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exploring carbon-neutral energy solutions

GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, U.S.

In 2011, Georgia Tech (GT) and the Georgia Tech Research Institute were awarded a Department of Energy grant to achieve extreme cost reduction in what's called the "balance of systems", to slash the cost of solar power to \$1 per watt.

But solar research is just one area of expertise at the recently-opened GT Carbon-Neutral Energy Solutions (CNES) Laboratory. The research focus of the facility is sustainable energy solutions, including high-efficiency combustion engines, biomass gasification kinetics, biochemical-enzymatic conversion of biomass materials, and the capture of carbon dioxide from power plants and combustion engines. During the original building construction, **exp** provided LEED® commissioning services, assisting in achieving Platinum LEED certification.

Inside the labs at CNES, the mission is to bring clean energy technologies to a 90-percent commercialization level, industries can then license the technologies and bring them to the

market. **Exp** is now completing process design services for the combustion research test areas. When completed, testing areas will be equipped with high pressure, high flow utilities that support research in advanced combustion.

The scope of the process infrastructure project includes the development of full process design and coordination of supporting disciplines to complete architectural, civil, and structural to install the equipment. During the design process, several feasibility studies were completed to evaluate emissions from the test area, sound abatement and impact on surrounding areas, and alternative equipment to provide the required flows and pressures. The systems include bulk storage and delivery of O₂, N₂, H₂, CO, CO₂, CH₄, liquid fuels storage and delivery, high pressure and high temperature gas delivery systems, process controls and gas detection.

We're proud to be a part of the creation of a sustainable space to facilitate the research into low carbon energy solutions.

pumping iron

MONT-WRIGHT MINING COMPLEX, QUEBEC, CANADA

The Mont-Wright mine is one of North America's largest open-pit iron mines. Looking to increase production of iron ore destined for the world steel market, Arcelor Mittal had to expand its tailings site and upgrade its pumping system.

Our team acted as Principal contractor for the commissioning of the new pumping station. The services we provided included project management, plans and specifications preparation, estimating, tender management, work surveillance, as well as preliminary, hydraulic, and arc flash studies. Significant challenges were associated with the construction of the station:

- The pumping system had to be designed to withstand extreme temperature and weather fluctuations specific to Northern Quebec.
- The residues—50% of which are solid matters—had to travel a distance ranging from 2 to 6 km to several different

deposit points located across the tailings site. Our solution was to design a piping network that redistributes the mixture of residues to four other networks in which 26 valves have been installed.

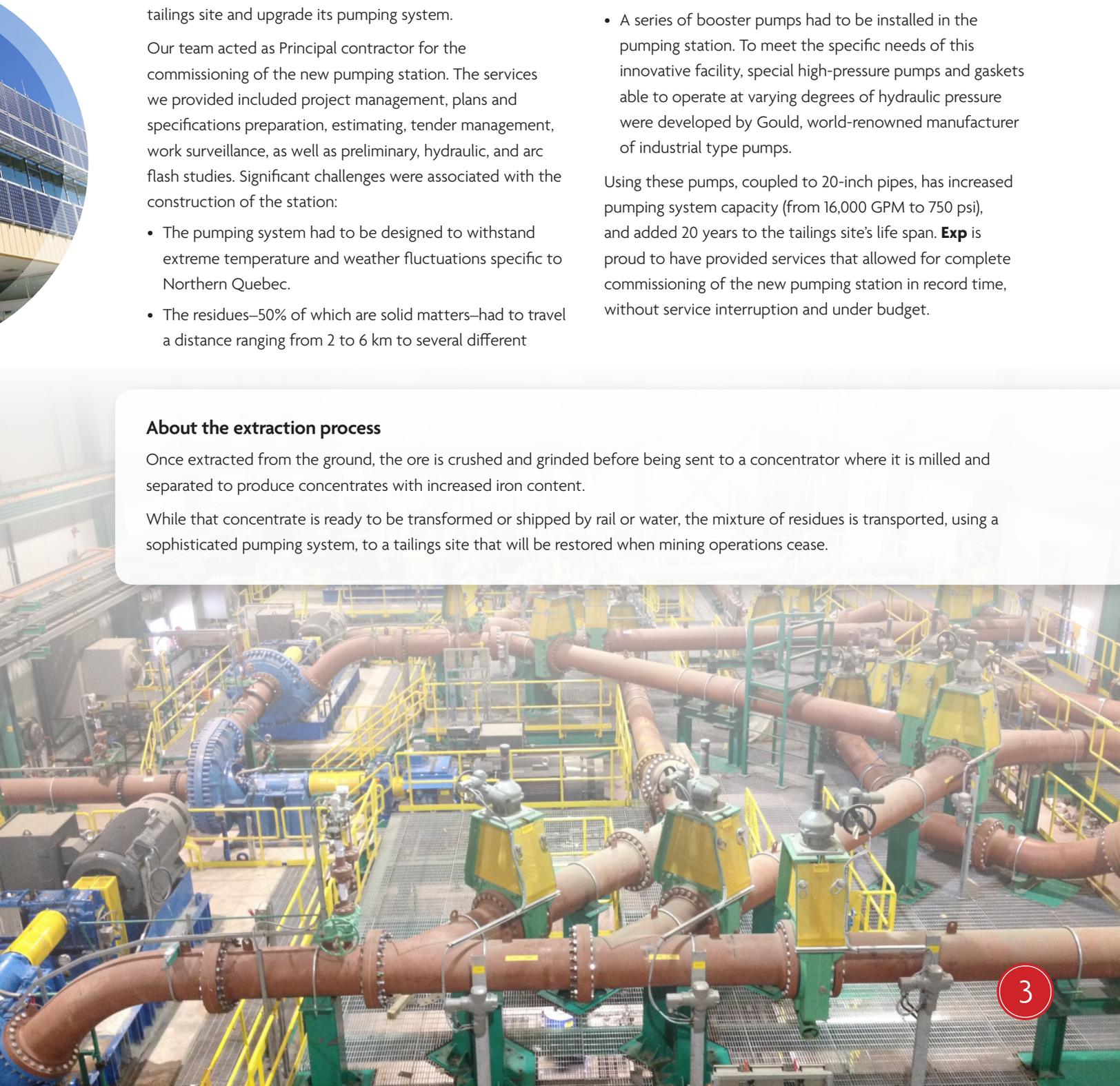
- A series of booster pumps had to be installed in the pumping station. To meet the specific needs of this innovative facility, special high-pressure pumps and gaskets able to operate at varying degrees of hydraulic pressure were developed by Gould, world-renowned manufacturer of industrial type pumps.

Using these pumps, coupled to 20-inch pipes, has increased pumping system capacity (from 16,000 GPM to 750 psi), and added 20 years to the tailings site's life span. **Exp** is proud to have provided services that allowed for complete commissioning of the new pumping station in record time, without service interruption and under budget.

About the extraction process

Once extracted from the ground, the ore is crushed and grinded before being sent to a concentrator where it is milled and separated to produce concentrates with increased iron content.

While that concentrate is ready to be transformed or shipped by rail or water, the mixture of residues is transported, using a sophisticated pumping system, to a tailings site that will be restored when mining operations cease.





exp atlanta goes north for the edible oil industry

CANOLA PROCESSING PLANT, ALBERTA, CANADA

Richardson International Limited is Canada's largest, privately-owned agribusiness. Richardson is a worldwide handler and merchandiser of all major Canadian-grown grains and oilseeds. With canola processing plants in Lethbridge, Alberta and Yorkton, Saskatchewan, they are one of North America's largest suppliers of canola oil and meal.

Primus Builders, whose corporate headquarters are located in Woodstock, GA, just north of Atlanta, enlisted the expertise of the **exp's** process engineering group in Atlanta to expand and modify Richardson's edible oil blending and packaging facility in Lethbridge. Because Primus has a long-standing relationship with **exp**, they selected our Atlanta group for the project.

The scope of the project included process flow diagrams, piping design and instrumentation diagrams, equipment specification, selection and the development of a process

system for integration into existing control systems. MEP and fire protection were provided for the building addition and new packaging area. HVAC design work was also provided for the bottling and packaging systems. Other modifications included the addition of a bottling line and the design of process supply lines and utilities. Heat exchangers were installed to provide heating to the oils to allow flow for those that are solid at room temperature. The addition of bulk oil storage facilities for several types of oil, including palm oils, was also part of the work we did.

The project duration was from 2010 to 2012. We achieved the project goal, which was to increase plant capacity by 40%, raising their production to approximately 1,200 tons of canola per day. To keep pace with increasing demand for healthier food products, Richardson is planning another expansion, for which the Atlanta team has already completed a preliminary study.

giant-size paint shops

BOMBARDIER AEROSPACE, QUEBEC, CANADA

Over the last 15 years, our Industrial and Buildings groups have worked together to design, build and improve the paint rooms where Bombardier Aerospace's business and commercial aircrafts are painted. Through this experience we were able to develop an expertise which helped the client improve efficiency, safety and environmental management of its facilities.

Painting an aircraft is not like painting a car, a bus or other such vehicles. Because of an aircraft's shape and size, complex electrical, mechanical and safety systems have to be designed for painting operations.

When it comes to painting aircrafts, one of the important things to know is that, to obtain a high quality finish, the paint has to be applied in a continuous manner. In order for the aircraft painters to be able to complete their work, our team designs moving and static platforms equipped with ergonomic life lines and safety harnesses that lets them reach and paint elevated parts of the aircraft while always having the resources they need to work efficiently and safely (water, local exhaust ventilation, breathable air and compressed air for paint sprayers).

The different service platforms (fixed or with manual or hydraulic commands) are designed to let the painters

work under and over several aircrafts, including Global, Challenger, CRJ and CSeries aircrafts.

Decontamination was another major challenge. We designed adjacent rooms dedicated to employee decontamination, chemical storage and paint mixing. The rooms are equipped with an air lock to prevent spread of contaminated dust, gases and fumes to the rest of the facility. Because painting operations produce gases and fumes that are flammable and explosive, our team designed a fire protection system for the paint rooms that includes water and fire-fighting foam distribution systems as well as antispark zones.

The use of sophisticated filtration systems for volatile organic compounds (VOCs) and of complete personal protection equipment allows for recirculation of process air, which results in significant energy savings.

The strategies developed by our team of experts over the years for the design or redesign of paint rooms were instrumental in increasing performance and safety in these giant-size finish shops.



giving a steel company a little elbow room

JANCO STEEL WAREHOUSE, ONTARIO, CANADA

Exp has been prime consultant to Janco Steel, providing structural, mechanical and electrical engineering services for two expansion projects totalling 86,000 square feet.

Bays 5 & 6 Addition

In 2011, our work involved the design and construction review of a new 70,000 square-foot warehouse addition.

Mechanical features included gas-fired infrared heating units to provide efficient heating to the spaces. A new ventilation system consisting of a series of roof mounted exhaust fans were specified to provide ventilation to the space. A new standpipe system complete with fire hose cabinets and a new incoming fire service were provided to meet Ontario Building Code requirements.

Electrical services included extension and addition of building services including power distribution, lighting, fire alarm, overhead cranes, mechanical system wiring and electrical devices. It also included coordination of the power requirements with the client and processing line supplier for the new cut-to-length and stretcher processing lines. The work included modifications to the existing substation, as well as the specification of new breakers and electrical feeders to the processing line sub panels.

Bays 5 & 6 Extension

In 2014, we undertook another challenge for Janco. The project consisted of a 16,000 square-foot extension to the existing addition to accommodate a new cut-to-length processing line.

Mechanical services were involved providing new HVAC, plumbing and drainage, and sprinkler systems to serve the extension. Dedicated rooftop HVAC equipment was specified for each floor of the extension to provide optimum temperature control. Mechanical services for the plant included the addition of infrared heating, extension of the existing standpipe systems and additional ventilation to meet code requirements.

Electrical services included extension and addition of the electrical systems similar to the 2011 addition. It also included a power study to determine whether the existing 3,000 kVA main transformer was sufficiently sized to handle the large load requirements of the new processing line. The results of the study, including recommendations to reduce the electrical load, were presented to the client. We're also working on completing a pre-start health and safety review of the cut-to-length line.

The relationship we have with Janco, and our ability to provide comprehensive industrial services, as well as our experience with the steel industry, has earned us these opportunities to help them expand their operation, and grow their business.



building a safe haven in a challenging environment

BP WHITING REFINERY, INDIANA, U.S.

The current BP Whiting Refinery was originally constructed in the early 1890s and is a cornerstone in the development of the city of Whiting, Indiana, as well as an anchor of the industrial development of Northwest Indiana and Chicago-area economies. Well before the full potential of the gasoline-powered engine was realized, the refinery was turning crude oil pumped from fields in Pennsylvania, Indiana, Illinois and other parts of the Midwest into products such as grease, kerosene and even paraffin wax candles.

Owned by BP Products North America Inc., the Whiting Refinery has recently completed a multi-billion dollar expansion and modernization project that makes it one of the most technically-advanced refineries in the world. In early 2012, **exp** was awarded the contract to provide engineering/procurement/construction services for the emergency services building project (ESB).

Designed to resist toxic/flammable gas intrusion and exposure to blast overpressures, the 36,000 square-foot ESB consists of an administrative wing and apparatus bay housing the refinery's fire and security departments. Construction of the facility integrated a blend of commercial and industrial systems, providing the client with an extraordinary level of quality of installation in the demanding technical and safety culture of the petrochemical industry.

A key construction and design challenge was to provide a new facility sited where the boundary of the refinery meets that of the city of Whiting. This was important because, while on refinery property, the new ESB was located on a city street, adjacent to an older neighborhood of wood frame and masonry residences, some dating back to the early 1900s.

The Construction/Design team met this challenge by placing the structure as close to the city street edge as possible. This followed the urban, zero front yard guidelines of the older neighborhoods, where it was typical to have the residence's front door open onto the stoop and down onto the city sidewalk.

The facility's exterior lighting, landscape, sidewalks and hardscape followed the design elements of the project directly across the street. This will enhance what is to eventually become a walkable, urban, office and learning environment complimenting the city of Whiting's trails, ballpark and recently developed lakefront.

The **exp** team can be proud of meeting the design challenges head on, while enhancing the safety of the sixth largest refinery in the U.S.

rebuilding conveyor galleries

PORT-CARTIER, QUEBEC, CANADA

In the mining sector, conveyor galleries are an integral part of the ore delivery process. They form an aerial link between various buildings and ensure material transportation from one site to another. Located some 20 to 50 metres above ground, these structures may run between 50 and 250 metres in length. This equipment frequently dates back to the late 1950s. **Exp** has been involved in several conveyor rebuilds for various clients.

In the case of one of our clients, an iron ore producer, structural elements of the installations found on site were heavily corroded (a process accelerated by the presence of iron ore on the floor combined with floor-washing operations), so much so that the entire structure was at risk of collapsing and potentially causing injuries, damages and production losses. These conveyor galleries were clearly at the end of their lifecycle. The failure of a single part could result in a chain reaction leading to a complete or partial collapse, since these are isostatic structures.

We therefore developed a process that allowed us to reconstruct the floors, lower rails, brackets, beams and columns without disrupting production, despite these conveyors' heavy production capacity (6,000 tons/hour).

First, we used structural modelling to develop an analysis model based on and validated by the original design. Next, we integrated the residual steel thicknesses into the model, to obtain a dynamic model of the structure's current condition. Using this model, we also analyzed the various loading methods (mineral, wind, snow, etc.), and prepared a forecast of additional material losses in the coming years. In doing so, we were able to demonstrate the incurred risks, both current and future, of failing to carry out major work to remedy the situation. We were able to focus our reconstruction work and, in the end, give these structures an additional lifespan of over 25 years.

Since 2006, we have carried out five conveyor gallery reconstruction projects totalling more than \$18 M in job costs. This success is directly attributable to our innovation, ingenuity, and boldness, and to the trust of our clients.





supersizing an industrial plant

MAPEI WAREHOUSE AND PRODUCTION PLANT, ONTARIO, CANADA

The MAPEI Group, with 70 subsidiaries including 64 plants in 31 countries, is today the world leader in the manufacturing of adhesives and complementary products for the installation of all types of floor and wall coverings. They also have an extensive range of products for all types of concrete restoration systems, sealants and waterproofing.

Our team was involved with the renovation of an existing warehouse and the construction of a new 44 m tall mixing tower (which can be seen as far as 20 miles away) for the new MAPEI Americas dry mortar production plant in Brampton, Ontario.

Our team provided civil, geotechnical, structural, mechanical, electrical, inspection and testing services in the renovation of the existing warehouse. The facility contains new offices, a quality control lab, a training room, mixing tower and over 100,000 square feet of high density racking storage.

As far as developing the site goes, **exp's** involvement included schematic design and detailed design, stormwater management system design, construction drawings and construction review.

The structural renovations to the existing building included major revisions to the primary lateral force resisting system and the existing slab-on-grade was replaced with a new specially

designed slab-on-engineered fill to withstand the high loads of the storage racking and forklifts. Our structural engineers were also responsible for the design of the mixing tower foundation systems which was comprised of a framed concrete slab supported on drilled caissons.

Mechanical systems include HVAC modifications for the office space, new washroom and locker facilities and fire protection. Mechanical systems for the mixing tower include a dedicated ventilation system and gas-fired heating units. For the truck bay, a dedicated NO₂ and CO ventilation system with remote sensors is provided along with heating units.

New lighting for the warehouse incorporates energy efficient fixtures with occupancy sensors and self-testing integral emergency inverter lighting ballasts. A new 1600-amp electrical service with 1500 kVA transformer vault was provided as well as power distribution and controls for all the grout handling equipment. An aspiration-type fire alarm system was also provided for the mixing tower to provide early warning smoke detection in the high dust and high heat environment.

This "supersizing" project was completed in June, 2013. The work on the facility led one Ministry of Labour inspector to comment, "These people work for employers who really care about their employees."

turning landfill gas into energy

MUNICIPAL SOLID WASTE, NEW BRUNSWICK, CANADA

Northwestern New Brunswick and parts of Maine produce over 50,000 tons of municipal solid waste (or MSW) each year. The “Commission de gestion enviro ressources du Nord-Ouest” (or COGERNO) is a non-profit organization mandated to manage this waste in an environmentally and socially acceptable manner.

A landfill was constructed in 1997 to collect and treat leachate (contaminated water) produced by solid waste. A recycling depot program was then introduced by COGERNO to divert recyclable materials from the landfill.

Although these processes address two major environmental impacts related to the disposal of municipal solid waste, landfill gas (LFG) emissions during decomposition continue to produce greenhouse gases, including methane.

Reduction or elimination of methane gas discharges was identified by the client as the main objective for this project. With the help of **exp**, a landfill gas collection and utilization project was completed (from 2009 to 2013) to further minimize the environmental footprint of MSW management operations. The services we provided included project management, development and planning for the entire project, conduction of a landfill gas production pilot study, and design and construction of the landfill gas wells and collection system.

Over time, landfill waste settles and the collection pipes located above it also settle. Therefore, the slopes of the collection pipes were increased to compensate for future settlement. In addition, pipes were installed along the finished landfill slopes to minimize the depth of overlying waste. In order to improve previous applications and energy efficiency, the design team applied a number of innovative technologies including:

- Construction of large 900 mm diameter gravel packed wells with specialized 250 mm diameter wells to optimize gas extraction
- Increase of slopes on LFG piping and installation of these pipes along the slopes using trenchless technology (horizontal drilling)
- Installation of fully operational system including a 633 kW LFG-fired generator with energy recovery to heat COGERNO's buildings

This project has played an important role in the reduction of greenhouse gases. It's also a perfect example of how innovative thinking can turn a potentially harmful situation into one with environmental, economic, and social benefits.

Social, economic and environmental benefits

- Reduction of over 17,000 tons of carbon equivalents of greenhouse gases emissions
- \$30,000 savings in buildings heating cost (ROI estimated under 8 years)
- 5,000 MWh of electricity produced - reducing tipping fee charged to municipalities for waste management

Exp and COGERNO received the Environmental/Society award from the ACEC-NB for the project in 2014.





- Winner of the Léonard award at the 2012 Grands Prix du génie-conseil québécois
- Winner of the ACEC's 2012 Schreyer Award
- Winner of the OIQ's Prix Génie Innovation 2013

Hydrogen sulphide is a flammable, highly toxic, colorless and foul-smelling gas.

gas treatment and odour elimination

WORLD-UNIQUE PROCESSES

When it comes to gases produced by waste from industrial processes, very few reclamation or destruction processes are available, and those that are available are either damaging to the ozone layer or have limited effectiveness. Our experts in research laboratories and mobile units are working on developing and implementing new processes.

Photocatalytic oxidation process (PGT)

When working with Uniboard Pflleiderer, we invented a photocatalytic gas treatment (PGT) process capable of destroying certain volatile organic compounds (VOCs).

Because they produce greenhouse gases, release into air of those VOCs and other molecules—such as methanol and formaldehyde—is subject to strict standards.

With destruction levels reaching 94%, the results are well above expectations and easily meet all applicable regional or national environmental standard requirements. This is a first in advanced oxidation where hydrogen peroxide is used to produce, by homogeneous catalysis, the oxidizing agent—the hydroxyl radical—allowing for the dynamic cleaning of polluting industrial gases.

This ground breaking technology developed by **exp** is unique and

is now patented or has patents pending in 39 countries. To this day, ten PGT units were built and are currently in operation across Canada and the United States.

Odors and odorous molecules elimination process

Initially developed for a French company looking for an odour abatement solution for one of its plants which produced high emissions of hydrogen sulphide (H₂S), and then further developed for implementation in a Malaysian company plant producing extremely toxic emissions, a team of experts from our Québec city office designed an innovative odour and H₂S elimination process. The new process, which uses two acid-base absorption towers, eliminates 100% of H₂S and 97% of odours, thiols and ammonia products.

The process invented by our professionals can be adapted for use in all municipal sewage treatment plants. It is currently undergoing audit in our labs for a Saudi Arabian company looking for an innovative process to clean 10 million CFM of vitiated air at the Mecca—a huge project. Patent applications are currently undergoing expedited examination in Canada and the United States.

With a mission to understand, innovate, partner and deliver, **exp** provide professional, technical and strategic services to the world's built and natural environments in six key practice areas: Buildings, Earth & Environment, Energy, Industrial, Infrastructure, and Sustainability. Our heritage dates back to 1906, when the earliest of **exp's** predecessor companies started its engineering infrastructure practice in northern Ontario.

Today, close to 3,000 creative **exp** professionals across North America and around the globe provide the expertise and experience needed to deliver successful projects for clients.

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