



The NStar Chronicle

Project North Star Association of Canada

September 2010

Overhauling a Merlin 622 Engine

First in a series

Ted Devey

The Merlin Musings series of articles completed in June 2010 dealt in a broad sense with the Rolls-Royce Corporation from its beginning in the aircraft engine industry, its various models through the years and ending with the engines and their applications in aircraft. Particularly, the Merlin 622 engines as fitted in the North Star aircraft. North Stars were transport aircraft using the Douglas DC-4 as the basic aircraft. The RCAF used a C-54 model, non-pressurized to carry goods and sometimes personnel. The other North Stars were pressurized DC-4s used in the passenger service by Air Canada, Canadian Pacific Airlines and the British Overseas Airways Corporation which called these aircraft "Argonauts".

The details of the selection of the Merlin engine Power Pack over radial engines is provided in the book "The Canadair North Star" by Larry Milberry.

Rolls-Royce engines were all in-line and liquid-cooled. Radial and air-cooled engines were not marketed.

The Merlin engine is the result of development work in the R (for Racing) engines which powered the racing seaplanes by Supermarine in the Schneider Cup races in the late 1920s which were won by the British. The prototype Merlin appeared in the early '30s and went on to provide power in the Supermarine Spitfire and Hawker Hurricane fighter

planes which distinguished themselves in the Battle of Britain in 1940 in which the RAF first defeated the German Luftwaffe. Merlins were V-12 in form displacing about 1650 Cubic inches with a compression ratio of 6 to 1. These parameters remained unchanged. Continual development of the Merlin produced engines of increasing power and performance through improvements in superchargers and fuel management. Early Merlins had single-stage single-speed superchargers but later a second stage turbine was added for higher power and finally a higher speed was made available for increased altitude capability. The Merlin 622 fitted to the North Stars had 2-stage 2-speed superchargers fuel was injected into the eye of the supercharger first stage of compression.

Because of the high temperature of the fuel charge leaving the supercharger, the fuel mixture was passed through an intercooler which reduces temperature before entering the cylinders in order to maintain a high volumetric efficiency. The maximum power rating of the Merlin 622 is about 1700 horsepower, just over 1 HP per cubic inch displacement.

A distinction should be noted between a supercharger which is used in airplanes and a turbocharger which is used mainly in automobiles. A supercharger is crankshaft driven through step-up gearing whereas a turbocharger is driven by a turbine in the exhaust pipe of the engine.

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Engine Cooling

At the high power levels of aircraft in the passenger/freight transport service, tremendous amounts of heat are generated by the engines. The cooling radiators are very much larger than those encountered in other Merlin applications such as fighter planes and bombers. In the cooling assembly, the largest radiator is for engine coolant, a water-glycol mixture, a second radiator removes heat acquired by the intercooler and a third one cools the lubricating oil which removes large amounts of heat from the internal works of the engine.

Engine coolant removes heat from the cylinders and the cylinder head. This is a full-flow system unimpeded by regulators in the water system. Temperature regulation is achieved by controlling the flow of cooling air through the radiators using a temperature sensing element in the header tank which receives heated water from the cylinder heads. Large flaps at the bottom of the Power Pack are adjusted automatically to maintain a reasonably constant water jacket temperature.

These cooling systems will be described in detail later in the series as they are worked on.

Number Two Engine – Port Inner

After #1 engine Power Pack was returned to the aircraft, #2 was removed, mounted on the blue trans-

port stand and taken to the shop for processing. Dismantling of the engine into its component sub-assemblies was uneventful. Fasteners were easier to remove than was the case for #1 engine, there being less corrosion. Some pistons were seized but eventually freed up. Some time would have been saved in freeing up frozen pistons if we had noted which exhaust valves were held open by observing the camshaft and concentrating efforts on those pistons.

Up to this point, the engine was completely broken down to sub-assemblies. Fasteners were placed in plastic bags with identifying labels and tied to their related sub-assemblies which were stowed. The first unit to be cleaned and processed was the upper crankcase which forms the foundation of the engine. Processing the engine will be described in detail in #2 of this series.

Tracking System

John Tasseron, a recently joined member of the Merlin Crew, devised a paperwork system of identifying various components of the engine providing information about storage location, and noting various processes of treatment up to completion and readiness for returning to the engine re-assembly. This will be described in further detail in future articles in this series.

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Project North Star – Progress Report

Bruce Gemmill

Nr 2 Engine

The engine team has 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 are now being cleaned so that the task of reassembling the engine can 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. That being said, the disassembly of Nr 2 has gone

much faster than the first engine, and this is very encouraging for future work on engines 3 and 4.

Cockpit

Once again, the North Star has been moved outside so that work can be done in the cockpit. Last year the forward portion of the cockpit was cleaned and painted. This summer it was time to address the radio rack. This is a multilevel rack that contained a large number of radios and related electronic equipment. Stripping and cleaning of the rack has taken several months, but all is now ready for painting. This should be done by early September. One disappointment is that several of the refurbished windows leak whenever it rains. This has not hampered outside work, but once the aircraft is back inside, some of the windows will have to be removed again, so that additional weatherproofing can be applied.

Work has also been completed on the centre en-

gine control pedestal. This was on display last Canada Day and looked very impressive. Also on display were the new cockpit curtains.

Some of the equipment removed from the cockpit for restoration has now been put back. The rudder pedals were installed, along with trim wheels and heater and ventilation controls. Once the radio rack is painted, other items will be re-installed.

While the radio rack was being prepared for painting, a number of electronic assemblies were removed from the navigator rack. This equipment rack will be the next to be refinished, likely next summer.

Crew Door

The crew door was removed so that a ventilation system could be installed for extraction of paint fumes. The crew door was disassembled, cleaned and stripped of old paint. A fresh coat of paint was applied to the inside, and the outside was polished.

Richard Lodge

Richard Lodge became a Chartered Accountant in England in 1962 and immigrated to Canada in 1976.

After he obtained his designation, Richard worked in several companies before moving to Canada. During this time he worked from 1963 to 1966 as a project accountant in the Aero Engine Division of Rolls-Royce Limited in Derby, England. This was at the time when the company was developing the RB 208 engine, the predecessor to the successful RB 211 engine.

Upon arrival in Canada, Richard moved back into professional practice and became a founding partner in a firm of Chartered Accountants with offices in Pointe Claire, Québec and Ottawa. It was through this work that Richard met Robert Holmgren, the

The old door lock has proven to be a big challenge. Exposed to the elements the inner workings were badly rusted and some items needed to be replaced. Last year we salvaged a spare door from a DC-4 that was being scrapped, and we have used pieces from that door to rebuild the handle and lock mechanism.

Engine Frame

While work progressed on disassembling Nr 2 engine, the engine frame was stripped of parts, cleaned and painted with a fresh coat of silver paint. All the fittings now need the same attention. This work will carry on until next year, but the newly painted engine frame has already been re-installed on the engine assembly stand. Work that took two years for Nr 1 engine has now been completed in about four months for engine Nr 2. All the lessons learned from engine Nr 1 are beginning to pay off.

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founding President of PNSAC.

Aviation involvement continued when Richard was for some years assisting with the financial operation of a small airline with scheduled services in Northern Québec and Southern Ontario.

Richard became the first Treasurer of PNSAC and continued in this position until June 2010 when he was elected President of the Association.

A transport enthusiast, Richard has always been interested in all forms of transportation. He was one of the original volunteers in the preserved railway movement in the UK. He is still an active volunteer with the Bluebell Railway in England. With many years of volunteering experience, Richard brings to PNSAC knowledge of the operations and administration of a preservation organization.

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Classic Air Rallye Photo Feature

Project North Star Volunteers Welcome Classic Air Rallye Visitors to the North Star

Photos in this section by Chris Payne.



Figure 1: Nimal



Figure 2: Amy



Figure 3: Bruce



Figure 4: Tim with visitors



Figure 5: Jim pondering a correct response during Q&A post-lecture



Figure 6: Seawind 300c detail



Figure 9: Ted and rally visitor



Figure 7: Ron and centre console



Figure 10: Young North Star visitor



Figure 8: The next generation of fighter pilot



Figure 11: Jim and visitor



Figure 12: Pierre with visitor



Figure 14: Lysander start-up

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Figure 13: Tim

PNSAC Board's Report to Members

June 12, 2010

Introduction

The Association has had an eventful and productive year. Our volunteers have contributed approximately 22,000 hours to date on restoration tasks; several have contributed over 2500 hours. This effort is beginning to yield tangible and visible results: #1 engine fully restored and mounted on the aircraft, three spinners restored, and, all four propellers restored. As well, good progress is being made on the flight deck. Our efforts to improve communications, both internal and external, have yielded positive results. The Association web site and recent articles in the local papers have generated numerous inquiries about volunteer opportunities. Also, our members have recruited several new volunteers.

The increase in volunteer numbers and the formation of restoration teams holds promise for improvements in overall productivity. The quality of the restoration work is being sustained at a high level.

The Association web site upgrade has been completed. Improvements in content are ongoing. The present site is very attractive, functional, and relatively easy to manage.

Sustaining Association membership is a continuing challenge.

The Association has long sought corporate support for Project North Star. Through a stroke of good fortune, there is the prospect of assistance from Air Canada and its MRO, Aveos.

Project Manager's Report

This past year has seen significant progress on several major components of the North Star restoration.

Nr 1 Engine and Propellers

The assembly of Engine Nr 1 was completed with the installation of the engine into the refurbished engine frame, while major components such as supercharger and intercooler were installed. After that all electrical parts, pipes, hoses and other fittings were attached to the engine and frame. With the engine off the aircraft, we were able to properly clean and polish the firewall, then restore and replace the auxiliary gearbox. On February 22nd a team of volunteers

installed engine Nr 1 on the aircraft, then moved propeller Nr 1 into place and installed the remaining engine cowl panels.

Nr 2 Engine

Engine Nr 2 was removed from the aircraft and transferred to the restoration shop. Several major assemblies, such as the radiator and intercooler have already been removed. A new quality control system has been put in place to help track progress on cleaning and restoring each assembly.

All propellers have now been restored by Hope Aero. Three are mounted on the aircraft, while the fourth will be kept in storage until all four engines are overhauled and installed on the North Star. Several of the spinners have corrosion damage, so patches are being installed where needed.

Cockpit

Last summer the North Star was moved outside for approximately four months to allow cleaning and painting of the cockpit. This required extensive preparation, including the removal of the cockpit headliner, insulation, floors and many pieces of equipment, as well as sealing the aircraft to prevent water leaks. After extensive cleaning and some minor repairs to replace corroded structure, most of the interior of the cockpit was sprayed with zinc chromate primer. The upper half of the cockpit was then painted dark green, while the lower half and window openings were painted flat black. The rear portion of the cockpit was painted light green, again matching the original colour.

Once the aircraft was back inside the storage hangar, the windows were removed, stripped, painted and reassembled. This proved to be a major task, as the seals and caulking needed to be replaced, and suitable materials were hard to find and had to be special ordered for the project. At the same time sections of the floor that were constructed of wood lattice were painstakingly reconstructed, as the original flooring had rotted due to water intrusion, and could not be restored.

The rudder pedals, control column and many of the fittings and equipment removed last year have been restored and are now being re-installed in the cockpit.

The front windshields have now been reassembled and installed on the aircraft, along with the

side view windows, emergency escape windows and emergency hatch. All frames were cleaned and painted, new fasteners purchased, and all window glass was caulked inside and out to ensure a water tight seal for when the aircraft is outside for display. New insulation has been placed on the walls and ceiling of the cockpit.

Most recently, the forward crew door was removed for restoration, and a temporary cover placed over the door opening. A major rebuild of the centre console that houses the engine and flight controls is also underway.

Team Concept

Early in 2010 our volunteers felt we would enjoy a greater sense of purpose if we were more closely attached to specific restoration tasks. We decided to form teams, each with assigned tasks and priorities.

Each of our regular volunteers is now part of one of the following teams: Engines, Cockpit, Cowls/Floors/Windows/Doors, or Engine Frame & Accessories. Each team has a team lead and an alternate who is responsible for assigning daily tasks, coordinating team efforts, and ensuring project documentation is maintained.

We also created a Priority Task Board located in the restoration shop that lists the current top work priorities to keep the teams focused on the most important outstanding work.

The volunteers hold a monthly volunteer meeting, normally on the first Monday of each month, during our lunch break. Here, we review priorities for the next several months, discuss issues with particular tasks underway, and get feedback from all the volunteers on issues of concern.

Planned Restoration Work – 2010-2011

This summer will see the completion of cockpit cleaning and painting, which will allow us to re-install most of the cockpit equipment and fixtures that were removed over the past five years. Following this, items will be removed from the navigation station, equipment rack and galley.

Work will continue on engine Nr 2, with a possible completion date of end 2011. We also hope to begin work on cleaning and restoring each engine nacelle.

Air Canada support

Recently a team from the Canada Aviation Museum and Project North Star met with senior representatives of Air Canada and AVEOS (Air Canada Maintenance) with the hope of arranging for corporate support for the project. Air Canada has agreed to pro-

vide some support and AVEOS is willing to take on some work items, such as restoring the landing gear. The details of this agreement still need to be worked out, but this support will be a big help.

Air Canada support

The Association's finances remain satisfactory. However revenues have not significantly increased during the last year.

The year ended with an increase in cash in the bank compared to last year – \$20,589 (2009 \$19,166)

Revenue from memberships was reduced from last year at \$1,225 (2008/9 \$1,320 and 2007/8 \$2,986). There has been a steady decline in membership revenue from a peak in 2007/8.

Cash donations amounted to \$3,322 (2008/9 \$6,772). There were several large donations in 2008/9 which were not repeated during the last year.

In common with many other charities, revenues in general were reduced due to the recession. In addition revenues from Canada Day and the Classic Air Rallye were reduced by poor weather and the inability of the public to go inside the aircraft.

There were no donations in kind during the last year.

Regular monthly donations continue to be received but have not increased during the last year. These monthly donations provide a regular income to the Association. Members are encouraged to start monthly donations and application forms are available from the Treasurer or the Membership Secretary.

On the expenditure side, there has been a considerable reduction in some categories of expense. This was not due to a conscious decision of the Board to reduce expenses but more reflective of the requirements of the project which this year needed many hours of work but not great expenditure. This situation is likely to change in the future and the need to collect memberships and donations to finance Association work remains important.

Current position

The Association has a chequing account at TD Canada Trust and a savings account at ING Direct. On June 2, 2010 the checking account had a balance of \$2,438 and the ING savings account a balance of almost \$18,158

The payables for the Association on June 2, 2010 amounted to than \$630 and there were no receivables.

Membership Report

The Association finished 2009 with a total of 63 paid members. This was down somewhat from 2008, continuing the trend of the past several years. Early in 2010 all current members were contacted by mail or e-mail with a request to renew their membership and to continue to support our restoration effort. So far this year over 30 members have renewed, plus several new members have joined PNSAC. This was mainly through personal association with our volunteers. As well, a recruiting poster was developed to encourage volunteers, and several articles on the North Star restoration project in local papers generated some interest.

All members received copies of our newsletters and notification of all meetings.

We currently have 35 registered and trained volunteers, of whom 26 are active in some capacity. This is good news for the project, as there is good breadth and depth to our volunteer workforce. Several other potential volunteers are waiting for approval and safety training.

Members are again encouraged to tell friends and associates about the project and encourage them to support our restoration work by joining our association or making a donation.

Communications

Our communications effort over the past year included four issues of the NStar Chronicle, material and notices sent to Pionairs (Air Canada retirees), the Legion Magazine, 426 Squadron Association, and articles written by Michael Lomas, a volunteer freelance writer, published in EMC Orleans and EMC South. As noted previously, the revision and upgrading of our web site has been completed. The content has been greatly improved over the past several months.

Members able to attend meetings at the Museum, were briefed on Association matters and progress on

Project North Star. These meetings included Q&A sessions and concluded with a social exchange. An introductory handout package has been developed for new volunteers and a comprehensive Project Guide for volunteers is under development.

There has been a substantial increase in inquiries about Project North Star over the past year. This is attributed to improvements in the web site, articles in the local press, and personal contact with our members. However, the interest is sharply focussed on volunteering and we have had little success in generating supporting for PNSAC through membership or donations. The challenge for us is to engage those unable to become volunteers, to join us in our mission to preserve Canada's aviation heritage through the restoration of North Star 17515.

Conclusion

The re-mounting of the #1 power plant on the aircraft represents a major milestone in the Project. The experience gained over the past several years has been applied in organizational changes that will improve future productivity.

It is evident that there is a growing awareness and interest in Project North Star. This has resulted in a substantial increase in inquiries and has allowed us to recruit more volunteers. Our efforts to improve communications have generated these positive results.

Our inability to attract more members, and sustain their membership, is a long standing and challenging issue. Also, we are relying on a small number of loyal donors to provide us with funds to finance our operations.

We continue to receive the full cooperation and support of Mike Irvin and Sue Warren for Project North Star. We offer our thanks to them, and to all who have assisted us over the past year.

The Board respectfully presents its report to members of PNSAC.

PNSAC

Miscellany

Newsletter distribution

The NStar Chronicle is delivered to members by e-mail or by regular post to members not having e-mail addresses.

Project North Star Quarterly Meeting

The next meeting of the Project North Star Association will be on Saturday, September 25 from 10:30 to 12:00 at the Canada Aviation and Space Museum in Ottawa.

All members are welcome to attend. Be sure to advise museum staff that you are attending the PNSAC meeting so you are not charged for admission.

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