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CANADIAN CONSULTING ENGINEERING AWARDS 2013

Maintenance Hangar 1, CFB Trenton, Ontario

Canadian Consulting Engineering

INFRASTRUCTURE AND BUILDINGS

18 | April | 13

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SNC·LAVALIN

Certified ISO 9001

SNC-LAVALIN INC.
Suite 200
Park Lane Terraces
5657 Spring Garden Road
Halifax, Nova Scotia
Canada B3J 3R4

Telephone: 902-492-4544
Fax: 902-492-4540

17 April 2013

Canadian Consulting Engineer
80 Valleybrook Drive
Toronto, Ontario
M3B 2S9

Attention: Ms. Bronwen Parsons, Editor

Dear Ms. Parsons:

RE: Canadian Consulting Engineering Awards 2013
- Maintenance Hangar 1, CFB Trenton, Ontario

SNC-Lavalin Inc. (SLI) is pleased to submit our entry for the Canadian Consulting Engineering Awards 2013, for the recently constructed Maintenance Hangar 1 located at Canadian Forces Base Trenton, Ontario. The facility became operational to the Department of National Defence on 30 April 2012.

SNC-Lavalin Inc. (Halifax, Nova Scotia) acted as the Prime Consultant for this project and provided Project Management, Civil Engineering, Structural Engineering, Electrical Engineering, and Mechanical Engineering utilizing our in-house local engineering staff. In addition, we managed a diverse team of sub-consultants including architects, engineers, and specialists. Additional details on the project are enclosed.

If you have any questions regarding our submission please contact the undersigned, or in his absence Vivek Tomar, P.Eng., FEC, at 902-492-4544.

Yours truly,

SNC-LAVALIN INC.

J. Brian DeCoste
Vice President, Operations
Maritimes

BD/ml

000832-0001-C-MSC-000-0005 Rev 0

1 CONFIRMATION RECEIPT

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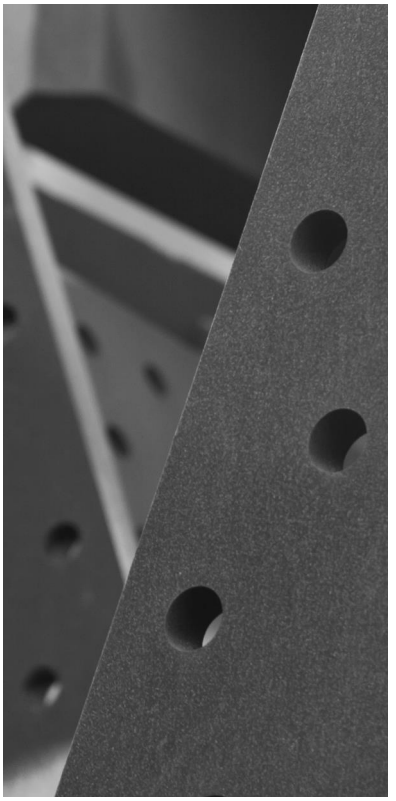

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2 ENTRY CONSENT FORM

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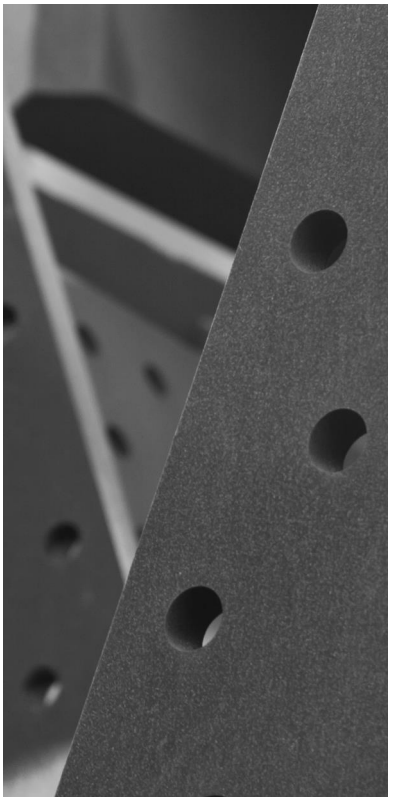

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3 FULL PROJECT DESCRIPTION

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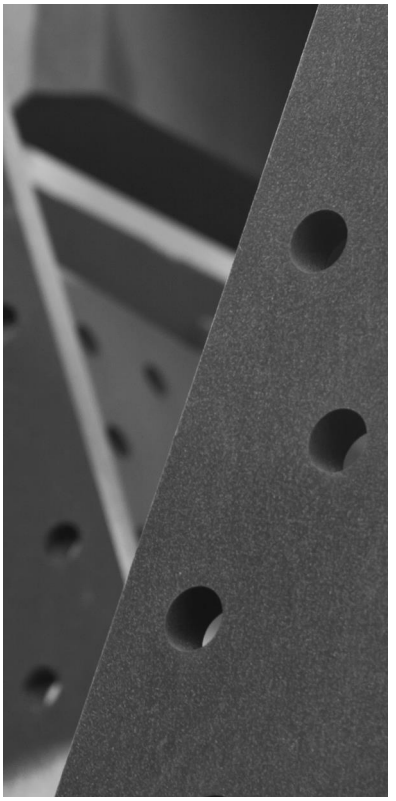

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B. PROJECT SUMMARY

Through a competitive Request for Proposal, SNC-Lavalin was awarded an architectural and engineering contract from the Department of National Defence (Canada) for the design of Maintenance Hangar 1 at Canadian Forces Base (CFB) Trenton, Ontario. SNC-Lavalin's mandate was to design hangar facilities for the maintenance of the Air Force's newly acquired fleet of C-17 Globemaster III military transport aircraft. Existing hangar facilities at CFB Trenton were not large enough or suitable to perform routine maintenance work and Home Station checks on the C-17. At the time of the contract award in 2008, the C-17 fleet had been partially delivered to the Air Force and, due to operational requirements, were already deployed to support Canadian Forces operations in Canada and abroad, and were being maintained in the United States. Now fully operational, the C-17 is the "workhorse" of the Canadian Forces.

Maintenance Hangar 1 is a two-bay corrosion control and fuel cell maintenance hangar that was planned and designed on a fast-track schedule starting in 2008. The 22,700 m^2 (gross) facility is located on a 60,000 m^2 site on the North side of CFB Trenton and has a building footprint of 18,500 m^2. This hangar is the first phase of the overall Maintenance Hangar Development Project at CFB Trenton, and was constructed at a cost of $90M.

The Corrosion Control bay is used for the following functions:

- Home Station checks for the C-17;
- A check for the C-150;
- Wash bay for any 8-Wing aircraft;
- Touch-up paint bay for any 8-Wing aircraft; and
- Second-line aircraft maintenance.

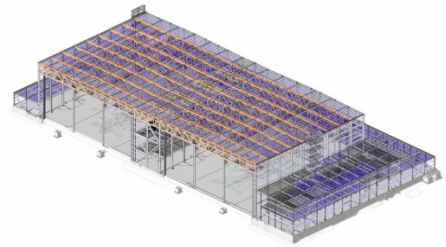
The Fuel Cell bay is used for the following functions:

- Fuel cell maintenance for the C-17;
- C-150 bulk fuel POD storage and maintenance; and
- Alternative location for long-term maintenance.

Some of the state-of-the-art features incorporated into the design of Hangar 1 and which meet LEED® Silver requirements, include:

- Telescoping maintenance platforms, hung from roof trusses;
- A wash water recycling system;
- In-floor radiant heating;
- Energy conservation and controls systems;
- A superior building envelope.

Significant challenges overcome by SNC-Lavalin's project team include:



- Completing the design in Autodesk Revit (Building Information Modeling);
  - This is the first project to be completed in Revit by this division of SNC-Lavalin;
  - An upfront investment in training personnel led to a successful application;
  - Client expectations were met by providing 3D walk-throughs of the facility;
- Coordinating a geographically diverse design team:
  - The client is located in Trenton, ON;
  - The design was completed in Halifax, NS;
  - Key specialist sub-consultants were located in Vancouver, BC, and Fort Worth, TX;
- For the Canadian Forces, the first uses of:
  - Vertical fabric doors for each bay (60-m wide x 19-m high, weighing 49,000 kg);
  - State-of-the-art telescoping work platforms that provide access to a working height of 17.6 m above the floor and that are supplied with compressed air, breathing air, electrical outlets, and water (for aircraft washdown);
  - High-expansion foam fire suppression system capable of filling the hangar floor with one meter of foam in less than two minutes.

Completed in April 2012, the facility is now capable of providing maintenance to the fleet of four C-17s and provides a significant improvement to maintenance operations and savings for the Canadian Forces. The first Home Station Check for the C-17 at CFB Trenton was performed in May 2012. Providing this capability has had a tremendous impact on flight operations, as air and maintenance crews no longer have to fly to Jackson, Mississippi, to perform Home Station Checks. Prior to this capability, the air and maintenance crews were required to be off-site for 12 days out of every month.

For additional technical details related to this project, please see Appendices A and B.

C. PROJECT HIGHLIGHTS

C.1 Innovation

SNC-Lavalin recognized the necessity of ensuring an early engagement of the Prime Consultant Team to ensure the delivery of this time-sensitive project, as the C-17 was being flown to the United States for routine maintenance, which was inefficient and costly to the Canadian Forces. To provide DND with the best service possible, we partnered with two companies well acquainted with military hangar projects; Jacobs Carter Burgess (JCB), Fort Worth, TX, and Kasian Architecture, Vancouver, BD. JCB, a was responsible for the design management and leading the multidiscipline design during the Concept Studies and Design Development phases. This was a key partnership as JCB had previously designed C-17 maintenance hangars for the U.S. Air Force. Kasian was responsible for the architectural design during the Construction Documents phase. The company was selected to join our team based on ongoing work with DND on other maintenance hangar projects. The engineering and architectural experience of these two companies allowed us to provide DND with the latest innovations in hangar design and lessons learned from previous C-17 hangar design projects, allowing for a more complete design without design revisions and increases to construction cost.

Early in the design process, it was apparent that DND required a maintenance hangar not only for the C-17 aircraft, but a building that would also act as a general maintenance hangar for all aircraft at CFB Trenton (including C-130H/J Hercules and C-150 Polaris). Presented with the challenge of collaborating with a diverse number of stakeholders whose priorities were focused on various active military missions, a new approach was implemented using a week-long “Design Charette Open House” process. During the span of a few days, representatives from all engineering and architecture disciplines met with stakeholders on common meeting ground where the specialized requirements of the aircraft and of the facility users and managers were decided upon in an open and collaborative forum. This session brought the DND and SNC-Lavalin project team together to work towards a common goal, accelerated the concept design period and allowed many opinions to be voiced and heard.

The outcomes of the Design Charette provided a Concept Design that addressed concerns from all stakeholders and resulted in very few major design changes throughout the following design phases of the project. As a result, client satisfaction was high all throughout the design and construction phases and the Design Charette process has been implemented on other DND projects as a new standard for future major projects.

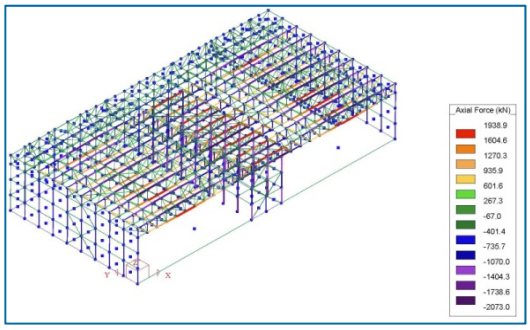
At the conclusion of the design phase of the project, the DND presented the SNC-Lavalin with a plaque expressing their gratitude for a job well done.

To ensure the highest quality design submissions, the entire project was completed using Revit. Revit is a 3D design software package for Building Information Modelling (BIM) and it was used to interactively develop floor plans with DND’s specialized user groups. This model was particularly useful when modelling the three-dimensional moves of the highly specialized ceiling-mounted telescopic aircraft maintenance platforms. Before the project began, it was ensured that all team

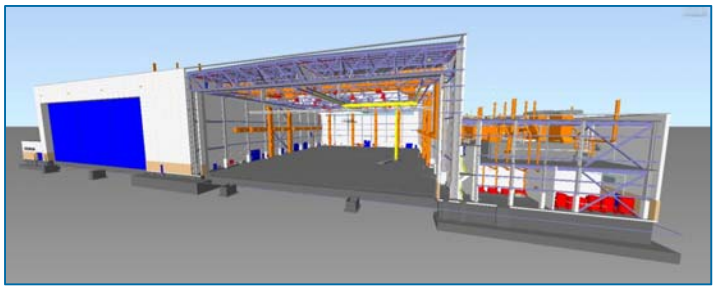
members were given access to and were trained with the software. This new software not only produced quality results, but allowed the team to easily produce 3D drawings.

The ability to provide a live model walk through, detailed renderings, and spatial analysis was proven to be invaluable in the ultimate goal of providing a building design that met DNDs goals and specific user requirements. In addition, the ability to perform clash checks to identify interferences and correct them during the design phase has translated into savings for DND during construction.

The use of 3D design by all architectural and engineering disciplines involved in both concept and detailed design greatly reduced the risks of incorrect spatial requirements (i.e., aircraft not fitting in the hangar) and poor coordination between disciplines. All disciplines were committed to using this new software package. In order to mitigate risks related to first-time use of this design tool, a further step was taken to enable model walk-throughs using Navisworks at the design management level. Navisworks enabled weekly model walk-throughs directly by the project manager, cost controller and all discipline leads across various geographical office locations. At all major design reviews, this was presented to DND with walk-throughs of all spaces as the design was developed.



A separate constructability analysis was carried out that linked a proposed Microsoft Project construction schedule to the Revit model to investigate alternative construction strategies and their effect on the active air base. This resulted in a well-coordinated model of the final building, which was ultimately used by the construction team as a basis for the production of shop drawings.



C.2 Complexity

Early on in the design process, it was apparent that DND required a maintenance hangar not only for the C-17 but that would also act as a general maintenance hangar for all aircraft at CFB Trenton (including C-130H/J Hercules and C-150 Polaris). Each hangar bay's size is based on the dimensions of the C-17 aircraft. In order to provide flexibility between aircraft types, one of the hangar bays was designed to allow for two C-130Js to park within the bay. This was achieved by orienting the two aircraft front to back and providing a nose dock space for the front aircraft.

Overall Floor Plan of Hangar 1
Overall: 190 m (w) x 97 m (d) x 29 m (h)
Each hangar bay: 66 m (w) x 74 m (d) x 21 m (h)

Within both hangar bays, steel trusses were designed to span 65.6 m clear of the width of each bay, supporting significant loads, such as the two telescopic platforms (55,000 kg each), 60 m (l) x 23 m (h) vertical lift fabric doors (some of the largest in North America), five-tonne overhead steel-rail-mounted crane, snow, mechanical equipment, fall arrest systems and material dead load.

The high-expansion foam fire suppression system is a first of its kind for DND. The system is capable of filling the hangar floor with one meter of foam in less than two minutes. Within 24 hours, the foam breaks down into a powder that can easily be disposed. The water used to produce the foam is

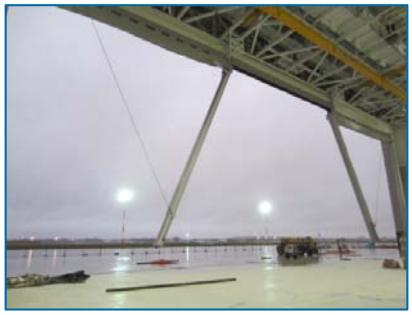
collected in a 1.5-million-litre underground storage tank. The dedicated fire protection system includes pumps that power the delivery of water to sprinklers and high-expansion foam systems. The system also includes in-ground concrete water holding tanks for both fire water storage and effluent storage.

Two state-of-the-art telescoping platforms were incorporated into the structural design. The remotely controlled platforms are mounted on the ceiling and provide access to the entire surface of the aircraft in all three dimensions, providing workers with full maintenance access within minutes, without ladders or scaffolding.

“Wing walking” must also be carried out regularly to inspect and repair damaged parts of the airplane. While this practice is minimized by the use of telescoping platforms, nevertheless, close inspections are still required. This activity exposes personnel to fall hazards and SNC-Lavalin provided a unique design of fall arrest tracks and equipment that were specifically designed for the C-17’s massive wings, fuselage and elevated “tail wing”, all coordinated to work in a space with operational cranes and telescoping platforms. Up to four users per track can be accommodated at any one time and a total of 1,000 m of track with 20 fall arrest lines attached were provided.

Many of the DND’s older hangars are equipped with rolling doors that require heavy and costly maintenance at mid-life and provide poor sealing to the exterior environment. Vertical lift fabric doors are a unique solution that provide fast access to a large open space with the added benefit of providing a superior seal and allowing varying amounts of daylight into the space. In collaboration with

the DND, SNC-Lavalin performed a cost-benefit analysis on alternate door systems and, this type of door was chosen for the project. The result is one of the largest vertical lift fabric doors in North America that provides fast and efficient aircraft access while allowing large amounts of light into the hangar bay work area and minimizing heat loss through enhanced R values and reduction of air infiltration. The doors were also connected to the building's emergency power grid to ensure uninterrupted operation as required by military specifications to open in conditions of 100 km per hour wind storm gust.



Aircraft maintenance requires access to the massive fuel tanks in its wings and the fuel cell hangar bay was dedicated to this task. This maintenance requires Confined Space Entry procedures into the tanks, which must be continuously purged with fresh air. To provide a healthy and safe environment to carry out this work, SNC-Lavalin designed a ceiling-mounted, motorized and retractable air purge system designed to provide permanent reliable fresh air quantities into the large fuel tanks to allow safe and efficient access to personnel for the critical inspections of the interior spaces of these tanks.

Aircraft maintenance on the C-17 requires repair and refinishing of major parts, which requires full Paint and Refinishing shops to be designed to meet the most stringent Health and Safety standards, as well as air emission standards and environmental containment of hazardous dusts and particles from the composite materials used. Stringent zoning of "Cold areas, Warm areas and Hot areas" were clearly demarcated and sealed to avoid cross contamination and all designs were strictly reviewed by DND's Health and Safety division for compliance to military standards for refinishing shops. Speciality "Air showers" were provided between Hot and Warm areas to blast dry contaminates off environmental protection suits required on all personnel carrying out this type of work.

The corrosion control bay was designated as the aircraft painting bay and DND's requirements conflicted between users' and budgetary constraints. Users requested the capability for stripping and painting an entire aircraft, which would require a high capital cost investment in mechanical ventilation and filtration equipment. SNC-Lavalin, in collaboration with the DND, presented a "hybrid" heating and ventilation system that allowed painting of smaller areas and provided increased ventilation "on demand" to ensure workers' health and safety during extended operations. The result was greatly reduced costs that matched the client's fixed budget while providing the users with an enhanced flexible environment that respected workers' long-term health and safety.

C.3 Social and Economic Benefits

The introduction of the first C-17 aircraft to the Canadian Forces in 2007 has provided the Royal Canadian Air Force with a new strategic airlift capability, and represents the beginning of a new era of airlift capabilities.

"With an approximate range of 2,400 nautical miles, an ability to land on unpaved short runways (about 2,400 metres with maximum payload) and a cargo area about 27 metres long, five metres wide and four metres high, the CC-177 Globemaster III is an unprecedented capability to support both domestic and international operations. Generators, water purification equipment, medical equipment and or food supplies are examples of some of the life-saving cargo that strategic airlift can deliver to Canadians, or to those in need around the world, in emergency situations. The Canadian Forces Disaster Assistance Response Team (DART), for example, will use strategic lift to great advantage by deploying troops and equipment faster to alleviate suffering in those parts of the world afflicted by crisis due to natural disasters" (Source: Royal Canadian Air Force website, Air Force News, Air Force Articles, *First CC-177 Globemaster III Receives Patriotic and Enthusiastic Welcome,* August 13, 2007*)*

The hangar's construction means that the Royal Canadian Air Force, which maintained and repaired these the C-17s either outside in frigid weather or in the United States, can now conduct these critical operations at home in Canada in the comfort and safety of a climate-controlled building. Providing this capability has had a tremendous impact on flight operations, as air and maintenance crews no longer have to fly to Jackson, Mississippi, to perform Home Station Checks. Prior to this capability, the air and maintenance crews were required to be off-site for 12 days out of every month, at a cost of $230,000 per month from August 2007 until April 2013, by the time the maintenance hangar was completed.

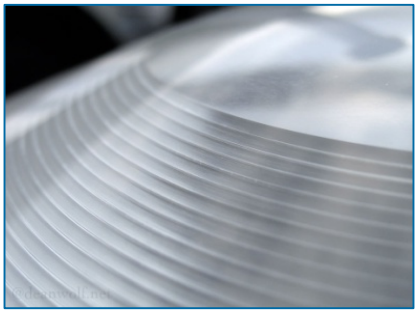
Maintenance Hangar 1 was designed to allow for the maintenance of all other aircraft located at CFB Trenton, including the C-130H/J Hercules and CC-150 Polaris (Airbus A-310).

The strategic airlift capacity of the C-17 will ensure the Canadian Forces can quickly move heavy equipment, supplies, humanitarian aid, or passengers over long distances, when and where they are needed in Canada or overseas. It has been beneficial to Canada's strategic airlift capability in delivering international, continental, and domestic operations in support of Canadian Forces missions and in the interest of Canada around the world.

This $90 million project was completed on time, on budget, and on specification. In fact, the final construction cost included just 6.7 % in change orders, representing $3.4 million in savings to the Department of National Defence when compared to their three-year national average of 10.53%.

C.4 Environmental Impact

Hangar 1 was designed to limit the physical effects on the surrounding environment. It integrated a reflective roofing material that is meant to help reduce the heat island effect, which creates a hot microclimate, as a result of heat absorbing materials. This site also utilizes a storm water runoff management pond to reduce overload on municipal systems. The building's integrated lighting was designed to minimize light trespass from the building site, reduce sky glow, improve night time visibility through glare reduction and reduce development impact on nocturnal environments.



The reuse of building products was cost-effective, reduced the consumption of raw materials and minimized environmental impact while meeting project specifications with the use of post-/pre-consumer products (steel) and the reuse of existing building materials (i.e. demolition concrete for aggregate). This, along with the adoption of CFB Trenton's Waste Management Plan, will limit the amount of waste generated over the building's life.

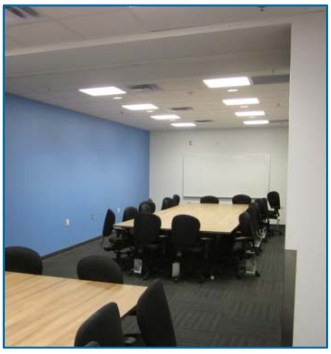
The interior building systems include a rainwater harvesting system (20,000 L cistern), low-flow fixtures and xeriscaping in order to reduce potable water use and water consumption. Also incorporated in the desigh, an aircraft wash-water recycling system was put in place to reduce water consumption. This system stores, processes and reuses aircraft wash-water.

Through an enhanced building envelope, energy efficient mechanical/electrical equipment and a Bacnet IP-network-based building automation system, a 28.9% reduction in energy costs is projected compared with a conventionally constructed building set by MNEBC.

The building was designed to create a healthy and comfortable work environment by implementing ASHRAEs 62.1 and 55 standards for ventilation and thermal comfort, indoor air quality controls, limits for exposure to VOCs by using certified green seal products and a flush out of the HVAC system before occupancy.

In order to provide a healthy and efficient work environment in the hangar bays, maximizing daylighting to provide enhanced illumination was a high priority for the users and DND. This was achieved using translucent fabric across the entire width of the vertical lift fabric doors which allowed daylighting to flood the workspace. High-bay curtain wall glazing was also used on all exposed walls to provide usable daylighting that did not negatively affect workers carrying out intricate work on aircraft parts. All glazing was double-acid etched to provide thorough light diffusion into the space and a state or the art “new to the market” extra-low E coating was specified on the exterior panes to reduce any possibility of reflective glare to incoming aircraft. Finally, a “new to the market” light-reflective floor hardener was applied to the hangar bay floor to maximize light reflectivity, allowing workers to clearly identify intricate parts or tools that may fall to the floor during maintenance operations.

The DND also responded to a recommendation from SNC-Lavalin to incorporate an experimental daylighting device into an interior operations meeting room. The daylighting “Light Tube” relies on a high rate of internal reflection on an extremely reflective surface with “Fresnel” lenses to diffuse incoming rooftop daylight. After installation, user experimentation and reviews, the DND decided to subsequently incorporate over 50 daylighting light tubes in the next hangar design, which SNC-Lavalin has completed and that will be finishing construction in 2013.



SNC-Lavalin recommended the use of hydronic in floor heating with light-reflective flooring throughout the hangar bays. This provided a comfortable environment for workers as they are close to the radiant heat source that originates at floor level through a concrete slab and acts as a slow thermal-release mechanism. SNC-Lavalin has had previous experience with this type of heating system in heavy maintenance workshop projects with very positive feedback from users. For the C-17 hangars, this presented challenges in the slab on grade design to accommodate heavy wheel loads from the C-17 and extremely high tire pressure (up to 160 psi) while maintaining exacting tolerances for aircraft jacking areas and sloping floors required by the fire protection codes for aircraft hangars, NFPA 409. The DND noted that the system had the advantage of retaining heat when hangar doors were open, since the rate of heat release/loss from the massive heat sink of the slab on grade was greatly reduced compared to conventional hangars that lose all their heat when doors are open.

C.5 Meeting Client's Needs

At the onset of the project, the DND requested SNC-Lavalin to investigate alternate construction delivery methodologies that would allow the project to be accelerated in order to reduce the cost of sending air and maintenance crews to the U.S. for routine aircraft maintenance. The urgency was immediately apparent and SNC-Lavalin recommended a modified construction management approach, which could achieve the shortest possible design and construction schedule. After consideration of procurement policies, the client decided on an alternative recommendation, which involved pre-selecting a short list of three major contractors, based on credentials and bonding capability, and subsequently issuing a comprehensive drawing and specification package for competitive bids, which accelerated the schedule.

All design deliverables were delivered on time and within budget and due to the complexity of the design documentation, DND requested that SNC-Lavalin provide them with extra time to complete their reviews. To accommodate this request SNC-Lavalin's design team continued to work on non critical areas of the project during the client's extended review periods, which allowed the design schedule to be fast-tracked to the maximum extent possible.

Design and Construction projects with DND are contracted and administered by a separate government agency, Defence Construction Canada (DCC), who has the sole right by law to carry out this mandate. To avoid potentially conflicting instructions from the DND project manager and the DCC contract manager, the SNC-Lavalin project management team continuously monitored design work requests from DND and immediately communicated all potential issues directly to the contracting agency through a one-to-one relationship set up solely for the purpose. The outcome was clear and continuous communication of design budget burn rates and progress in a "surprise-free" environment to the complete satisfaction of DCC.

SNC-Lavalin provided independent capital cost estimates at all stages of the project including Concept, 60%, 90% and 100% complete design documents to provide continuous cost updates to the DND as design decisions were made. In order to obtain accurate estimates, SNC-Lavalin's project management team met with major suppliers and vendors of the specialized equipment early in the project to fully identify options and provide clear specifications of expectations of product performance. Key vendors for such items as the large fabric doors (only produced by two companies globally) and the telescoping platforms were provided with the opportunity to review draft specifications and layout drawings and provide comments prior to acceptance by DND. The result of this collaboration and the costing exercizes was the complete satisfaction of the DND when the publically tendered prices from short-listed contractors were within 5% of expected budget and with a total spread of 10%. DCC and the successful General Contractor both expressed their satisfaction with the quality of the design package.

To mitigate risks of contractor misinterpretation of DND's operational requirements at the active air force base, SNC-Lavalin was engaged to prepare a comprehensive Concept of Operations plan in collaboration with DND. This plan greatly reduced delays during construction by identifying base operations that were required to be accommodated by the contractor. This included: height restrictions near runways and ramps that could impact crane operations; site security (within the General Restricted Area of the base) and NATO-grade fencing supporting the construction access plan; a "heightened state of security" when combat fighter jets were present; the construction of a temporary taxiway; the construction of a temporary access road to the runway for snow removal and maintenance vehicles; sharing of utilities between adjacent construction sites; and the establishment of protocols during repatriation ceremonies for "Fallen Soldiers".

A DCC AT WORK JUNE 2010

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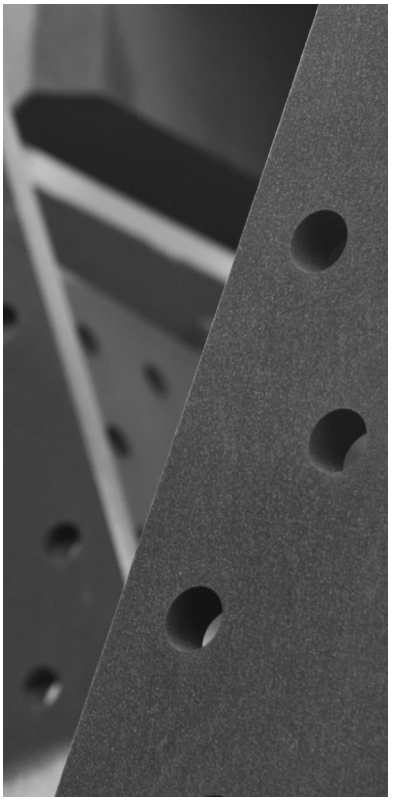

INFRASTRUCTURE AND BUILDINGS

Canadian Consulting Engineering Awards 2013

Infrastructure Index

Constructing Trenton hangar like building 500 houses in two years

Under the *Canada First Defence Strategy*, Canadian Forces bases, wings and installations across the country are being upgraded or replaced. The idea behind the construction program is for Canada to enable its military to build on its reputation of excellence to become an even stronger, first-class, modern military.

Defence Construction Canada is at the forefront of much of that construction with concrete being poured at a pace not seen by many in decades.

Take, for example, the new Maintenance Hangar for the CC-177 Globemaster III strategic airlifter (C-17) at 8 Wing Trenton. The hangar is part of a $334 million infrastructure program announced by the Minister of National Defence, Peter MacKay, last September.

10 storeys high and the length of two Canadian football fields, the enormous hangar involves approximately 17,500m^3 of concrete – equal to 43 per cent, or almost half, of the above ground concrete used in the CN Tower in Toronto.

Here are 10 other fast facts about the hangar project in Trenton:

- Building area is 97.1m x 190.9m = 18,536m^2 or about 200,000 sq ft;
- Largest single pour footing was 50 metres long by six metres wide by three metres deep = 900m^3;
- Largest single concrete pour in one day was the 1,825m^3 fire effluent tank bottom slab = 197 concrete truck loads;
- Approximately 3,000 tons steel;
- Approximately 2,000,000 person hours;
- 370 drawings and 2,800 pages of specifications;
- Two vertical lift fabric doors, approximately 60m wide x 19m high weighing 49,000 kg a piece;

- Two state-of-the-art telescoping platforms for maintenance and inspection of aircraft;
- A five-tonne overhead crane;
- $84.7M over two years is like building a $170,000 home every day for two years; or, building 200,000 sq ft in two years is like building an 800 sq ft home a day for two years. Either way, you can think of it as building 500 houses in two years.

Construction of the hangar began in spring 2010 and is expected to open in fall 2011.

Defence Construction Canada's Client Service Newsletter

B HANGAR 1 FACTOIDS

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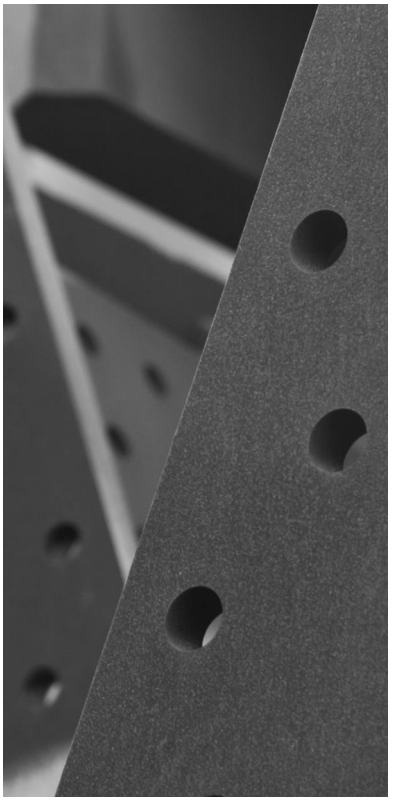

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New Maintenance Hangar 1

8 Wing, Trenton

60 YEARS ANS

DCC | CDC

New Maintenance Hangar 1 – Project Introduction

Maintenance Hangar No. 1 - Corrosion Control and Fuel Cell Hangar Maintenance Hangar has been planned and designed on a fast track schedule starting in 2007. Planning studies were completed by Stantec of Vancouver and the project was designed by a team lead by SNC Lavalin of Halifax, with Jacobs Carter Burgess of Ft. Worth, Texas and Kasian Architects of Vancouver. The 22,700 gross square metre facility, located on a 60,000 square metre site on the North side of CFB Trenton has a building footprint of 18,500 square metres. It consists of a two bay maintenance Hangar which is the first phase of the overall New Maintenance Hangar Development Project.

Facilities include a Corrosion Control Hangar to conduct Home Station checks on CC-177 and A Checks on CC-150, a Wash Bay - for any 8 Wing Aircraft, a touch up Bay - for any 8 Wing aircraft, a Primary Facility for 2nd line Aircraft Structures Workshops, a Fuel Cell Hangar for Specialized Maintenance on Fuel Cells, a Primary Facility for CC-150 Bulk Fuel POD Storage and Maintenance, and an alternate location for Long Term Maintenance. Driven by the urgent need for a CC 177 facility this is proposed to be a shared facility for all fixed wing aircraft at 8 Wing, so flexibility and multiple uses were key design criteria.

State of the art features such as ceiling mounted telescoping maintenance platforms, a wash water recycling system, in floor radiant heating, energy conservation and controls systems and a superior building envelope contribute to a world class Hangar Facility. It has been designed with the intent to meet a LEED Silver standard of sustainable design.

The general construction contract for this facility was awarded to Bird Construction Company of Toronto, on October 2 , 2009 with the beneficial occupancy date (BOD) expected in early spring 2012.

New Maintenance Hangar 1 – Cool Facts

Hangar 1 Summary – At a Glance

- Footprint: 97m x 191m = 18,550 m^2 or 200,000 sq ft or 4.5 acres
- Length: 2 Canadian football fields
- Height: 29m or 95 ft or 10 storeys
- 17,500m3 (or 1900 truck loads) of concrete foundations
- 4,000 tons steel
- 2,000,000 person hours (150 men on site at peak of construction)
- Design, Bid, Build
- Designers: SNC Lavalin Inc., Halifax

- Award: October 2, 2009
- Awarded to Bird Construction Company, Toronto
- Award Value: $84.7M
- Current Value: $90M
- Completion: March 2012
- 370 drawings
- 2,800 pages of specifications
- Currently:
  - 655 Requests for Information (RFI's)
  - 230 Site Instructions (SI's)
  - 350 CCN's, claims, and quotes
  - 4700 shop drawing submissions

Corrosion Control Hangar (North Hangar Bay)

- Home Station check on CC-177 and A Checks on CC-150
- Wash Bay – for any 8 Wing Squadron
- Aircraft Touch up Bay - for any 8 Wing Squadron
- Primary Facility for 2nd line Aircraft Structures Workshops – all 8 Wing Squadrons

Fuel Cell Hangar (South Hangar Bay)

- Specialized Maintenance on Fuel Cells
- Primary Facility for CC-150 Bulk Fuel POD Storage and Maintenance
- Alternate Location for Long Term Maintenance
- Two CC-130J's can fit in this Bay at one time. The first plane is brought into the "Nose Cone Bay" with the second plane brought in directly behind the first.

CC-177 Globemaster III Aircraft

- Approximately 174' long with 170' wingspan
- A single CC-177 refueling involves 27,000 US gallons of fuel. If you average 23 mpg, you could travel around the world 24 times without stopping for gas (or drive for 25 years)
- One CC-177 can haul three CH-146 Griffon helicopters with refueling tanks, or one Leopard 2 tank, or as many as 102 paratroopers

Fire Suppression

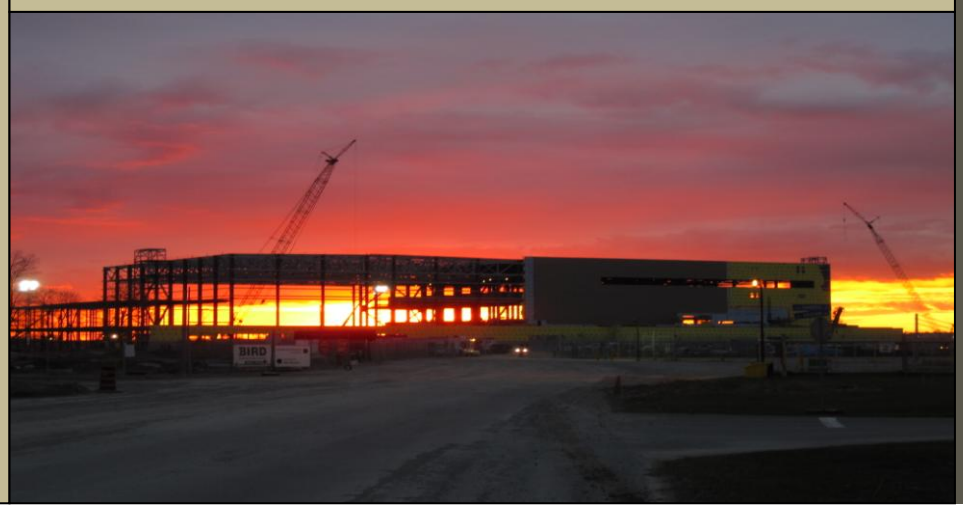
- High Expansion Foam (HEF) generators, combined with a wet pipe sprinkler system and foam-water hand hose system provides fire suppression in the hangar bays
- HEF system design objective is to achieve initial foam coverage within 30 seconds of system activation and extinguishment of the fire within 60 seconds. The system is designed to achieve foam over the entire aircraft storage and service area within 3 minutes of system actuation.
- The HEF system commissioning involves setting off the system.

Mechanical Features

- Corrosion Control Bay requires increased ventilation for prep and spot painting and aircraft washes. Full Cell Bay requires fuel vapour exhaust system.
- Engineered Air, supplier of the HVAC units on the project reported that this was the largest single purchase order they have ever received. Mechanical units on the project are valued at approximately $5.7M.
- Hangar Trench Drain system: sized to collect 475 litres per second of firewater flow
- A building automation system (BAS) adjusts building systems to optimize their performance in order to minimize the overall power and fuel consumption of the building. The BAS system is web-based to allow for remote building control and monitoring.

Architectural Features

- 6000 gallons of paint on the project. Repainting a whole house would take 15 gallons; therefore, painting Hangar 1 is equivalent to painting 400 houses.
- Each Hangar Bay is approximately 4850 m^2 or 1.2 acres. This is slightly larger than the area of one NFL football field, or 3 NHL rinks.



New Maintenance Hangar 1 – Cool Facts

Electrical

- Approximately 15 kilometres of conduit have been installed; 50 kilometres of wire
- A 100’ lift is required to change a light bulb in the Hangar bays!
- There are two completely separate feeds into the building. The building can be switched from one to the other without losing power in the building.
- Each feed is about 50 times the size of a modern home service.
- The diesel generator is a truck engine – about 600hp. It has a 2700 liter fuel tank and can provide emergency power the building continuously for about 36 hours.
- The transfer switch automatically detects a power failure and turns on the generator, then takes power from it to the building electrical system. This takes about 7 seconds. It is less time going back to grid power.
- Grounding: 3⁄8” Copper cable surrounds the hangar and travels up to the roof at about 20m intervals, where it is connected to a series of lightning rods (we call them air terminals). As well as absorbing lightning strikes, this system of wiring is also connected to the antistatic grounding points that are placed in the floor of the hangar bays. The planes are connected to this grid when they are in the hangar.
- There is about 0.5 megawatts of lighting in the Hangar.
- The fire alarm system has over 100 smoke detectors, 36 flame detectors and 225 horn-strobes. It monitors over 100 different other devices in the building like valve positions, flows, and tank levels and so on. It communicates the status of each of these directly to the Fire Hall.

Structural Features

- Largest single pour footing was 50 metres long by six metres wide by three metres deep = 900m^3
- Two giant 1.5 Million litre underground concrete tanks have been constructed to serve the fire suppression system. The first, located under the fire suppression room within the plan area of the Hangar is the Fire Water Reservoir. This tank will remain full of water to meet the supply requirements should there be a fire in the Hangar. The second, located outside the plan area of the hangar, is the 1 Fire Effluent Tank that will hold the foam effluent until it can be treated and discharged to sewer. These tanks are shared between Hangars 1 and 2.
- Largest single concrete pour in one day was the 1,825m^3 fire effluent tank bottom slab = 197 concrete truck loads;
- Hangar 1 used approximately 17,500m^3 of concrete – equal to 43 per cent, or almost half, of the above ground concrete used in the CN Tower in Toronto
- Steel construction involved 18 trusses in total, each approximately 12’ deep, which were delivered in 3 sections: 70’, 130’ and 70’. The logistics of delivering the truss pieces from Burnco Manufacturing in Vaughan, Ontario was challenging as the oversize loads took up two lanes of traffic and required two police escorts. To summarize, Hangar 1 trusses blocked eastbound traffic on the 401 from Toronto to Trenton for a total of 54 days.
- Steel was erected with two cranes: 250’ and 300’ high. Open web steel joists (OWSJ) were tacked together on the ground on the current Hangar 2 site and lifted into place to save time working at heights.
- Hangar 1 consumed 3000 tons of structural steel – the equivalent weight of 2100 pick-up trucks
- Each truss was approximately 93,000 pounds – the equivalent weight of 31 cars. All 18 trusses weighed the equivalent of 557 cars.
- Hangar slabs on grade are fully reinforced with two rebar mats and are all heated by an in-floor hydronic radiant heating system.

Look Up…. Way Up

- Clear height of hangar bays: 23m or 75’
- Yellow fall arrest track provides safety tie-offs for personnel working atop of aircraft. The tracks follow the fuselage, wing, and tail outlines of the multiple aircraft to be maintained at Hangar 1.
- Draft curtains divide the Hangar Bays into areas for the wet-pipe sprinkler system.
- Red foam generators have been carefully coordinated with the multiple aircraft parking positions in each of the hangar bays to ensure the foam discharge does not fall directly onto the normal parking position of any aircraft, but falls near the aircraft to quickly spread beneath and cover the floor area below the aircraft.
- Two vertical lift fabric doors, approximately 60m wide x 19m high weighing 49,000 kg a piece have come from Mock Doors Ltd. In Finland. The doors are valued at approximately $1.8M.
- Two state-of-the-art telescoping platforms in North Bay for maintenance and inspection of aircraft. The platforms, supplied by CTI out of Luxembourg are worth approximately $3.7M and provide a working height of 17.6m above the floor to provide appropriate access to the CC-177. Each platform is equipped with compressed air for air tools and paint guns, breathing air, electrical outlets for test equipment and a large volume hose for warm water aircraft rinsing.
- 5 ton hoist in South Bay has a bridge span of 49m. Equipped with complete digital radio remote control system to permit full control of both the crane and hoist from the Hangar floor via a portable wireless transmitter.
- Hose reels in South Bay connect to aircraft fuel cells to remove vapours during maintenance.
- Rotating Unit heaters in South Bay maintain space temperature when the door is opened for a long period of time.

Putting it in Perspective

- $90M over two and a half years is like building a $145,000 home every day for two years.
- The Hangar 1 contract also involves equipment moves from existing 5, 6, and 10 Hangars. The relocation of these existing shops allows for demolition of the existing Hangars to make way for the future new hangars planned for the hangar line along Highway 2.
- Currently, two thirds of the maintenance on the fleet of four CC-177's is done outside in the heat of summer and frigid winter weather. One third is done in Jackson, Mississippi to conduct the mandatory Home Station Checks on the aircraft. This means once a month, 16-25 personnel from 429 Sqn flies to Jackson to work for 12 days. Completion of Hangar 1 will allow for the first Home Station Checks on the CC-177's to occur in Canada at 8 Wing Trenton.

From Major Guy Bouchard, Senior Aircraft Maintenance engineering Officer for 429 Squadron:

"What does this hangar mean? We only borrow the hangars from the USAF. We pack up our equipment, parts, and people, and send them off for 12 days a month. It feels like we're on temporary duty all the time. Those people, those 18,000 man hour of maintenance, will be brought back home to Trenton. We'll have a shelter to repair and inspect. We'll have our people at home. We'll have our Squadron at home. I'm looking forward to when we can look at the hangar and say, 'This is home.'"

SNC·LAVALIN

200 - 5657 Spring Garden Road
Halifax, Nova Scotia B3J 3R4
902-492-4544 - 902-492-4540