WHITE PAPER / **DESIGNING AND CONSTRUCTING IN NORTHERN CANADA**

OVERCOMING EXTREME WEATHER IN NORTHERN CANADA FOR EFFECTIVE PROJECT DELIVERY

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The world's second-largest country, Canada is known for its natural beauty, diverse wildlife and multicultural diversity. It's also known for its severe winters and below-freezing temperatures. Oddly enough — for many reasons — wintertime is the height of construction season, presenting a host of distinctive design and execution challenges.

With impassable swamplike environments and lively migratory seasons of protected species, summertime in Northern Canada is often more conducive to sightseeing than building. Though wintertime comes with many unique difficulties to overcome — especially in the northern, more remote areas where temperatures can drop to minus 50 degrees Celsius — it provides the frozen ground that allows heavy construction equipment access. Despite the area's sparse populations and harsh seasonal climate, this is where the mining, oil and gas, power generation and timber industries thrive.

These "ideal" conditions, however, provide only a 3- to 4-month window for construction activities, emphasizing the importance of strategic engineering design and efficient construction methods.

ESTABLISHING THOUGHTFUL DESIGN PLANS

For generations, the First Nations, or aboriginal, communities have found a home within the area's vast landscape, using the land for hunting, fishing, trapping and more. Consulting with local populations to identify areas of significant importance, including sacred sites, to avoid disturbing their way of life is crucial step in the planning process. The same amount of intense scrutiny goes into protecting endangered species' habitats and abiding by environmental conservation regulations. Developing design plans — creating custom routes around restricted areas while limiting environmental impacts — plays a significant role in achieving stakeholder approvals and maintaining community relations.

Within the plan itself, the main design consideration for completing work in northern Canada is the performance of materials — because, at frigid temperatures, many will fail. For this region, all structural steel, including bolts, nuts and hardware, is required to undergo a Charpy impact test to determine energy absorption, or the amount of energy absorbed by a material during fracture, and identify notch toughness. As a rule of thumb, project teams typically request the minimum acceptable value at a specified temperature to meet the Canadian Standards Association requirements. Additionally, the Association of Professional Engineers and Geoscientists of Alberta requires licensed structural engineers have experience working in Canada or similar extreme cold weather environments. Understanding the material property changes in cold environments help them deliver designs that consider environmental constraints and will perform at temperatures reaching minus 40 or 50 degrees Celsius.

Another requirement is a design that's quick to erect. Depending on the voltage of a transmission line, for example, structures can extend farther than the traditional 250-meter range at 230-kV class, minimizing the number required within a nontraditional design. For AltaLink's Christina Lake Area Development Project in Northern Alberta, the Burns & McDonnell transmission line team suggested using tubular steel H-frame structures, about 350 meters apart, instead of lattice steel towers because they would take less time to install: one day, rather than a week to build on-site. Though they could have required larger foundation build-up, H-frame structures helped AltaLink meet its in-service date for a new 22-kilometer (km) double-circuit 240-kV transmission line and 240-/138-kV greenfield substation. Guy wire — tensioned cable that adds stability to freestanding structures — will do the trick, too, and installation of the structure mast and guy anchor happens faster compared to a self-supported lattice steel tower.

Foundations, and their lasting performance, are heavily considered in these scenarios as well. Concrete, for instance, isn't easy to find or work with at temperatures drastically below freezing. In fact, it isn't allowed unless there's a heating source nearby to properly install and protect the concrete structures. To address the muskeg, or low-lying marsh made of decomposing organic material, in Northern Alberta, helical screw pile foundations are commonly used. Made of a series of strong columns inserted underground, this foundation is easier to install in softer terrain and provides protection from permafrost as it naturally creates separation between the frozen ground and structure.

To penetrate the shale in Ontario, however, a series of micropiles — consisting of small, high-strength steel casings — can be installed and secured with a steel pile cap, reinforcing the structure base connection within difficult ground conditions.

After establishing a durable design — by evaluating the most economical and effective material, structure and foundation options for the specified field condition — the focus turns to defining the safest approach for the fastest construction. This not only considers stringent Canadian laws but also the safety of the entire project team.

IMPLEMENTING RESOLUTE CONSTRUCTION PRACTICES

Though Canada is vast — nearly 10 million square kilometers — more than 90% of its population lives within roughly 240 kilometers of the U.S. border. Extending beyond that perimeter, however, is where most projects are constructed, requiring the construction schedule solve for a host of logical challenges presented by remote project locations. The limited availability of permanent roads and workforce accommodations; scarcity of resources; and the reduced productivity, up to 30%-40%, due to extreme weather conditions are main considerations for successful project execution.

DETAILS ON THE LINE

In these northern conditions, no detail is too small. Each carries a significant amount of weight. For instance:

- **Installing bird reflectors on shield wires to keep birds from flying into the wires.**
- **Adhering warning lights to conductor towers to alert aircraft.**
- **Denoting spin and railroad crossings to enhance safety measures along pathways to prevent accidents.**
- **Identifying and demarcating guy wires to caution approaching users of snowmobiles.**
- **Employing selective vegetation clearing along a right-of-way to limit the line of sight, increasing protection from caribou predators.**
- **Banning the use of implosions for conductor splicing because of the noise disruption to pregnant caribou; only compression splicing is used.**

Northern Canada has few towns. Projects rely on permanent workforce accommodation camps where they exist, but there is a premium to pay for this access. These camps can be in high demand when competing projects are in the area so, depending on the level of activity, temporary workforce camps can be set up and administered by the project team but need to be accounted for in budget and schedule. Communication in these remote areas presents yet another challenge. Phone and internet access can be scarce, so project teams need to make extraordinary plans — including for installation and use of satellite communication — and develop emergency response plans tailored to these limitations.

In the field, soil conditions create specific challenges that require well-planned, and well-known, solutions. As previously mentioned, much of the soil in Northern Alberta consists of muskeg, which offers little structural value. For new sites, this material must either be removed — and replaced with imported material, trucked in at a potentially high cost — or drilled through to reach competent soil, usually a meter or two below. This swamplike environment is a significant impediment to transportation as it can fail to support equipment and lead to sinking, one of the main reasons why most civil work takes place in the winter. Another reason for winter construction is to avoid disturbances to migratory and calving seasons — generally spanning spring and summer months — for many of the endangered animals that reside in these project areas.

Acquiring structural backfill or aggregate, especially for building roads, can be a luxury. Most temporary access roads are either corduroy (log) roads, seasonal ice roads or trails made of construction mats. The cost of creating access to work sites, especially on lengthy linear projects, is high, sometimes accounting for up to half of the construction costs. Such expenses, along with the need to conserve undisturbed habitats, are reasons why projects compete for sites that are conveniently located next to existing roads.

Various projects, such as distribution lines, pipelines, oil wells, etc., tend to compete for the same resources. As project teams contend for what they need, these utility corridors can get congested. While working in proximity to other projects, the construction team must take action to protect nearby facilities and assets. Implementing additional safety measures, such as placing mats to bridge over utilities or installing cathodic protection for pipelines, can significantly increase the cost of projects when protecting several hundred feet of pipe.

This competition also factors into road use permits — because some roads are privately owned and charge usage fees. One of the goals of construction projects in the North is to minimize their footprints by avoiding unnecessary tree-clearing, compelling project teams to compete for leases of predisturbed, well-located sites that also can be used for storage of materials and equipment. Water, a resource that is abundant yet in high demand, is used to freeze and maintain ice roads. A water diversion license is required to pump water from an abundance of water sources — and the Alberta Environment Protection Agency limits the number of these licenses awarded each year.

Given the short construction season, work must happen quickly. To the extent possible, project teams can incorporate modularization and prefabrication — as our team did for Saskatchewan's 353-megawatt natural gas-fired Chinook Power Station in Swift Current for SaskPower — for added efficiency within a construction schedule. Any preassembly that can be done in a shop or at a yard, sheltered from the harsh environment, will benefit project schedules; however, any modularization plan must consider limitations on road use. Several roads are closed seasonally or not rated to support heavy loads, so a thorough material transportation plan is key to efficient project advancement.

To successfully execute work within such unfavorable environments requires a qualified, capable, well-rounded team of professionals. It helps to partner with constructors who have knowledge of the environment, especially since time is of the essence. Project teams can work to support local economies by establishing partnerships with local companies, many of which have aboriginal affiliations, that can clear the right-of-way and perform earthwork and many other trades that are required on our projects, including project logistics with workforce camps, fueling services, security, treatment of medical emergencies, and more.

Knowing what to expect is half the battle. Addressing province intricacies while preserving traditions will get the job done fast and deliver lasting, predictable results, no matter the weather. However, for successful project completion in Northern Canada, at times, the colder, the better.

BIOGRAPHIES

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