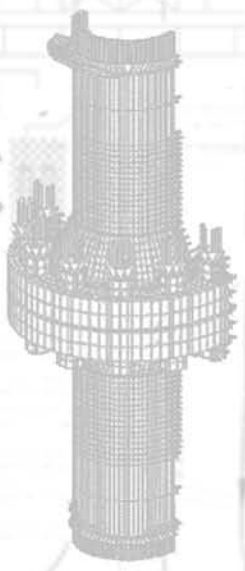
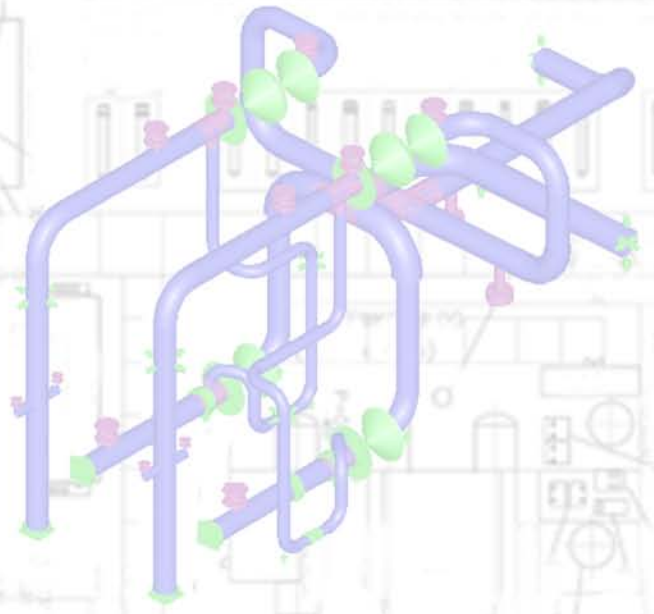


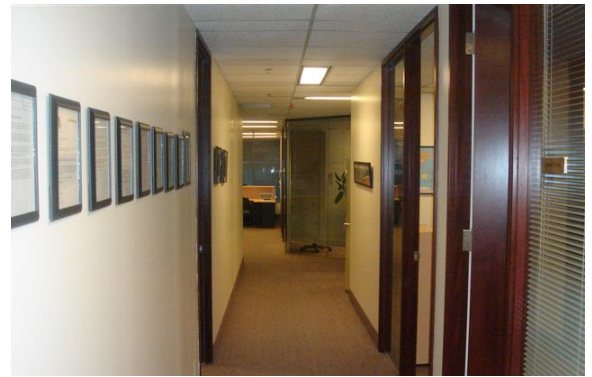
CONSULTING ENGINEERS



 **Brighton Solutions Ltd.**

Company & Services

Brighton Solutions Ltd. is a Canadian owned multi-disciplinary consulting firm. Brighton has been providing professional engineering and management services since 1988 to industrial clients in Canada and countries around the world.



Brighton services include:

B Failure Analysis and Fit-For-Service Report

B Pipe Stress Analysis, Materials Engineering, Design Audit and CRN Registration

B Finite Element Analysis (FEA) on Pressure Vessel and Piping

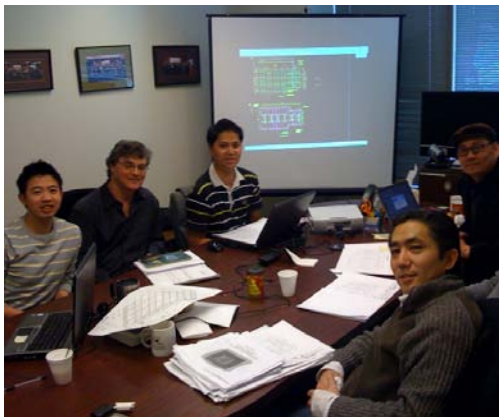
B Water Hammering and Surge Analysis

B Vibration Analysis and Solutions

B Structural Analysis and Module Design

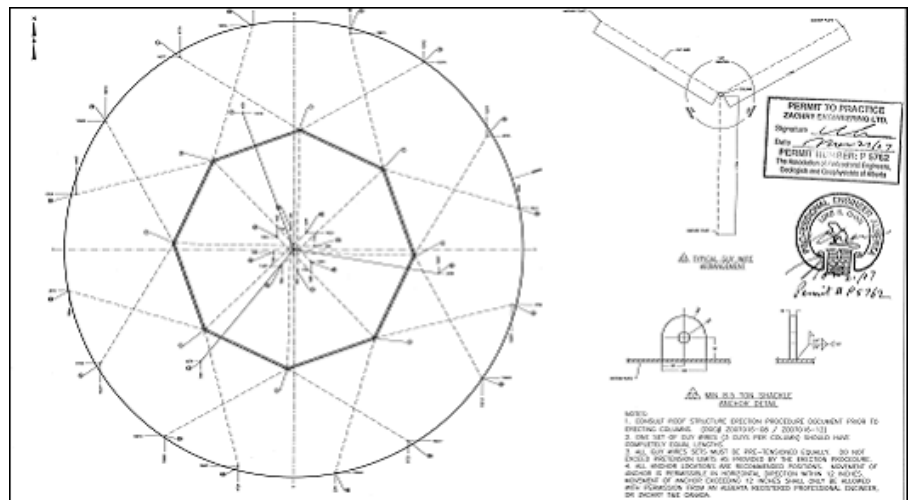
B Electrical and Instrumentation Facility Design and Audit

B Process Engineering SAGD



Our goal is to provide the highest services to our clients at extremely competitive rates. This added-value service includes client focus, being innovative and flexible and ongoing commitment to quality.

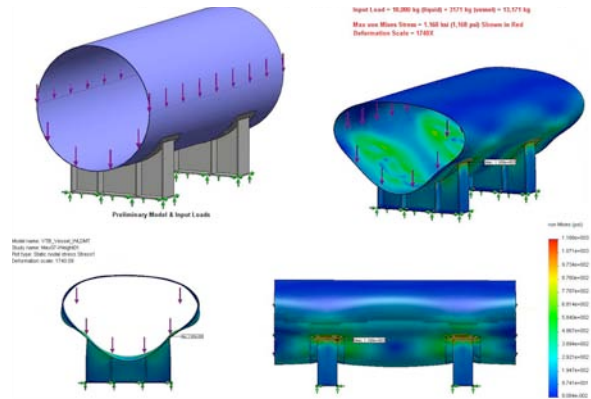
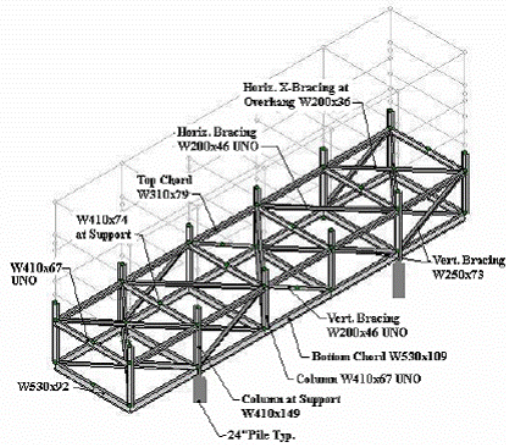
“Our goal is to provide the highest services to our clients at extremely competitive rates. This added-value service includes client focus, being innovative and flexible and ongoing commitment to quality.”



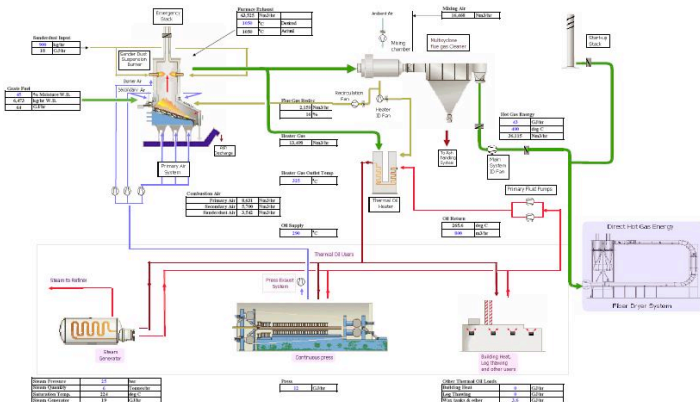
Professional Engineers

Our teams of professional engineers are members of:

- APEGGA (Association of Professional Engineers, Geologists and Geophysicists of Alberta)
- APEGBC (Association of Professional Engineers and Geoscientists of British Columbia)
- APEGS (Association of Professional Engineers and Geoscientists of Saskatchewan)
- NAPEG (Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists)
- PEO (Professional Engineers of Ontario)



We have participated in numerous projects in Canada, the U.S.A., Bermuda, China, South Africa, Japan and Australia. Extensive project experience including Shell Scotford Refinery, Cenovus SAGD plants, Syncrude engineering specifications, Penn West pipelines, OSB plant designs and British Barrick Cowal Gold Mine Project in Australia.

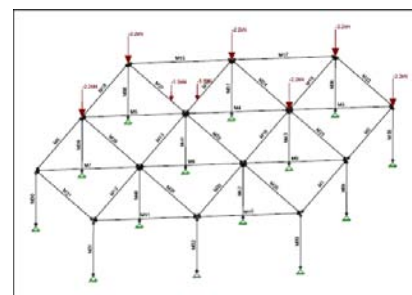


Principal Engineering Consultants:

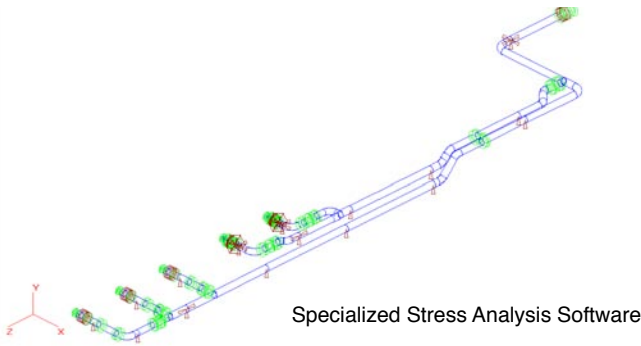
- Luke K Chan P.Eng.
- Gee K. Young P.Eng.
- Tony Lo P.Eng.
- Ian Liu P.Eng.
- Michael Cung P.Eng.
- Enoch Ng P.Eng.

Brighton is an integrated engineering-to-fabrication, installation and maintenance company with full engineering, design, fabrication and construction capabilities to provide complete start-to-finish project solutions to the energy and mining industries in Western Canada and other countries.

Our Approach has been to develop long term relationships and we recognize our client success is our success. Brighton has provided value engineering through auditing piping and structural designs, innovation logs and risk assessment of projects.

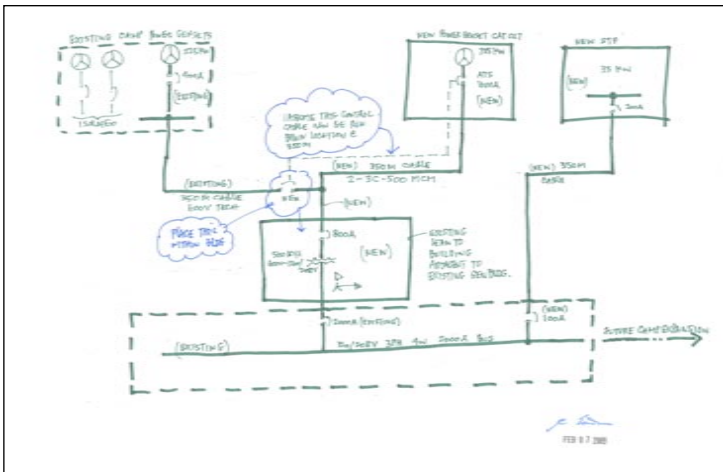


Brighton specializes in engineering design, project management, industrial equipment fabrication, construction, material handling, international labor sourcing and training. We are well versed in the areas of SAGD, oil sands, refineries, petrochemicals and pipeline segments and covers both operational and engineering aspects.



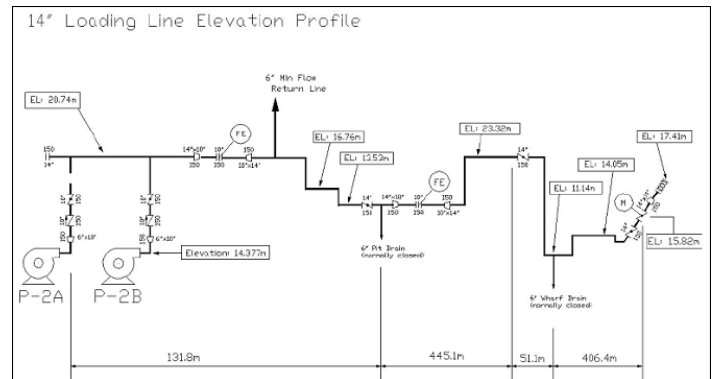
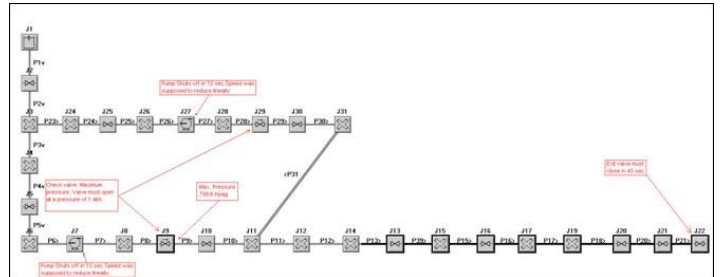
Specialized Stress Analysis Software

- Structural design software allows us to analyze structural loads and the forces that act on members to ensure that our structures meet Canadian and International Building Codes.



- Completing intricate Electrical calculations, we are able to procure large scale electrical systems such as power transmissions and motor controls.

- With our Specialized Stress Analysis software, we are able to analyze any piping system to ensure it meets Canadian (CSA), American (ASME) or International Codes.
- Finite Element software allows us to input real world static and dynamic conditions to simulate actual process conditions enabling us to provide optimal designs or failure analysis.



- We optimize chemical processes through computer-based methods to produce Process Conditions. With our vast experience, it allows us to create an ideal process for efficiency.
- Our team of experts can be readily mobilized for inspections, vibration measurement and even accurate laser-assisted As-Built modeling. This ensures a rapid and sound engineering solution to any problem that may arise.

Our Mission is to provide:

- High Quality Results
- Low Installed Costs
- Innovation and Efficiency
- Maintained Focus (On Time/Within Budget)
- Flexibility
- Responsiveness



Useful Engineering Charts

Accompanied along with our skills, knowledge and understanding, we have included some unique charts, tables and formulas that we frequently use.

When doing Stress Analysis with our specialized software, we follow this Suggested Guide Spacing table.

Pipe Guide Spacing

Suggested Pipe Guide Spacing				
Line Size (Inches)	Across Loops (Feet)	Horizontal Pipe Runs (Feet)	From Changes in Direction (Feet)*	On Pipe Risers (Feet)*+
2 & Smaller	20	30-40	20	20-25
3	30	40-50	25	25
4	40	50-60	30	30
6	60	50-70	35	30-45
8 through 12	60	60-80	40	35-45
14 through 20	60	70-90	45	50-55
24 and larger	60	80-100	50	60

*The use of Pipe Guides on Hot Lines must be investigated to assure that no excessive stresses or forces are transmitted to the piping system due to the location of the Pipe Guide.

+Recommend guide spacing for top supported risers with a wind pressure of approx. 30 lbs/sq ft. For risers supported at the bottom, the guide spacing must be computed to avoid buckling under the weight load.

For lines subjected to dynamic excitation, the guide spacing must be calculated to avoid span resonance and to control vibrations.

In general, space guides on lines 4 inches and smaller at every other pipe support. Guide lines 6 inches and larger at every third support.

Pipe Fatigue and Vibration Control

When analyzing Pipe Fatigue and Vibration Control, we refer to the Maximum Allowable Pipe Span for Detuning table to confirm our piping spans do not exceed the maximums.

Maximum Allowable Pipe Span (ft) for Detuning							
Natural Frequency	Nominal Pipe Size / Outside Diameter (in)						
	1 1/2	2	4	6	8	10	12
	1.90	2.375	4.500	6.625	8.625	8.625	10.75
10 Hz	11.9	13.3	18.3	22.2	25.3	28.3	30.8
20 Hz	8.4	9.4	12.9	15.7	17.9	20.0	21.8
30 Hz	6.9	7.7	10.6	12.8	14.6	16.3	17.8
40 Hz	5.9	6.7	9.2	11.1	12.7	14.1	15.4
50 Hz	5.3	5.9	8.2	9.9	11.3	12.7	13.8
60 Hz	4.9	5.4	7.5	9.1	10.3	11.6	12.6

PSV Reaction Forces in an Open System

Determining Reaction Forces in an Open-Discharge System

In the rare instance that we have to calculate reaction forces for PSV's (Pressure Safety Valves) in an Open System, we use the formula shown below.

$$F = \frac{W \sqrt{\frac{kT}{(k+1)M}}}{366} + (A_o \times P_2)$$

F = reaction force at the point of discharge to the atmosphere, in pounds.

W = flow of any gas or vapor, in pounds per hour.

k = ratio of specific heat (C_p/C_v)

C_p = specific heat at constant pressure.

C_v = specific heat at constant volume.

T = temperature at inlet, in degrees Rankine (degrees Fahrenheit + 460)

M = molecular weight of the process fluid.

A_o = area of the outlet at the point of discharge. in square inches.

P₂ = static pressure at the point or discharge, in pounds per square inch gauge.

Useful Engineering Charts

When calculating correct weights of pipe sections, we use the following table for materials other than carbon steel.

The formula following, is used to calculate the weight of insulation. The table below shows weight of insulation for Calcium Silicate.

Pipe and Insulation Weight

Weight of Pipe

Relative Weight Factors to Carbon Steel

Aluminum	= 0.35
Brass	= 1.12
Cast Iron	= 0.91
Copper	= 1.14
Ferritic Stainless Steel	= 0.95
Austenitic Stainless Steel	= 1.02
Carbon Steel	= 1.00
Wrought Iron	= 0.98

Weight of Insulation of the Pipe

- I = Insulation density in pounds per cubic foot
- T = Insulation thickness = inches
- D = Outside diameter of pipe = inches

$$\text{Weight of Insulation} = 0.0218 \text{ IT (D+T)} = \text{lb/ft.}$$

Values for I	Lbs./ft ³
Calcium Silicate	= 11
Poly-Urethane	= 2.3
Foamglass	= 9
Cellular Glass	= 9
Mineral Wool	= 8

Weight of Insulation Thickness of Calcium Silicate (lbs/linear feet)								
	1"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	4 1/2"
2"	1.01	1.71	2.53	3.48	4.42	5.59		
3"	1.25	2.08	3.01	4.07	5.24	6.65		
4"	1.62	2.55	3.61	4.66	6.07	7.48	9.10	
6"	2.11	3.28	4.57	6.09	7.60	9.82	11.5	
8"		4.13	5.64	7.85	9.48	11.5	13.8	16.0
10"		5.20	7.07	8.93	11.0	13.2	15.5	18.1
12"		6.04	8.13	10.5	12.7	15.1	17.4	20.4
14"		6.16	8.38	10.7	13.1	15.8	18.5	21.3
16"		6.90	9.33	12.0	14.6	17.5	20.5	23.6
18"		7.73	10.4	13.3	16.3	19.3	22.6	25.9
20"		8.45	11.6	14.6	17.7	21.1	24.6	28.1
24"		10.0	13.4	17.0	21.0	24.8	28.7	32.9

Conversion Charts

Specific Heat Capacity				
Conversion equivalents - SI Unit: (energy/mass x temperature) = J/kg K				
to obtain by multiply	kilojoule per kilogram degree Celsius (kJ/kg°C)	kilocalorie per kilogram degree Celsius (kcal/kg°C)	Btu per pound degree F (Btu/lb.°C)	foot-pound force per pound degree F (ft.lbf/lb.°C)
kJ/kg°C	1	2.3885 E - 01	2.3885 E - 01	1.8586 E + 02
kcal/kg°C	4.1868 E + 00	1	1.0000 E + 00	7.7817 E + 02
Btu/lb.°C	4.1868 E + 00	1.0000 E + 00	1	7.7817 E + 02
ft.lbf/lb.°F	5.3803 E - 03	1.2851 E - 03	1.2851 E - 03	1

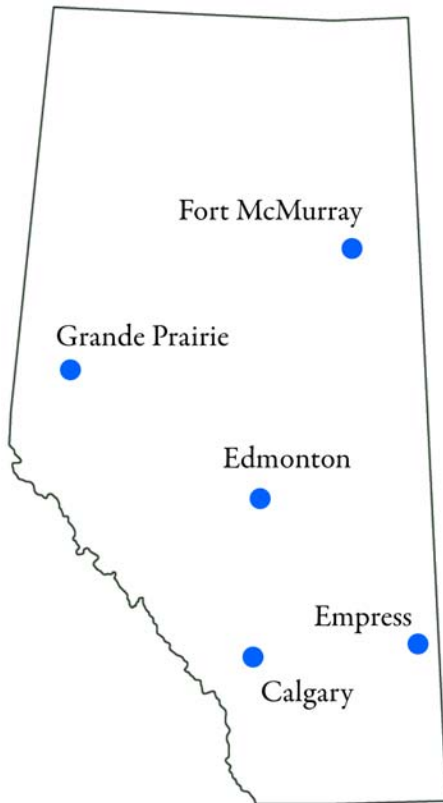
$$1 \text{ kgf.m/kg°C} = 0.0023423 \text{ kcal/kg.°C} = 0.0098066 \text{ kJ/kg.°C}$$

Power & Heat Flow						
to obtain by multiply	kilowatt (kW)	megawatt (MW)	kilocalorie per hour (kcal/h)	metric horsepower (metric hp)	Btu per hour (Btu/h)	Horsepower (hp)
kW	1	1.0000 E - 03	8.5985 E + 02	1.3596 E + 00	3.4121 E + 03	1.3410 E + 00
MW	1.0000 E + 03	1	8.5985 E + 05	1.3596 E + 03	3.4121 E + 06	1.3410 E + 03
kcal/h	1.630 E - 03	1.630 E - 03	1	1.5812 E - 03	3.9683 E + 00	1.5596 E - 03
metric hp	7.3550 E - 01	7.3550 E - 01	6.3243 E + 02	1	2.5100 E + 03	9.8632 E - 01
Btu/h	2.9307 E - 04	2.9307 E - 07	2.5200 E - 01	3.9846 E - 04	1	3.9301 E - 04
hp(Imp)	7.4570 E - 01	7.4570 E - 04	6.4119 E + 02	1.0139 E + 00	2.5440 E + 03	1

SI Prefixes		
Prefix	Symbol	Multiplying Factor
exa	E	1 000 000 000 000 000 = 10 ¹⁸
peta	P	1 000 000 000 000 000 = 10 ¹⁵
tera	T	1 000 000 000 000 = 10 ¹²
giga	G	1 000 000 000 = 10 ⁹
mega	M	1 000 000 = 10 ⁶
kilo	k	1 000 = 10 ³
hecto	h	100 = 10 ²
deca	da	10 = 10 ¹
deci	d	0.1 = 10 ⁻¹
centi	c	0.01 = 10 ⁻²
milli	m	0.001 = 10 ⁻³
micro	μ	0.000 001 = 10 ⁻⁶
nano	n	0.000 000 001 = 10 ⁻⁹
pico	p	0.000 000 000 001 = 10 ⁻¹²
femto	f	0.000 000 000 000 001 = 10 ⁻¹⁵
atto	a	0.000 000 000 000 000 001 = 10 ⁻¹⁸

Engineering Design Data for Fort McMurray

With the majority of the oil sands projects based in Fort McMurray, Alberta, this chart becomes very useful and is user-friendly, and accessible.



Basic Design Data (for Fort McMurray)								
Description	SI System				Imperial System			
		January	July	Yearly		January	July	Yearly
Temperature								
Average	°C	-21	16	-0.5	°F	-6	62	31
Maximum	°C	10	36	36	°F	50	96	97
Minimum	°C	-50	-3	-51	°F	-58	26	-59
Design (2-1/2 % Basis)	°C	-39	28	-	°F	-38	84	-
Design (Winterization)	°C	-	-	-51	°F	-	-	-59
Wind		Winter	Summer	Yearly		Winter	Summer	Yearly
Average Velocity	km/h			10	mph			6.2
Maximum Velocity	km/h			84	mph			45
Maximum Gust	km/h			105	mph			65
Prevailing Direction		ESE+NW	ESE+NNW	ESE		ESE+NW	ESE+NNW	ESE
Probability		Wind Pressure (KPa)	Wind Velocity (m/s)		Wind Pressure (psf)	Wind Velocity (ft/s)		
1/10		0.27	20.4		5.64	66.92		
1/50		0.35	23.3		7.31	76.44		
Earthquake (Design Basis)		CNBC ZONE NONE			CNBC			
Snow								
Average Annual	mm		1397		in.		55	
Greatest in 24hrs. Annual	mm		297		in.		12	
Ground Snow Load (1/50)	KPa		1.4		psf.		29.24	
Frost								
Perma Frost	mm		NO		in.		NO	
Design Ground Penetration	mm		3048		in.		120	
Rainfall								
Average Annual	mm		340		in.		13.4	
Greatest in 24hrs. Annual	mm		92		in.		3.62	
Design Max Rate - 15min	mm		13		in.		0.52	
Tides								
Low Below Mean Low Tide	m		N/A		ft.		N/A	
Low Above Mean Low Tide	m		N/A		ft.		N/A	
Degree - Days								
Heating - Below 18°C (65°F)			6.550					
Freezing - Below 0.0°C (32°F)			2.345					
Special Provisions Required								
Lightning			Yes				Yes	
Dust Storms			No				No	
Site Elevation above sea level is approx.	m		255		ft.		836.614	
Atmosphere Pressure - Design	kPa		95.95		psi		14.2	

Brighton has been involved in various projects in the Engineering discipline.

Ainsworth Grande Prairie OSB Plant
Amoco Nipissi Miscible Flood
Amoco West Pembina
ARCO Alpine Alaska South Slope
Bermuda (Municipal Waste Treatment)
Bermuda Ministry of Works
BP Wolfe Lake I and II
Calgary Bonnybrook Wastewater Treatment
Celanese Methanol Plant
Cenovus Christina Lake SAGD
Cenovus Foster Creek SAGD
CNRL Horizon U&O Piping Audit and Module Design Audit
CNRL Wolf Lake Primrose Steam and Production Pipelines
Comico Urea Revamp
Edmonton Municipal Wastewater Treatment Plants
Edmonton Power Steam Piping Revamp
Enbridge Tank Farm Piping
Esso Boundary Lake
Esso Cold Lake Pipeline Support FEA
Exxon Mobil Sakhalin Offshore Projects
Footner High Level OSB Mill
Gulf Rimbey Gas Plant Reciprocating Compressor
Hamilton Woodward Avenue Wastewater Treatment
JCOS Hanging Stone SAGD
Kazakhstan Hurricane Gas Utilization
Kuwaiti National Petroleum Mina Abulla Refinery
Newmont Mining (Denver, Colorado)
Nexen (Gas plants)
Nexen Gas Plant
Noranda Reactor Acid Plant
Novacor Medicine Hats Methanol and Joffre Plants
Novagas Compressor Stations in: Caribou, Midwinter, Jedni and Peygo

Penn West (Swan Hills Pipelines)
PetroCanada Gold River (Suncor)
PetroCanada Pipelines (Before the Suncor merging)
Placer Cego Gas Plant
Placer Dome Musselwhite Mine
Saferco Nitrogen
Shell Athabasca Hydrogen Manufacturing Unit
Shell Canada (Scotford/Athabasca Upgraders, Gas plants)
Shell Caroline Gas Plant, Limestone Plant, Ram River Station
Shell Global (Consulting Service)
Shell Peace River Soak Well In-Situ Project 2000
Shell Rosevear Gas Plant
Shell Scotford Refinery
Shell-Flint-TriOcean Alliance Pipelines
Sherritt International (Cuba Oil & Gas)
South Africa Bulyanhulu Gold Mine
Spectra Empress Ethane Extraction
Spectra Energy
Stauffer Regen Sulphuric Acid
Sulphur Canada Prince Rupert Export Terminal
Suncor (U&O)
Suncor Pressure Vessel Nozzle FEA
Sunoco Philadelphia Refinery
Syncrude Piping Specification Upgrade 1987
Synenco
TCPL Maxim Gold River
TCPL Pipeline Hot Tap Saddle Design
TCPL Winnipeg Compressor Station
TransCanada Pipeline Edson Pipelines
Weyerhaeuser Hudson Bay OSB Mill
Weyerhaeuser Kenora Joist OSB Plant
Williams Energy Cochrane Gas Plant



We are also an approved Vendor for the following companies:

Shell Canada
Shell Global
Newmont Mining
Nexen
Suncor
Penn West
Sherritt International
Bermuda
Spectra Energy
Synenco

 **Brighton Solutions Ltd.**

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