet, what got me was that starlings could get that far into the engine.

Richard Lodge

As probably the only volunteer who ever worked in the Aero Engine Division of Rolls-Royce in Derby, England, I was greatly interested in becoming involved in Project North Star, even though, as an accountant, I had never worked on the design or building of an aeroengine. By the time I started work at Rolls-Royce in 1963, new build of Merlin engines had ceased, and only spare parts were being manufactured.

I have several strong memories of working on the Merlin engine. In general, I particularly remember John Tasseron working endlessly on freeing seized piston rings. I learned much from John about patiently working at something which appeared to be impossible! Later, when working with Réj Demers and Garry Dupont, I started to learn how to rivet and how to lock wire. The most important lesson for me has been, photograph, photograph, photograph, at each stage of dismantling, cleaning and reinstalling an engine part. When sitting in an overcrowded office at Rolls-Royce, it never occurred to me that at some time in the future I would actually be working on a Merlin engine or working my way through an original parts manual to work out how to reassemble an item. Life is certainly full of interesting surprises.

John Tasseron

The list below is intended to give a brief overview of the various highlights that arose during my participation in the restoration of the second, third and fourth Merlin engines:

1. It's not every day one gets the opportunity to see up close what makes the Rolls-Royce 620 Series Merlin engine tick!
2. It's a real challenge to safely lower each "power egg" down off the wing, place it in "the big blue stand" and move it in to the workshop.
3. Then starts the process of carefully separating about 11,000 individual parts before cleaning, inspecting and re-conditioning them as necessary. Do not lose any and make sure everything is photographed for museum records!

4. When things unexpectedly go wrong, the real expertise kicks in to perhaps develop a repair scheme or even manufacture a brand-new replacement part. The objective is to bring everything back together again and end up with a "like new" engine, ready for preservation.
5. It all takes team effort based on effective communication and co-operation. There are no

dumb questions and the answers are all aimed at the challenge to create an "airworthy" product that will never fly.

6. Finally, it's important and fun to share the project with a curious public, so be ready to answer any questions that might be asked about the aircraft and its engines!

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The Four Merlins: The First Two

Bruce Gemmill

When North Star 17515 was retired from service with the RCAF, it was delivered to the National Aviation Collection at Rockcliffe in 1966, where it sat exposed to the elements for many years. When a volunteer group was formed in 2001 to restore the aircraft, the priority was to move the aircraft inside the newly constructed Reserve Hangar to prevent further deterioration. This was accomplished on August 11, 2005 when the North Star was moved inside for the first time.



North Star being moved inside hangar 11 August 2005 .

The restoration project attracted many aviation enthusiasts and the early group of volunteers were eager to work on restoring the four Rolls Royce engines. The Canada Aviation Museum (as it was then called) agreed and set this as the top priority for the volunteers. Work started in earnest in 2006 under the supervision of the Museum's Project Coordinator, Mike Irvin.

This is the detailed history of the restoration work on the first two Merlin engines.

Engine 1

The removal, restoration and assembly of Engine Nr 1 began in June 2006 and was completed in Feb 2010 with the installation of the engine back on the North Star. This work included a complete teardown and re-assembly of all major components including the Merlin V12 engine, propeller, supercharger, intercooler and auxiliary gearbox, as well as the engine frame, cowlings, radiators, pipes and accessories.

Before the engine could be removed, the propeller and spinner cover needed to be removed. The spinners were popular nesting sites for birds, and the bird droppings had caused extensive corrosion to the propeller hub. To remove the hub, a large wrench was fabricated to fit over the large, threaded ring that held the hub firmly in place. This was struck repeatedly with a 5 lb sledge hammer before the ring began to move. This process was repeated each time a propeller was removed. The propeller was then disassembled and sent to Hope Aero in Mississauga, Ontario for restoration.

Engine 1 was removed and mounted in a mobile assembly stand and moved to the conservation shop for inspection disassembly. Since this was the first Merlin engine any of the volunteers had worked on, much time was taken photographing the engine from all angles, and studying the Repair and Overhaul manuals that the RCAF and Rolls Royce had provided. The digital photographs were also an important conservation record for the museum.

Each engine is contained within a Quick Engine Change (QEC) assembly or power pack. This consisted of a rigid frame to hold the cowl panels which surround the engine, and also hold such vital parts as the two radiator flaps, the three piece radiator itself, and support the fire suppression system and various pipes and hoses. This frame also holds the four attachment points to secure the engine assembly to the aircraft.

The cowl panels were removed, along with the support frame, to expose the engine. Large amounts of nesting material were removed, even though mu-

seum staff had attempted to "bird-proof" the aircraft while outside. Old engine oil was drained from the crankcase, and the volunteers began familiarizing themselves with the numerous parts of the wonderful V-12 Merlin engine they would work on for the next four years.

Along with learning the intricacies of the Merlin, a substantial number of special tools and jigs needed to be found or made. This began with a full set of British sockets and wrenches for the Whitworth and BA nuts and bolts used throughout the engine.

When it came time to remove the cylinder head, the volunteers found the pistons were seized in place. To free up the pistons, large amounts of penetrating oil was applied, then each piston struck with a large sledge hammer and block of wood.

While this work was going on at the museum, Hope Aerospace in Mississauga was restoring the first of the four Hamilton propellers sent to them under contract. The first propeller was returned from Hope Aero after restoration in 2008, and Mike Hope volunteered his time to help assemble it.



Mike Hope and Bruce Gemmill assembled Prop 1 ready to install on Engine 1 October 26, 2008.

By early 2009, most of the main engine components had been cleaned, and painted or polished, ready to be assembled on the completed engine block and cylinder banks one and two.

Reassembly took place on the rotary engine stand, which aided installation of the crankshaft and other lower engine components. Below is a photo of the nearly completed engine, showing the cylinder heads and spark plug cables in place, before moving to the mobile engine stand for final assembly. Note the highly polished brass expansion tank for the main radiator, nestled behind the propeller cowl.



Engine 1 assembled in the Conservation shop Feb 2, 2010.

Once the engine was moved to the assembly stand where the engine frame and large radiator awaited, the wiring and various pipes and hoses could be fitted, along with the already assembled wheelcase and supercharger. Lowering this very large assembly into the tight space at the rear of the engine was a very delicate manoeuvre, but the reward was a nearly completed Merlin!

After installing the massive air intake and intercooler, the various cowl panels were fitted to the outside of the engine frame, to complete the QEC assembly.

While this work was going on, final preparations were being made at the aircraft to receive Engine 1. This required cleaning and polishing the firewall and various engine fittings, and installing the auxiliary gearbox that drives the electrical generator and other accessories on the engine.



Firewall ready, auxiliary gearbox installed Jan 7, 2010.



Engine 1 complete at the Restoration Shop Feb 9, 2010 .



Engine 2 with cowl panels removed, April 6, 2010.



Engine 1 installed Feb 24, 2010. Shown top left to bottom right, engine supervisor Ted Devey, Bill Tate, Ron Lemieux, Giuseppe Zanetti, John Corby, Garnet Chapman, Volunteer Project Manager Jim Riddoch, John Tasseron, Bruce Gemmill, Museum Project Coordinator Mike Irvin, Charles Baril, and then Association President Tim Timmins.

The engine was reinstalled on February 24, 2010 and the crew could take a short break before beginning work on engine 2.

Engine 2

Work started on the removal of Engine 2 in early April, beginning with removal of all the cowl panels, draining any fluids left in the engine and radiators, and disconnecting all pipes, hoses and electrical fittings at the firewall. Care was taken to take better photos of the removal of parts so reassembly would not be as much a challenge second time around.



Engine 2 removed April 14, 2010.

The engine team made a quick job of disassembling the number 2 engine. All major assemblies such as the intercooler and supercharger were removed, along with all pipes and hoses. The engine was removed from the frame and installed on the rotatable engine stand. The cylinder heads, cylinder blocks and pistons were removed, as well as the crankshaft. These major engine components were cleaned so that the task of reassembling the engine could begin. Disassembly was not easy. After years outside exposed to the elements, several of the pistons were seized inside the cylinders. Freeing these required a lot of muscle and Liquid Wrench. Still, the

disassembly of Nr 2 went much faster than the first engine.

A lot of corrosion was removed by a process called glass beading, but volunteers needed to be careful not to damage aluminum surfaces or contaminate seals. Most aluminum components were clearcoated to protect from further corrosion, while other parts were often painted with silver aluminum paint to restore the original look.

As with Engine 1, this engine was assembled in the rotating stand. Shown below, volunteer Stan Ride is adjusting the torque on the main bearing caps.



Stan Rideout working to reassemble Engine 2 in engine shop, Oct 7, 2010.

By December 2010 many major components such as the engine block, crankshaft and pistons had been refurbished and re-assembled. The experience gained from Number 1 engine paid off in spades.

The wiring harness was refurbished, but would not be installed until after the engine was in place. This was a key lesson learned from engine Nr 1. Some assemblies were installed too early, and had to be removed again so the engine was accessible. This time, the crew assembled the Quick Engine Change module from the inside out. Pipes and hoses would only go on after major parts were in place.

By March 2011 Nr 2 frame had been refurbished, and work was progressing on cowlings, radiators and accessories. In the meantime all four propellers had been restored, by Hope Aero along with the four spinners. Three were installed back on the aircraft, while the fourth was stored until all four engines were completed.

The Nr 2 engine was re-assembled by April 2011. The crankshaft and pistons had been installed, along with the cylinder heads and valve train. Work was then taken to restore the ignition wiring and the auxiliary gearbox.



Austin (Tim) Timmins.

Although engine Nr 1 was installed on the North Star in February, 2010, it continued to serve as a model for what engine Nr 2 should look like when completed. Volunteers made numerous trips to the storage hangar to compare engine Nr 1 to the items currently then being restored. This allowed the crew to solve several re-assembly problems quickly. The engine block was complete and the crankshaft, cylinder heads and pistons had been installed by June 2011. Many engine accessories and sub-assemblies had also been treated and were ready to be re-tacked.

The engine frame also received some attention. The rear cowl ring that held several of the external panels was completely stripped and repaired before painting and re-assembly. The three radiators for the engine, intercooler and oil cooler were dismantled, cleaned and painted. These three units were assembled and attached to the front of the engine frame. The radiators were then filled with inhibiting oil to prevent corrosion. There were many accessories that needed to be refurbished before being installed on the engine frame. When completed, most of these items were stored until after the engine was installed in the frame. This made assembly much easier.



Jim Riddoch and Bill Tate fill the radiators with inhibiting oil.

The auxiliary gearbox, which is a complex piece of machinery, was reassembled, but the reduction gear that connects the propeller shaft to the engine proved to be difficult, due to excessive corrosion.



Engine 2 on rotating assembly stand.

The cowl panels were rebuilt, as severe corrosion had affected many of the steel stiffeners riveted to the edges of the panels. These had to be removed and refinished. Several were so badly gone that new ones were fabricated and installed. Once riveted in place, the stiffeners were painted and the outside of the panels polished to a high shine. Again, these were stored until the engine assembly was complete, and then installed once all other assembly work was finished.

By December 2011 the engine was nearly complete, with only a few sub-assemblies to be added. The engine was installed in the engine frame and this allowed many pipes and hoses and electrical components to be added. The supercharger was installed, which was another major milestone for the engine crew. This went much quicker than installation on engine Nr.1.



Engine Nr 2 being re-assembled in the engine shop.

Engine Nr. 2 was completed by March 2012, with all assemblies and most cowl panels in place. A lot of detail work was needed to ensure all pipes, hoses, clamps and other items were all installed exactly where they were originally. Quality control was important to ensure accuracy of the final assembly. The auxiliary gearbox was installed on the firewall, so final preparations could be made to install engine Nr. 2 and the propeller, before the aircraft was moved outside for Canada Day.

It is worth noting that while Engine 1 required more than four years to complete the restoration, Engine 2 was completed in just 2 years.

Finally, after six years of work by a host of dedicated volunteers, both restored engines were once again fitted to the North Star by May 2012 as shown in the photo below.



In our next edition we plan to tell the story of the restoration of engines 3 and 4.

PNSAC

The Civil Merlin

Dr. Jakob Whitfield

The following article is an extract from a larger piece which appeared in the July 2017 edition of Aeroplane magazine under the heading "Rolls-Royce Merlin." We wish to thank Allan Bowes for bringing it to our attention. This article is republished with the kind permission of the publishers of the magazine and the author Dr. Jakob Whitfield.

The earliest Merlins to operate in a civil mode were the Merlin T24 series, developed in 1944. These were single-stage twin-speed units similar to the Merlin 24s fitted to the RAF's Lancasters, but were modified to improve service life, and were fitted to Transport Command's Avro Yorks. Long-range transport operation entailed running at relatively low cruise powers for long periods—under these conditions the lower cylinder head temperatures caused deposits of lead oxide from the fuel, resulting in excessive spark plug fouling. To counter this, the Merlin T24/4 incorporated a charge heater to increase the inlet temperature. Post-war, the Merlin 500 series essentially comprised civil and export versions of the T24, incorporating its modifications, though only the Merlin 501 included a charge heater.

The 600 and 700-series engines were two-speed two-stage engines, based on the military 100-series. They were fitted with the so-called 'transport heads and banks', strengthened for greater reliability. Most marks had some form of variable intercooling to allow for charge heating to reduce plug fouling under cruise conditions. Initially the system was plagued by coolant leaks, but as experience showed that zero intercooling at cruise allowed enough charge heating to reduce leading, a simple stop valve was fitted to the system. This allowed full intercooling for take-off

and climb, which could then be turned off for cruise.

Civil Merlins were fitted to Avro Lancastrians, Yorks and Tudors, but their flagship role was on the Canadair DC-4M North Star, a Douglas DC-4-derived design intended for Trans-Canada Air Lines (TCA). The North Stars used a modified Universal Power Plant installation, as the DC-4's nacelle bulkheads were slightly larger than the SBAC standard. In practice it turned out the Merlins were not ideally suited for use in civil operations: though the North Stars flew higher and faster than DC-4s, their time between engine overhauls was around 850 hours, roughly a third of that of commercial US radial engines. The engines also produced a lot of cabin noise, though this was alleviated somewhat by revised 'cross-over' exhausts that ducted the cabin-side stacks outboard, developed first by TCA and then by Rolls-Royce themselves.

The extra running costs were mostly borne by Rolls-Royce. When TCA's managing director expressed dissatisfaction with the Merlin's commercial performance, Hives asked what a reasonable level of maintenance cost would be. Being told \$4 per engine hour, he agreed to service the fleet's engines for this amount. This early form of 'power by the hour' was initially expensive for Rolls-Royce, but by the end of the Merlin's life the company had learned enough to supposedly make a small profit at this level.

What was undoubtedly true was that Rolls-Royce learned a great deal about the harsh realities of commercial operation in a short time. Hives is supposed to have said to TCA, "We didn't know the Merlin until you started operating it!" In the longer term, this paid off, TCA—later Air Canada—selecting Rolls-Royce engines for its future fleet: Darts in Viscounts, Tynes in Vanguards, Conways in DC-8s, and RB211s in TriStars.

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North Star Propeller Restorations

Harry Hope, with assistance from Michael Hope.

Hope Aero has played a major role in the restoration of the North Star. The following article provides some background about the company and its work on the North Star's propellers.

Hope Aero was formally government approved to certify aircraft propellers in 1992, at their facility in Mississauga, Ontario. Harry Hope however, already had 40 years of propeller overhaul experience on many varieties that included Hamilton Standard propellers, which were quite common, as well as Hartzell, McCauley, and Sensenich. Harry's first restoration to flying condition, was the propeller for the Lysander, which was restored by the Air Force in Winnipeg for their Centennial project in 1967. This Lysander is now displayed at CASM. Since that time, they have restored several propellers, some to flying condition, three are the Lancaster for the Canadian Warplane Heritage, Super Constellation (Super Star) for Lufthansa, and the Honningstad C5 Polar for Norway which is on display at the Aviation museum in Boda, Norway.

Since that time, their capabilities have added MT, Dowty, Hoffman, and Hamilton Standard Dash 7 and 8, and later the Dowty propeller on the Q400. As their customer base expanded to include different types of aircraft, the requirement for them to service more types became evident. They kept up with the required technology.

Along the way, they also expanded into aircraft Wheel and Brake overhaul, sales, service and on wing dynamic balancing of fixed wing and Helicopters. Harry retired in 2001, but the third generation is now capably looking after the business.

In the spring of 2006, Hope Aero took on the task of restoring the four North Star propellers, for the "North Star Restoration" project. The first challenge was to remove the propellers from the engines as neither the restoration crew nor Hope Aero had any recent experience removing this type of propeller. Michael Hope made the trip to Ottawa to assist with this operation and to help prevent any damage, which turned out to be exceedingly difficult due to the corrosion, starting with the spinner and then

the propeller. Once the propeller was removed the blades were removed for shipping to Hope Aero.

The first 43D50 Hamilton Standard Hydromatic propeller was received at Hope Aero in 2006. It was completely disassembled, cleaned and inspected. The external parts were very badly corroded, with most damage being to the aluminum blades and dome shells, and rust to the steel hub and tail shaft, which was likely caused by the outside storage environment. The inside parts were in relatively good condition. It was established, that both technical and visual effort would be required to restore the propeller to an acceptable display condition.

The restoration work commenced with the blades, the alcohol de-icer feed shoes, troughs and paint being removed. The corrosion of the blade surfaces was such that removal by grinding was abandoned, as the inner half of the blades are shot peened and grinding would remove this and the authenticity. It was decided to media blast the complete airfoil surfaces with an aluminum oxide media, thus removing the surface corrosion but leaving a good surface for paint to be adhered to; an aviation grade grey paint was applied with yellow stripes at the tips. New alcohol feed shoes were installed, however the troughs, which direct the alcohol to the shoes, were not available. As the troughs are hidden inside the spinner, it was determined that they could be omitted.

The external hub, barrel halves, spider tail shaft, slinger ring, de-icer tubes, and dome retaining nut, were extremely rusty. They were glass bead blasted to remove the rust; this did not remove the heavy pitting but did leave a surface that could be cadmium plated. After plating, a clear coat material was sprayed on these parts to improve the resistance to rust. The internal surfaces were in good condition, and they were well oiled.

A replacement dome shell in relatively good condition was found, requiring only to be sanded, anodized, and be reinstalled with new seals.

The propeller was then completely assembled to confirm that all the refurbished parts fit together. The blades were then removed to facilitate being shipping back to the museum.

All of the four propellers were found to be in similar condition, and all were restored in a similar manner.

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