NEXTBRIDGE
INFRASTRUCTURE

February 24, 2014

VIA COURIER, EMAIL, RESS

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON
M4P 1E4

Dear Ms. Walli:

Re: EB-2011-0140: East-West Tie Line Designation
Monthly Report February 24, 2014

Enclosed for filing is the monthly report for Upper Canada Transmission, In. ("NextBridge"), a copy of which was filed through RESS earlier today.

Yours truly,

(Original Signed)

Tania Persad
Senior Legal Counsel, Enbridge Gas Distribution Inc.

ONTARIO ENERGY BOARD

IN THE MATTER OF sections 70 and 78 of the *Ontario Energy Board Act, 1998*;

AND IN THE MATTER OF a Board-initiated proceeding to designate an electricity transmitter to undertake development work for a new electricity transmission line between Northeast and Northwest Ontario: the East-West Tie Line.

UPPER CANADA TRANSMISSION, INC. (d/b/a NextBridge Infrastructure)

Monthly Report

February 24, 2014

1. By the *Decision and Order* dated August 7, 2013 (Decision), the Ontario Energy Board (OEB or Board) decided that the designated transmitter for the development phase of the proposed East-West Tie Line (EWT Project) is NextBridge Infrastructure (NextBridge).

2. In accordance with Ordering Paragraph 2 (page 42) of the Decision and the Board's September 26, 2013 *Decision and Order regarding Reporting by Designated Transmitter*, NextBridge provides this monthly report. This report reflects the financial status of development work on the EWT Project through January 31, 2014. Other aspects of this report are current as of the close of business on the last business day prior to the filing date.

3. This report is organized as follows:
   (a) A summary report on overall EWT Project progress.
   (b) A cost summary providing details for each cost category included in NextBridge's Board approved development cost budget of: i) actual costs to date; ii) percentage of budgeted costs spent to date; iii) updated budget

forecast (if applicable); and iv) forecast variance. Reasons for any forecast variance and associated mitigating measures for negative forecast variances are also provided.

(c) A summary of the status of NextBridge's Board approved development milestones, indicating those that are complete and the status (i.e. on schedule, ahead of schedule or delay/potential delay) of those in progress. If any delay or potential delay in achievement of any of the milestones has been identified, the reasons for the delay, the magnitude and impact of the delay on the broader development schedule and cost, and mitigating steps that have been or will be taken, are reviewed.

(d) A summary of risks and issues that have arisen during development work, including discussion of potential impact of any such developments on schedule, cost or scope, and discussion of options for mitigating or eliminating the risk or issue. This section also provides an update on any previously identified risks or issues.

Overall Project Progress

4. Overall during this period, work towards all milestones continued to progress and the EWT Project is on schedule.

5. In respect of engineering work activities:

(a) Design criteria for conductor and structure was finalized in accord with milestone 3; and

(b) Proposals for the detailed engineering, testing and supply of the steel towers were received on January 30, 2014 and are being evaluated. A contract is expected to be awarded late February, 2014.

6. In respect of route selection, land/ROW acquisition and community/municipal consultation activities, discussions with landowners, permitting agencies and other stakeholders have continued.

   (a) Activities within the community/municipal consultation area included developing the record of consultation and responding to and tracking stakeholder inquiries, including queries in connection with the Terms of Reference (the “ToR”);

   (b) Activities in respect of route selection, land/ROW acquisition included:

      (i) Responding to and tracking landowner inquiries and other landowner engagement activity, including queries in connection with the ToR;

      (ii) Awarding of contract for land appraisal work and initiation of land appraisal activity;

      (iii) Awarding of contract for land survey work and initiation of field work activity; and

      (iv) Compiling a list of mining claim holders to facilitate engagement and land rights acquisition as required.

7. Aboriginal engagement, consultation and participation activities included meetings with the 18 identified First Nation and Métis communities to carry out consultation discussions in person, via telephone and through external consultants, as well as continued discussions on ways these communities can commercially participate in the EWT Project, as outlined in the Aboriginal Participation Plan (Schedule C) submitted as part of the EWT Project January 22, 2014 Monthly Report.

8. In respect of environmental assessment activities, work included:

(a) Continued development of the ToR;

(b) Continued consultation with the Ministry of Environment, Natural Resources, and Tourism, Culture and Sport and others in relation to the ToR; and

(c) Initiation of background review of available data as part of the Environment Assessment.

9. Additional general updates for the reporting period include:

(a) Continued work towards finalization of a System Impact Assessment Study Agreement with IESO.

(b) The procedural steps respecting the appeal by the Ojibways of Pic River First Nation (Pic River) of the Board's designation decision continue to proceed on schedule. NextBridge has served and filed its written argument. The appeal remains scheduled to be heard in Toronto on Wednesday April 2, 2014 and Thursday April 3, 2014.

(c) NextBridge is pleased to announce that it has engaged Michael Power, P.Eng as Project Director for the EWT Project. Michael has over 32-years of progressive management experience in the areas of engineering, construction, project management and stakeholder engagement.

With extensive technical and leadership experience, Michael has served in senior management roles within the electrical utility and power transmission sector in the areas of engineering, construction and project/contract management. In addition, he has experience in managing relationships and negotiations with First Nations, overseeing environmental assessments, and the development and management of effective planning and reporting for project stakeholder review. Michael comes to NextBridge from his role as Director of Project Development at Hydro One Networks Inc.

Attached at Schedule A is a summary of Michael Power's qualifications.

(d) Parks Canada advised NextBridge on February 11, 2014 that it is not prepared to accommodate routing the EWT Project through Pukaswka National Park at this time. NextBridge is evaluating this information and its implications on EWT Project development.

Cost Summary

10. Table 1, below, details for each cost category included in NextBridge's Board approved development cost budget: i) actual costs to date; ii) percentage of budgeted costs spent to date; iii) updated budget forecast (if applicable); and iv) forecast variance.

11. There are no development cost forecast changes arising from work to date.

Table 1: Budgeted Costs Status

	PROJECT TO DATE		TOTAL PROJECT ESTIMATE			
Cost Category	**Actual[1]**	**% of total budget**	**Forecast**	**Budget**	**Variance $**	**Variance %**
Budgeted						
Engineering, Design and Procurement Activity	$935,203	8.9%	$10,553,292	$10,553,292	-	0%
Permitting and Licensing	-	0.0%	47,320	47,320	-	0%
Environmental and Regulatory Approvals	590,922	16.4%	3,592,680	3,592,680	-	0%
Land Rights (Acquisitions or options)	584,921	29.4%	1,991,000	1,991,000	-	0%
First Nation and Métis Consultation	373,503	21.7%	1,724,000	1,724,000	-	0%
Other Consultation	313,815	63.3%	496,001	496,001	-	0%
Regulatory (legal support, rate case and LTC filings)	291,793	29.6%	985,000	985,000	-	0%
Interconnection Studies	40,000	22.3%	179,000	179,000	-	0%
Project Management	420,166	32.3%	1,300,000	1,300,000	-	0%
Contingency (Engineering, Design and Procurement)	-	0.0%	1,529,708	1,529,708	-	0%
Total Budgeted	**$3,550,323**	**15.9%**	**$22,398,001**	**$22,398,001**	**-**	**0%**

12. Table 2, below, details costs to date not included in NextBridge's Board approved development cost budget. This table includes two categories of cost expressly excluded from the development cost budget filed by NextBridge: First Nation and

[1] "Actual" refers to actual costs plus estimated accruals.

Métis land acquisition costs and First Nation and Métis participation costs (see NextBridge Response to Interrogatory 26 to all applicants, attachment 1).

13. The "Other" category on Table 2 records unbudgeted costs that are, to date, for the most part related to the Notice of Appeal filed by Pic River in the Ontario Divisional Court in respect of the Decision.

Table 2: Unbudgeted Costs

Cost Category	Project to Date Actual[2]
Not Budgeted	
First Nation and Métis Land Acquisition	$18,659
First Nation and Métis Participation	54,401
Other Costs Not included in Budgeted Categories	168,800
Carrying Cost	1,187
Taxes and Duties	-
Total Not Budgeted	**$243,047**

Development Milestone Summary

14. Table 3, below, provides a summary of the status of NextBridge's Board approved development milestones, indicating those that are complete and the status of those in progress (i.e. on schedule, ahead of schedule or delay/potential delay).

15. For each of the Board approved milestones, Table 3 provides:

(a) The Board approved milestone date.

(b) The status of those milestones due within 3 months of the reporting date.

[2] "Actual" refers to actual costs plus estimated accruals.

(c) A “revised forecast date” if applicable, indicating NextBridge’s current forecast of the date for completion of the relevant milestone if the current forecast differs from the Board approved date.

16. NextBridge has focussed, for the purposes of this reporting, on the status of those milestones due within 3 months of the reporting date in order to highlight the development activities in respect of which efforts are primarily focussed, and which are of most immediate relevance to project progress and status. At this stage in project development, but for this approach all milestones would indicate “On schedule”, but such information would be of limited use to the Board given that the relevant milestones are currently far out in time. As the development work progresses, the status column will be completed for more of the milestones.

17. NextBridge does review its development schedule on a monthly basis, in conjunction with preparation of these monthly reports, and should an issue or risk regarding a milestone that is scheduled beyond 3 months from the reporting date be identified, NextBridge will nonetheless report on that issue or risk, and include an appropriate status indication and revised forecast date in Table 3.

Table 3: Milestone Progress and Status

Engineering Milestones

	Milestone	Board Approved Date	Status	Revised Forecast Date
1	Initiate engineering	13 Sep 2013	Completed	
2	Sign contract for engineering	31 Oct 2013	Completed	
3	Finalize design criteria for conductor and structure	31 Jan 2014	Completed	
4	Complete conductor optimization study	7 Mar 2014	On schedule	
5	File request for a System Impact Assessment (SIA) with the IESO	12 Mar 2014	On schedule	
6	Status report on progress toward finalization of structure choice	31 Mar 2014	On schedule	
7	Obtain senior management approval of the structure configuration proposal	1 July 2014		
8	Complete aerial surveys	14 Oct 2014		
9	Receive final SIA from the IESO	21 Nov 2014		

Route Selection, Land/ROW Acquisition and Community/Municipal Consultation Milestones

	Milestone	Board Approved Date	Status	Revised Forecast Date
10	Prepare list of landowners along the ROW	10 Oct 2013	Completed	
11	Complete design of Landowner, Community and Municipal Consultation Plan	1 Nov 2013	Completed	
12	Commence negotiations or discussions with all landowners and permitting agencies	25 Nov 2013	Substantially completed as per EWT Project December 20, 2013 Monthly Report	
13	Finalize proposed route and obtain senior management approval	1 Jul 2014		

Aboriginal Engagement, Consultation and Participation Milestones

	Milestone	Board Approved Date	Status	Revised Forecast Date
14	Send introductory correspondence to aboriginal communities	30 Aug 2013	Completed	
15	Initial meeting with Ministry of Energy regarding the MOU for delegation	15 Sept 2013	Completed	
16	Complete initial/introductory contact with all aboriginal communities identified by the Ministry of Energy	30 Sept 2013	Completed	
17	Sign MOU with Ministry of Energy regarding the delegation	5 Nov 2013	Completed	
18	Complete design of First Nations and Métis Participation Plan with community input	2 Jan 2014	Completed	
19	Complete design of First Nations and Métis Consultation Plan with community input	2 Jan 2014	Completed	

Environmental Assessment (Provincial) Milestones

	Milestone	Board Approved Date	Status	Revised Forecast Date
20	Consult with environmental agencies (Ministry of Environment, Ministry of Natural Resources, Parks Canada and Ontario Parks)	10 Oct 2013	Completed	
21	Issue notice of draft Terms of Reference (ToR) available for review	16 Jan 2014	Completed	
22	File Environmental Assessment ToR	28 Feb 2014	On schedule	
23	Initiate wildlife, aquatics and early season vegetation assessments	1 May 2014	On schedule	
24	Approval of Environmental Assessment ToR	3 Jul 2014		
25	Complete Environmental Assessment Consultation Report	27 Jan 2015		
26	Submit Environmental Assessment to Ministry of Environment	27 Jan 2015		

Leave to Construct Milestone

	Milestone	Board Approved Date	Status	Revised Forecast Date
27	Submit Leave to Construct (LTC) application	28 Jan 2015		

18. In respect of the milestone achieved during this reporting period:

    (a) **Milestone 3: Finalize design criteria for conductor and structure.** Attached at Schedule B is a copy of the design criteria report as proof of completion of this milestone.

19. With respect to milestones due within the next 3 months, activity is on track to achieve the relevant milestones in accordance with the Board approved target dates.

Issues/Risks/Mitigation Summary

20. This section of NextBridge's monthly report provides a summary of risks and issues that have arisen during development work, including discussion on potential impact of any such developments on schedule, cost or scope, and of options for mitigating or eliminating the risk or issue.

21. There are no risks or issues that have arisen during development work to date in respect of which NextBridge has identified an impact on its development schedule, cost or scope of work.

Attachments to NextBridge Monthly Report

Schedule A

Summary of Michael Power’s qualifications

Michael Power *P.Eng, CET, CD* - Project Director

Biography

Project Director with over thirty-two years of progressive management experience in the areas of engineering, construction, project management and stakeholder engagement. Mr. Power is a Licensed Professional Engineer (P.Eng.) in the Province of Ontario, and his educational credentials include a Bachelor of Science Degree, a Bachelor of Technology Degree, and two Engineering Technology Diplomas. With extensive technical and leadership experience, Mr. Power has demonstrated a successful track record in performing at senior management levels within the Electrical Utility and Power Transmission Sector in the areas of engineering, construction and project/contract management. Michael is a strategic team leader, experienced in delivering large multi-disciplinary projects and successfully achieving business objectives in a safe, timely and cost efficient manner. Mr. Power is also experienced in managing relationships and negotiations with First Nations, overseeing environmental assessments, and the development and management of effective planning and reporting for project stakeholder review. Mr. Power's military experience includes operational leadership, project management and advanced level Marine Engineering Systems experience, coordinating and managing large military field operations to ensure the technical readiness of a variety of warships with organized skills in vision, strategy, budget management, staff development and effectiveness.

Professional Experience

Hydro One Networks Inc., Director - Project Development, 2013 – January, 2014

Director - Project Management, 2012 - 2013

- Responsible for the leadership of Hydro One project initiatives, including governance and managing the delivery of annual capital programs. This includes the accountability for the development of all engineering standards, equipment and material specifications, repeatable designs and engineering practices.

Hydro One Networks Inc., Chief Engineer & Director - Project Development, 2011 - 2012

- Responsible for project development and management of technical staff team. Controlled the annual Line of Business project portfolio of $850M.

Hydro One Networks Inc., Director - Bruce x Milton Transmission 500KV Line Project, 2009 - 2012

- Provided senior management leadership in the development and execution of the project operational plan. Identified, and tasked, the project team with the authority to conduct their work with in-house resources and elements of EPC contracting methodologies. Effectively identified and resourced the project to safely meet its $750M cost on budget and on-time 36-month delivery date.

Hydro One Networks Inc., Manager - Major Projects, 2002 - 2009

- Responsible for establishing the Engineering and Construction Services Outage Planning Groups and formed the E&CS Commissioning Planning department. Also led the effort in establishing the department to work in coordination with the outage planning group to manage efforts in a focused manner and maximize results.

Hydro One Networks Inc., Project Manager - Parkway Transformer Station, 2005

- Responsible ensuring all stakeholders were kept informed of the status and ensured a safe project delivery on time and within budget. Led the project team to the successful completion of the final phase of a new 2x750 MW Autotransformer station in Toronto.

Education and Credentials

- McMaster University ('03) Bachelor of Technology, (Manufacturing Engineering Technology)
- University of Victoria ('92) Bachelor of Science, (Physics)
- St Lawrence College ('85) Diploma, (Mechanical Engineering Technology)
- St Lawrence College ('85) Diploma, (Marine Engineering Technology)

- Professional Memberships and Designations include P.Eng designation from Professional Engineers of Ontario (PEO), CET designation from the Ontario Association of Certified Engineering Technicians and Technologists (OACETT).

Attachments to NextBridge Monthly Report

Schedule B

Milestone 3: Finalize design criteria for conductor and structure – proof of completion

Final Design Criteria for Conductor and Structure Selection Report,
January 31, 2014

Final Design Criteria for Conductor and Structure Selection

NextBridge Infrastructure LP
Toronto, ON, Canada

Ontario East-West Tie Line Project
Project No. 76120

January 31, 2014
Rev. 1

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

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LIST OF TABLES

1.0 SCOPE

1.1 Purpose

This document is intended to consolidate and summarize design criteria for the purpose of facilitating conductor and structure selection. The information presented herein is based on project requirements set forth by the Ontario Energy Board, applicable design and safety codes, and good engineering practice. During detailed design, this document will be superseded by the Project Transmission Line Design Criteria document.

1.2 Project Description

The Ontario East-West Tie Line (OEWTL) project consists of development, design, and construction of a dual-circuit, 230-kV overhead transmission line running east-west across Ontario Province, approximately parallel to the existing East-West Tie. The line originates at Wawa TS in Wawa, Ontario, extends northwest to Marathon TS in Marathon, Ontario, and then traverses westward to Lakehead TS located near Thunder Bay, Ontario. Combined, the proposed circuits will traverse a total distance of approximately 400 km, and will be capable of transmitting a combined total of up to 932 MVA when operating continuously at 240 kV, per OEB Minimum Design Criteria Appendix A, Table 2.

The new dual-circuit line will be constructed with a combination of self-supporting and guyed lattice towers. The line is proposed to be constructed with a single 1192.5 kcmil "Grackle" ACSR conductor per phase, along with an Alumoweld shield wire and 48-fibre OPGW cable to facilitate shielding and protection and control. Polymer insulation is anticipated for "I" and "V" string suspension assemblies, and glass or porcelain insulator assemblies will be used for deadend hardware assemblies.

2.0 PROJECT DATA

2.1 Minimum Transmission Reliability Data

For the purpose of structure selection, a reliability level associated with a 50-Year return period for climatic loads will be used, which is in accordance with industry standard practices and consistent with load cases presented in the OEB Minimum Technical Requirements, as Appendix A, Table 6 specifies a 50-year wind case. The minimum Grade of Construction for the Project will be Grade 2 as defined by CSA 22.3 No. 1 and OEB Minimum Technical Requirements, Appendix A, Table 6B. If CSA 22.3 No. 1 dictates more stringent requirements in specific locations, those criteria will govern locally.

3.0 PLS-CADD DESIGN CRITERIA

The primary engineering tool being used to complete design of the OEWTL transmission lines is PLS-CADD (Power Line Systems, Inc.). The information included in this section summarizes base criteria that will govern the PLS-CADD design, including weather cases and stringing criteria among others.

3.1 Weather Cases

The weather cases applied in the design of transmission towers and other line components for this project are based on code and design requirements set forth by the following sources:

- Canadian Standards Association (CSA) documents C22.3 No.1-10 and C22.3 No. 60826-10.
- Ontario Energy Board (OEB) "Minimum Design Criteria for the Reference Option."

Weather cases reviewed in the course of design of the OEWTL include a combination of reliability-based and deterministic weather conditions. NextBridge is concurrently performing a meteorological study and developing load cases to evaluate the impacts of conversion to a 100 year return period.

Reliability-based weather cases were derived specifically for this project based on information and calculations from CSA 22.3 No. 60826, and are presented in Table 3-1. Deterministic weather cases were also provided as part of the OEB "Minimum Design Criteria for the Reference Option" document, and are summarized in Table 3-2.

Table 3-1. Reliability-Based Weather Cases

WC	Case Description	Wind Speed (km/h)	Radial Ice (mm)[a,b]	Temperature (°C)	Reference
R1	50 Year Wind Event	93	0	3	CSA 22.3 No. 60826 §6.2.3
R2	50 Year Ice Event	0	31.4	-10	CSA 22.3 No. 60826 §6.3.4
R3	Combined Ice and Wind A[c]	37	31.4	-5	CSA 22.3 No. 60826 §6.4.1
R4	Combined Ice and Wind B[c]	56	16.3	-5	CSA 22.3 No. 60826 §6.4.1

[a] Radial ice thickness includes correction to 50-year return period reference thickness of 25.0 mm to include CSA 22.3 No. 60826 prescribed corrections for conductor diameter and height, as well as the prescribed spatial factor, S_a, of 1.3 to account for climatic variation between observation points used to compile the climatic data presented in CSA 22.3 No. 60826.

[b] For the purposes of "For Bid" structure development, the same radial ice thickness has been assumed on all conductors and shield wires alike.

[c] CSA 22.3 No. 60826 recognizes that the likelihood of simultaneous extremes of wind and ice events is low, and therefore proposes the application of two separate combined ice and wind events for the given return period. The first case, presented here as "Combined Ice and Wind A" represents the combination of the 50-year return period icing event and a wind speed that is deemed likely to occur simultaneously. The second case, "Combined Ice and Wind B", represents the 50-year return period wind event that would occur in the presence of icing, combined with the likely icing event.

Table 3-2. Deterministic Weather Cases

WC	Case Description	Wind Pressure on Wire (Pa)	Wind Pressure on Tower (Pa)	Radial Ice (mm)	Temperature (°C)	Reference
D1	CSA Heavy Loading	400	1200	12.5	-20	CSA 22.3 No. 1 Table 30
D2	OEB Cold Temperature	0	0	0	-50	OEB Min. Tech. Req Appendix A Table 5
D3	OEB 50-Year Wind Gust	770	2110	0	10	OEB Min. Tech. Req. Appendix A Table 5
D4	OEB Static Ice	0	0	25	0	OEB Min. Tech. Req. Appendix A Table 5

Details regarding the derivation of the reliability-based weather cases and resulting design load cases is detailed further in Section 8.0, which also provides additional details on how these weather cases are applied to establish design loads.

3.2 Creep and Load

Creep is permanent stretching of wire in response to application of tension over time. This permanent stretch results in lower tensions for wires in the after creep condition than in the initial condition. For calculation of permanent stretch due to creep, the 3°C weather case will be used based on temperatures used for similar conditions presented in the OEB Minimum Technical Requirements Appendix A, Table 7. Wires can also be permanently stretched due to short exposures to extreme load. Sag at maximum temperature (127°C, see Table 5-1) will be evaluated for both creep and load conditions. Calculations done in the after load condition will include an adjustment for the permanent stretch caused by a short term exposure to the following weather cases:

- CSA 22.3 No. 1 Heavy Load Case (Combined Ice and Wind Event)
- CSA 22.3 No. 60826 Extreme Ice (50-year Ice Event)
- CSA 22.3 No. 60826 Extreme Wind (50-year Wind Event)
- OEB 50-Year Wind Gust
- OEB Static Ice

3.3 Cable Tensions

Phase conductor sag and tension criteria for the Project are based on those defined in Appendix A of OEB document “Minimum Design Criteria for the Reference Option” and CSA 22.3 No. 1. Those criteria for phase conductors are presented below in Table 3-3. Sag and tension criteria for overhead shield wires (OHSW), including optical ground wire (OPGW), are based on those defined in Appendix A of OEB document "Minimum Design Criteria for the Reference Option", and are as follows in Table 3-4.

These tensions and load conditions will be used as the basis of the criteria for automatic sagging to be used with design tools on the Project.

Table 3-3. Phase Conductor Sag and Tension Criteria

Case Description	Climatic Condition	Tension Condition	Maximum % RBS	Reference
OEB Vibration Limit	-30°C	Initial	25%	OEB Min. Tech. Req. Appendix A Table 7
Any Combined Ice and Wind Condition	See Table 3-1 and Table 3-2	Final	75%	CSA 22.3 No. 1 §8.7.3.1.3
OEB Tension Limits	3°C	Initial	35%	OEB Min. Tech. Req. Appendix A Table 7
	3°C	Final	25%	
CSA 22.3 No. 1	See Table 3-2	Final	60%	OEB Min. Tech. Req. Appendix A Table 7; CSA 22.3 No. 1 §8.7.3.2.1

Table 3-4. Overhead Shield Wire Sag and Tension Criteria

Case Description	Climatic Condition	Tension Condition	Maximum % RBS	Reference
OEB Vibration Limit	-30°C	Initial	25%	OEB Min. Tech. Req. Appendix A Table 7
Any Combined Ice and Wind Condition	See Table 3-1 and Table 3-2	Final	75%	CSA 22.3 No. 1 §8.7.3.1.3
OEB Tension Limits	3°C	Initial	20%	OEB Min. Tech. Req. Appendix A Table 7
	3°C	Final	15%	
CSA 22.3 No. 1	See Table 3-2	Final	60%	OEB Min. Tech. Req. Appendix A Table 7; CSA 22.3 No. 1 §8.7.3.2.1

3.4 Weight Spans

Design weight spans will be derived from evaluation of the climatic load cases and cable conditions noted in Table 3-5. Structure design will apply the worst case weight span which yields the highest vertical load.

Table 3-5. Weight Span Evaluation Criteria

Climatic Condition	Cable Condition
CSA 22.3 No. 60826 50-Year Ice	Creep RS
CSA 22.3 No. 60826 50-Year Wind	Creep RS
CSA 22.3 No. 1 Heavy Loading	Creep RS
OEB Cold Temperature	Initial RS
CSA Vibration Limit	Initial RS
Max Operating Temperature	Creep RS

3.5 Insulator Swing

Insulator swing criteria and associated minimum air gaps for 230-kV phase conductors are based on those defined in Appendix A of OEB document "Minimum Design Criteria for the Reference Option", and are as follows in Table 3-6.

Table 3-6. Insulator Swing Criteria and Minimum Air Gaps to Structure Surface for 230-kV Phase Conductors

Case Description	Wind Pressure (Pa)	Conductor Temperature	Tension Condition	Minimum Air Gap (m)		Reference
CSA 22.3 No. 1	230	4°C	Bare Conductor Final Tension	1.586		OEB Min. Tech. Req. Appendix A Table 4
OEB 60 Hz Flashover (5 Year Gust)	350	4°C	Bare Conductor Final Tension	0.60	Phase to Ground	OEB Min. Tech. Req. Appendix A Table 4
				1.020	Phase to Phase	
OEB Moderate Wind	230	-30°C	Bare Conductor Final Tension	1.20		OEB Min. Tech. Req. Appendix A Table 4

4.0 CONDUCTOR AND SHIELD WIRE

4.1 Conductor Selection

In order to select the conductor that would most cost-effectively satisfy the Project needs, a conductor selection study is being carried out in accordance with Section 3.2.3 of the OEB Minimum Technical Requirements. This evaluation will consist of an economic review of the life cycle costs of the line due to installation and operating losses. Specifically, the study will consider the following factors:

- Estimated material and installation costs for towers and foundations
- Estimated material and installation costs for conductor
- Anticipated span length
- Environmental load cases
- Applicable load growth scenarios and costs of power.

This economic evaluation will select the conductor which is expected to yield the lowest present value life cycle cost based on a study period of 25 years per OEB Minimum Technical Requirements, Appendix A Table 2. Those assumptions are summarized here in Table 4-1.

Table 4-1. Key Conductor Selection Criteria

Continuous Loading per Circuit at 240 kV, 93°C	466 MVA
Short Term Emergency Loading per Circuit at 240 kV, 127°C	599 MVA
Evaluation Period	25 Years
Energy Cost ($CAN/MWhr)	$40
Energy Cost Inflation Rate per Annum	3%
AFUDC Rate per Annum	5.6%
Discount Rate per Annum for Losses	7%

For the purposes of structure evaluation, the proposed phase conductor for all 230 kV transmission lines is 1192.5 kcmil 54/19 ACSR (Grackle) based on the reference case indicated in the OEB Minimum Technical Requirements, Appendix A Table 2 and the Independent Electricity System Operator (IESO) Feasibility Study for the OEWTL.

4.2 Shield Wire Selection

Preliminary shield wire selection was completed based on design requirements identified in OEB Minimum Technical Requirements (Sections 3.2.4 and 3.2.5; Appendix A Table 2 for OPGW and OHSW). These criteria provide specific requirements for lightning protection and fault capacity. Anticipated shield wires for all proposed transmission lines will consist of a single 19#10 Alumoweld cable and a single 48-fibre Optical Ground Wire (OPGW). When all system fault studies are complete, shield wire size will be re-evaluated.

4.3 Cable Characteristics

The Table 4-2 provides technical information for proposed cables to be utilized for structure evaluation.

Table 4-2. Cable Characteristics

Application	Description	Diameter	Weight	RBS
Phase Conductor	1192.5 kcmil “Grackle” 54/19 ACSR	34 mm	22.3 N/m	186.4 kN
Shield Wire	19#10 Alumoweld (TBD)	12.9 mm	6.56 N/m	121.1 kN
Optical Ground Wire[a]	TBD	TBD	TBD	TBD

[a] “For Bid” tower design loads for the OPGW were developed based on modeling of the 19#10 Alumoweld, but will be revised once selection of an OPGW cable is complete.

4.4 Aeolian Vibration

Stockbridge vibration dampers will be installed on phase conductors as required. Spiral vibration dampers will be used on shield wire and OPGW for vibration control.

4.5 Galloping

Galloping analysis is to be performed to evaluate the phase-to-phase separation between galloping ellipses for typical spans. As typical spans on this line are approximately 400 m, the maximum ellipse to be evaluated will be 12 m on the long axis per OEB Minimum Technical Requirements Section 3.6.4. For tower design, the shape of the ellipse was determined based on recommendations by Cigre (Taskforce B2.11.06, Lilien & Havard), supplemented by an CIGRE presentation from Dr. Havard, a recognized authority on conductor galloping. Based on the methodology presented by Dr. Havard, a 20% ratio of the short to long ellipse axes was used for tower design.

If the impacts of galloping cannot be controlled economically by increasing the phase spacing, the preferred mitigation for galloping will be to utilize spoilers or other mitigation hardware on spans demonstrating the occurrence of galloping, as recommended by Cigre TF B2.11.06, Section 8.

5.0 ELECTRICAL CLEARANCES

Structure configuration, and ultimately structure spotting, will be performed to ensure appropriate electrical clearances are met throughout the line. Clearance requirements for the OEWTL Project shall be per CSA 22.3 No. 1, and shall also include additional requirements set forth by OEB and NextBridge. These minimum required clearances are further increased by a number of design safety factors as described in detail below. The transmission lines will be designed to meet clearances to obstructions or ground as specified.

5.1 Vertical Clearances

Vertical clearances are to be maintained in conditions producing maximum conductor sag, and will be evaluated as defined in Table 5-1.

Table 5-1. Vertical Clearance Evaluation Criteria

LC	Case Description	Cable Condition	Reference
W15	Max Operating Temperature (127°C)	Max Sag RS	OEB Min. Tech. Req. Table 2
W3	50-Year Ice Event	Max Sag RS	CSA 22.3 No. 60826 §6.3.4
W8	OEB Static Ice	Max Sag RS	OEB Min. Tech. Req. Table 5

[a] Refer to Table 8-2 for details of climatic conditions associated with each load case.

The minimum vertical clearances for 230-kV transmission lines to be used in the design are presented in Table 5-2 and Table 5-3, and are based on the clearance requirements of CSA 22.3 No.1. Note that the OEB specifies that a safety factor of 1.2 meters must be applied to vertical clearances. NextBridge also includes an additional design buffer of 0.8 m to account for construction tolerances and other items.

In locations where clearing of snow is not anticipated, seasonal conditions warrant additional clearance for snow depth. In certain cases, clearances for the applicable surface crossed will be increased to account for the mean annual snow depth. Per information provided in CSA 22.3 No. 1 Table D.1, the maximum mean annual snow depth along the route occurs in Wawa, ON where the mean annual snow depth is 1.1 m. For the purposes of structure evaluation, this mean annual snow depth was chosen for adjustment of applicable clearances. The snow depth to be applied in detailed line design will be re-evaluated upon completion of the meteorological study commissioned by NextBridge to refine design criteria.

Table 5-2. Vertical Clearances for 230-kV Conductors Above Land

Nature of Surface Beneath Cables or Conductors	CSA 22.3 No. 1 Table 2 Minimum Required Clearance (m)	OEB Design Safety Factors (m)	Design Buffer[d] (m)	Proposed Total Design Clearance (m)
Over land likely to be travelled by road vehicles (including highways, streets, lanes, alleys, and driveways other than those leading to residences or residence garages)	6.1	1.2	0.8	8.1
Over the right-of-way of underground pipelines	6.1	1.2	0.8	8.1
Alongside land likely to be travelled by road vehicles§ or within the limits (with no overhang) of streets and highways	6.1	1.2	0.8	8.1
Over or alongside farmland likely to be travelled by vehicles	6.1	3.9	0.8	8.1
Over driveways to residences and residence garages	6.1	1.2	0.8	8.1
Alongside roads and highways in areas unlikely to be travelled by road vehicles (with no overhang) and within 1.5 m of the limit of the road right-of-way[a]	5.5	1.2	0.8	7.5
Over walkways or ground normally accessible only to pedestrians, snow mobiles, and personal-use all-terrain vehicles[b]	4.6	1.2	1.9	7.7
Above top of rail at railway crossings[c]	9.0	0.6	0.8	10.4
Primary and secondary highways, unless part of a high load corridor	7.9	1.2	0.8	9.9
High load corridor for unescorted, 9 m high loads	11.5		0.8	12.3
Extra high load corridor for unescorted 12.8 m high loads	15.3		0.8	16.1

[a] These areas are generally adjacent to fences and accessible to small vehicles, but are not likely to be travelled by high road vehicles or farm machinery.

[b] For the purposes of structure evaluation, this clearance has been increased by the maximum mean annual snow depth along the route occurs in Wawa, ON where the mean annual snow depth is 1.1 m.

[c] Because the rail level of a railway where ballast is used is not fixed, where any line that crosses a railway is constructed or altered, an additional 0.3 m of vertical clearance above rails shall be provided, unless a lesser amount is mutually agreed upon, to permit normal subsequent ballast adjustments without encroaching on the specified minimum clearance.

[d] The additional 0.8 m design clearance buffer is utilized to allow for construction and survey tolerances.

Table 5-3. Vertical Clearances for 230-kV Conductors Above Water

Nature of Surface Beneath Cables or Conductors	CSA 22.3 No. 1 Table 3 Minimum Required Clearance (m)	OEB Design Safety Factors (m)	Design Buffer[b] (m)	Proposed Total Required Design Clearance (m)
Minor waterways	6.1	1.2	0.8	8.1
Shallow or fast-moving waterways capable of being used by canoes and paddle boats in isolated areas where motor boats are not expected Creeks and streams: W = 3-50 m and D < 1 m Ponds: A<8 ha and D < 1 m H = 4.0 m	7.3	1.2	0.8	9.3
Shallow or fast-moving waterways capable of being used by motor boats with antennas and unable to support masted vessels. Creeks and streams: W = 3-50 m and D < 1 m Ponds: A<8 ha and D < 1 m H = 6.0 m	9.3	1.2	0.8	11.3
Shallow lakes and rivers used by masted vessels. Rivers: W = 3-50 m and D > 1 m Ponds and lakes: A<8 ha and D > 1 m H = 8.0 m	11.3	1.2	0.8	13.3
Small resort lakes, medium sized rivers and reservoirs, rivers connecting lakes, and crossings adjacent to bridges and roads. Rivers: W = 50-500 m Lakes or reservoirs: 8 ha < A < 80 ha H = 10.0 m	13.3	1.2	0.8	15.3
Large lakes, reservoirs, and main rivers in resort areas. Rivers: W > 500 m Lakes or reservoirs: 8 ha < A < 80 ha H = 12.0 m	15.3	1.2	0.8	17.3
Main lakes on main navigation routes and marinas. A > 800 ha H = 14.0 m	17.3	1.2	0.8	19.3
Federally maintained commercial channels, rivers, harbors, or heritage canals.	See note (a)			
A = Water Area, D = Water Depth, W = Water Width, H = Reference Vessel Height[c]				

[a] Clearances shall be as specified by the appropriate Transport Canada Office.

[b] The additional 0.8 m design clearance buffer is utilized to allow for construction and survey tolerances.

[c] Reference vessel height refers to the overall height of the vessel, including the heights of antennas or other attachments.

Table 5-4. Vertical Clearances Between 230-kV Wires Crossing Each Other or Supported by Different Supporting Structures [a]

Type of Line Or Cable Being Crossed	Minimum Required Clearance (m)	Design Buffer (m)[b]
Open Supply Conductors Being Crossed Over by 230-kV line-to-line AC Circuits		
Communications Cables	1.8	TBD
0-0.75 kV	1.7	TBD
>0.75 ≤22 kV	1.7	TBD
>22 ≤50 kV	2.0	TBD
>50 ≤ 90 kV	2.1	TBD
>90≤120 kV	2.3	TBD
>120 ≤150 kV	2.4	TBD
Open Supply Conductors Being Crossed Under by 230-kV line-to-line AC Circuits		
>120 ≤150 kV	2.4	TBD
>150≤190 kV	3.0	TBD
>190≤220 kV	3.4	TBD
>220 ≤320 kV	4.5	TBD
>320≤425 kV	5.2	TBD

[a] Voltages of AC lines being crossed over or under by 230-kV line-to-line conductors are shown in kV RMS, line-to-ground.

[b] Additional clearance requirements will be determined by negotiations with existing facility owners per OEB Minimum Technical Requirements Section 3.1.5.

5.2 Horizontal Clearances

The minimum horizontal clearances for 230-kV transmission lines to be used in the design are presented in this section, and are based primarily on the clearance requirements of CSA 22.3 No. 1. The climatic conditions to which horizontal clearances will be checked are identified in Table 5-5.

Table 5-5. Horizontal Clearance Evaluation Criteria[a,b]

Climatic Condition	Cable Condition
OEB Moderate Wind	Bare, Final, -30°C
CSA 22.3 No. 1 Moderate Wind	Bare, Final, 4°C
CSA 22.3 No. 1, Table 1	Unloaded, 40°C

[a] The bare cable condition represents the cable free of any ice or snow accumulation.

[b] The final cable condition represents a cable that has undergone the controlling load case (maximum tension) or has elongated due to creep.

The minimum horizontal clearances for 230-kV transmission lines to be used in the design are presented in Table 5-6 and Table 5-7 and will be checked for each of the climatic conditions identified in Table 5-5.

Table 5-6. Proposed Horizontal Clearances for 230-kV Conductors to Objects and Surfaces

Nature of Surface Near Cables or Conductors	Minimum Required Clearance (m)	Design Buffer (m)	CSA 22.3 No. 1 Reference Table
Buildings	3.2	TBD	Table 9
Railway Tracks	4.1	TBD	Table 6
Readily Accessible Portions of Bridges	2.7	TBD	Table 10
Inaccessible Portions of Bridges	1.8	TBD	Table 10
Swimming Pools[a]	7.8	TBD	Table 11
Supporting Structures of Another Line, Voltage of Other Line, AC kV			
0-50 kV	1	TBD	Table 13
>50 kV	1 m + 10 mm/kV over 50 kV	TBD	Table 13
Conductors of other 230-kV circuits attached to the same supporting structure	5.2	TBD	Table 13

[a] Clearances to swimming pools indicated here are to be taken in any direction from the water level, edge of pool, or diving platforms.

[b] Voltages are RMS line-to-ground.

Table 5-7. Horizontal Separation of Supply-Line Conductors Attached to the Same Supporting Structure

Line Conductor	Minimum Separations of Conductors for Spans ≤ 50 m (mm)	Minimum Separations of Conductors for Spans > 50 m and ≤ 450 m (mm)
0-5 kV AC	300	300 + the following three increments: 3x the distance (in meters) by which the span length exceeds 50 m; 83 x the final unloaded sag (in m) at 15°C conductor temperature for conductor(s) having the greatest sag; and 10 mm/kV over 5 kV
> 5 kV AC	300 + 10 mm/kV over 1 kV	

[a] Voltages are RMS line-to-ground.

[b] Information per CSA 22.3 No. 1 Table 17.

6.0 INSULATORS

6.1 Insulator Selection

Insulators are selected for the Project based on the requirements identified in the OEB Minimum Technical Requirements Section 3.3:

- §3.3.1 - Meeting requirements of CSA C411.1 or C411.4 as applicable
- §3.3.2 – Non-ceramic insulators provided with suitable grading rings for corona protection
- §3.3.3 – Non-ceramic insulators cable of withstanding high-pressure water washing
- §3.3.5 – Minimum of 1050 kV BIL, 1155 kV CIFO
- §3.3.6 – Minimum leakage distance of 3980 mm.

6.2 Insulator Characteristics & Strength Requirements

The implementation of the guyed-Y structure configuration will require the use of both "I" and "V" string suspension insulator assembly configurations. Strain or deadend insulator assemblies will be of "I" string configuration.

NextBridge anticipates the use of non-ceramic insulators in the majority of insulator assemblies for the Project. Insulators to be used will comply with requirements identified in Section 6.1. All deadend and strain insulator assemblies will consist of porcelain or glass insulation, while polymer insulators are proposed for suspension assemblies.

Insulator strength will be selected based on tensions induced in the insulator strings due to design loads identified in Table 8-2 and the applicable overload and strength reduction factors indicated in Table 8-5.

7.0 LIGHTNING MITIGATION

Appendix A to the OEB "Minimum Design Criteria" document requires a maximum shielding angle of 15° for double-circuit transmission lines. The OEB requirements further specify that single circuit lightning related outages shall not exceed 3.0 outages per 100 circuit miles per year, and that multi-circuit lightning related outages per 100 circuit miles per year not exceed 1.0.

Shielding analysis will be performed following IEEE Standard 1243 "Guide for Improving the Lightning Performance of Transmission Lines," and NextBridge standard practices using data obtained as part of an independent meteorological study. Such an analysis is necessary to determine the appropriate placement of the shield wire and optical ground wire such that lightning related failures due to shielding and back flashovers are minimized to result in annual failure rates below the prescribed limits. The IEEE Flash program, associated with Standard 1243, will be used to calculate the required shielding angle through detailed analysis of the structure configuration, anticipated structure footing resistances, regional ground flash density, estimated stroke current magnitude, and line insulation.

8.0 STRUCTURES

8.1 General Structure Information

For the OEWTL Project, NextBridge proposes to employ a combination of guyed and self-supporting lattice steel towers. The line will primarily consist of double-circuit, guyed-Y lattice steel suspension towers as illustrated in Figure 8-1. Preliminary project development efforts included analysis of accessibility, constructability, cost, foundation requirements, associated geotechnical factors, and construction methodologies. It was determined that the guyed-Y structure type would allow NextBridge to most cost-effectively meet the OEB's requirements.

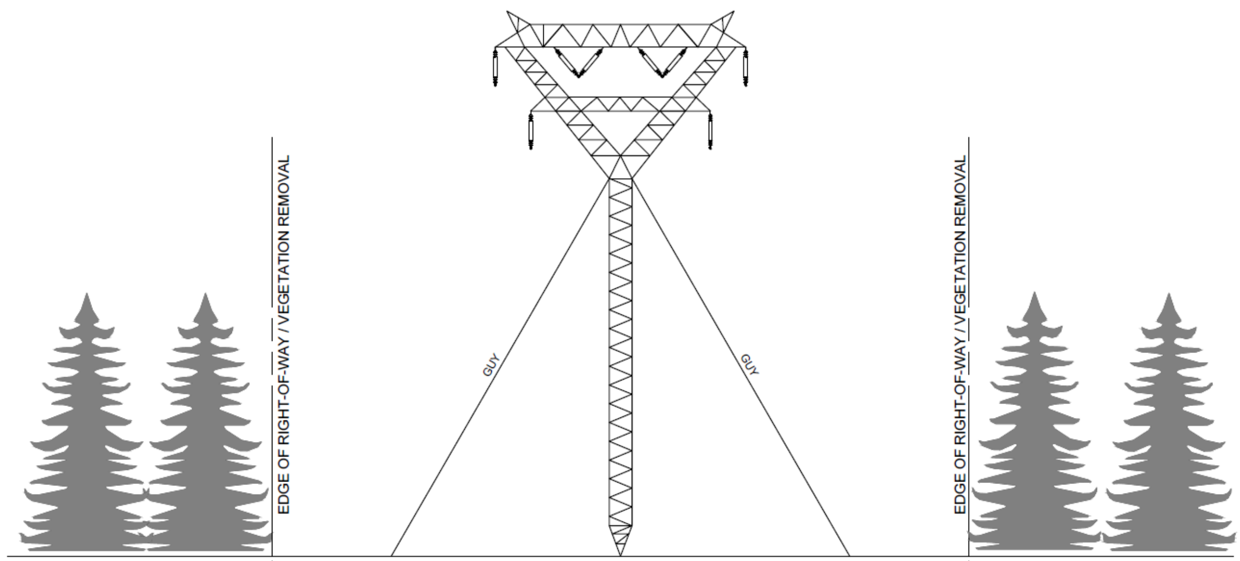

Figure 8-1. Typical Guyed-Y Lattice Tower Configuration.

While the guyed-Y structure is expected to be the most widely used structure, self-supporting strain and deadend towers will also be used in conjunction with the guyed suspension towers. It is also anticipated that self-supporting suspension towers will be utilized in specific locations where terrain or other circumstances make the application of the guyed tower unfeasible. The anticipated self-supporting lattice structure is depicted in Figure 8-2.

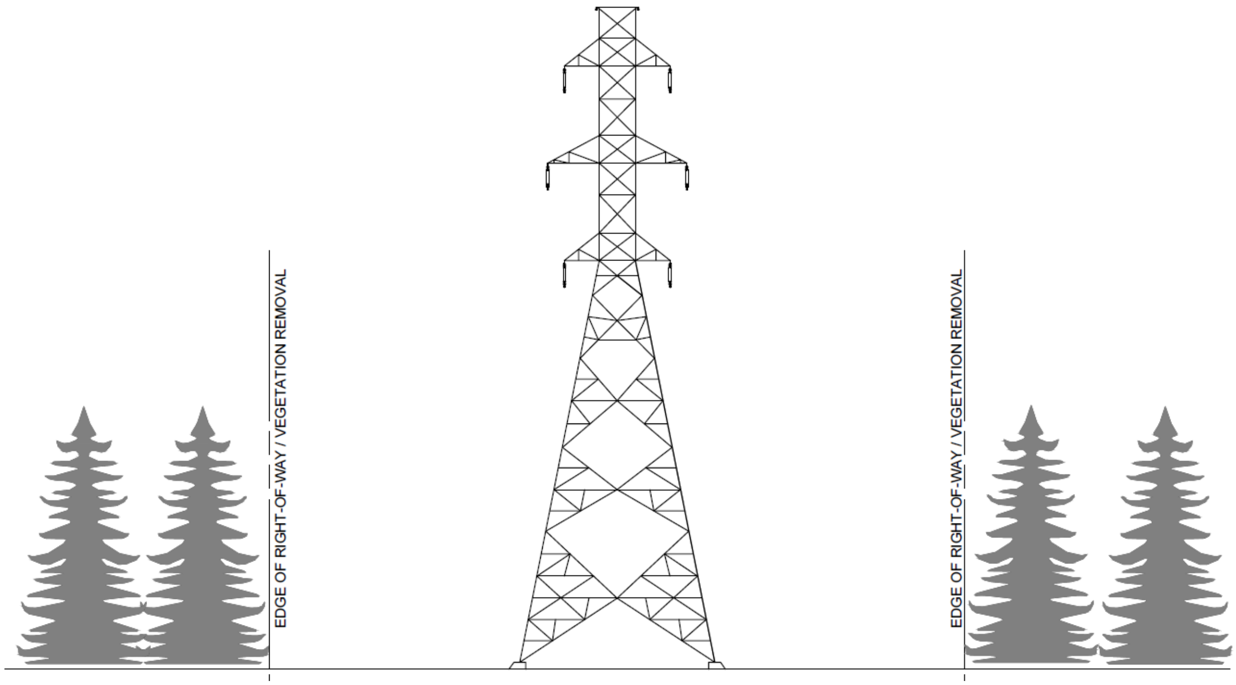

Figure 8-2. Typical Guyed-Y Lattice Tower Configuration.

8.2 Climatic Loading Cases

Climatic load cases are developed based on the weather cases referenced in Section 3.1. The climatic conditions act directly on the supporting structure and the supported wires, both of which result in loading of the structure. These interactions with supporting structure and wires are treated differently in the design process; different factors are used to calculate the design wind pressure on the structures and wires resulting in different design wind pressures. Each scenario is detailed separately below.

8.2.1 Loads Applied to the Supporting Structure

Weather conditions and the resulting design loads applied to supporting structure are detailed in Table 8-1.

Table 8-1. Loads Applied to the Supporting Structure

LC	Case Description	Temperature (°C)	Radial Ice Thickness (mm)	Wind Speed (km/h)	Unit Action Wind Pressure (Pa)[a]	Design Wind Pressure (Pa)[b]	Reference
S1	Ice and Wind Case A	-5	31.4	37	72	-	CSA 22.3 No. 60826 §6.4
S2	Ice and Wind Case B	-5	16.3	56	162	-	CSA 22.3 No. 60826 §6.4
S3	50-Year Ice Event	-10	31.4	0	0	-	CSA 22.3 No. 60826 §6.3.4
S4	50-Year Wind Event	3	0	93	425	-	CSA 22.3 No. 60826 §6.2.4
S5	Wind at Low Temp	-5	0	37	68	-	CSA 22.3 No. 60826 §6.2.4
S6	OEB Moderate Wind	-30	0	-	-	230	OEB Min. Tech. Req. Table 4
S7	CSA 22.3Heavy Loading	-20	12.5	-	-	1200	CSA 22.3 No. 1 Table 30
S8	OEB Static Ice	0	25	0	0	0	OEB Min. Tech. Req. Table 5
S9	OEB 50-Year Gust	10	0	-	-	2110	OEB Min. Tech. Req. Table 5
S10	OEB Low Temperature	-50	0	0	0	0	OEB Min. Tech. Req. Table 5
S11	NextBridge Oblique Wind	3	0	93	425	-	
S12	NextBridge Longitudinal Wind	3	0	93	425	-	

[a] Unit action pressure defined as resultant basic pressure of the wind on a surface not accounting for drag coefficient, shape factors, etc.

[b] Design pressure is the factored pressure to be applied to the surface of the interacting object inclusive of drag coefficients, shape factors, etc. For reliability-based cases, the design pressure is dependent on a number of final tower design parameters including tower height and tower solidity ratio. As these parameters vary by tower, no specific design wind pressure is shown here, and it will be the duty of the tower vendor to apply these loads during tower design.

8.2.2 Loads Applied to Supported Wires

Weather conditions and the resulting design loads applied to supported wires are detailed in Table 8-2.

Table 8-2. Loads Applied to Supported Wires

LC	Case Description	Temperature (°C)	Radial Ice Thickness (mm)	Wind Speed (km/h)	Unit Action Wind Pressure (Pa)[a]	Design Wind Pressure (Pa)[b]	Reference
W1	Ice and Wind Case A	-5	31.4	37	72	165	CSA 22.3 No. 60826 §6.4
W2	Ice and Wind Case B	-5	16.3	56	162	372	CSA 22.3 No. 60826 §6.4
W3	50-Year Ice Event	-10	31.4	0	0	0	CSA 22.3 No. 60826 §6.3.4
W4	50-Year Wind Event	3	0	93	425	978	CSA 22.3 No. 60826 §6.2.4
W5	Wind at Low Temp	-5	0	37	68	156	CSA 22.3 No. 60826 §6.2.4
W6	OEB Moderate Wind	-30	0	-	-	230	OEB Min. Tech. Req. Table 4
W7	CSA 22.3Heavy Loading	-20	12.5	-	-	400	CSA 22.3 No. 1 Table 30
W8	OEB Static Ice	0	25	0	0	0	OEB Min. Tech. Req. Table 5
W9	OEB 50-Year Gust	10	0	-	-	770	OEB Min. Tech. Req. Table 5
W10	OEB Low Temperature	-50	0	0	0	0	OEB Min. Tech. Req. Table 5
W11	OEB Vibration Limit	-30	0	0	0	0	OEB Min. Tech. Req. Appendix A Table 7
W12	OEB Tension Limit	3	0	0	0	0	OEB Min. Tech. Req. Appendix A Table 7
W13	NextBridge Oblique Wind	3	0	93	-	978	
W14	NextBridge Longitudinal Wind	3	0	93	-	978	
W15	Maximum Operating Temperature	127	0	0	0	0	OEB Min. Tech. Req. Table 2

[a] Unit action pressure defined as resultant basic pressure of the wind on a surface not accounting for drag coefficient, shape factors, etc.

[b] Design pressure is the factored pressure to be applied to the surface of the interacting object inclusive of drag coefficients, shape factors, etc.

8.3 Security Loads

Certain security loads are to be applied during structure design including longitudinal and torsional imbalanced loading conditions for evaluation of failure containment. Each security loading case used for obtaining tower bids is identified in Table 8-3 along with the climatic conditions present during each event. All security load cases were developed in conjunction with NextBridge engineering staff, based on guidelines for developing such cases presented in CSA 22.3 No. 60826 Section 6.6. Security loads continue to be evaluated as engineering progresses.

Table 8-3. Security Load Cases

LC	Case Description	Temperature (°C)	Radial Ice Thickness (mm)	Design Wind Pressure on Wire (Pa)	Design Wind Pressure on Tower (Pa)
X1	NextBridge Unbalanced Ice	-10	16.3	0	0
X2	NextBridge Torsional Ice	-10	16.3	0	0
X3	NextBridge Broken Conductor	-20	12.5	400	1200
X4	CSA 22.3 No. 60826 §6.6.3.1 Torsional Load	-20	0	0	0
X5	CSA 22.3 No. 60826 §6.6.3.2 Longitudinal Load	-20	0	0	0

Three scenarios addressing unbalanced, torsional, and broken wire conditions will be assessed. The NextBridge unbalanced ice case (X1) applies the specified radial ice to any combination of conductors on one side of the structure only (ahead or back span), while the other side is exposed to the same climatic conditions without the ice load. The shield wires under all combinations shall be unbalanced.

The NextBridge torsional ice case (X2) simulates the scenario in which the specified radial ice is dropped from one circuit, in one direction only (ahead or back span, circuit 1 or 2), while the other conductors are exposed to the same climatic conditions with the ice load remaining intact.

The NextBridge broken conductor case (X3) simulates the scenario in which two phase conductors and one shield wire are broken in the combination yielding the highest imbalanced structural load, while other conductors and the structure remain exposed to the climatic conditions indicated. This load case is not applied to each structure type.

The torsional load case (X4) simulates the scenario in which one phase conductor or one shield wire releases tension and applies a residual static load to the structure. For suspension structures, the resulting residual static load can be relaxed accounting for the swing of insulator assemblies, structure deflection or rotation, foundation deflection or rotation and interaction with other phase conductors or wires. The remaining wires are exposed to the same climatic conditions with the wires in an intact condition.

The longitudinal load case (X5) simulates a longitudinal load being applied at all attachment points simultaneously.

8.4 Construction Loads

Construction load cases are to be applied during structure design to account for short term or temporary loading that may occur during maintenance or construction of the transmission line. All construction load cases were developed in conjunction with NextBridge engineering staff, based on guidelines for developing such cases presented in CSA 22.3 No. 60826 Section 6.5.

The construction snub load case (C1) is identified in Table 8-4 along with the climatic conditions assumed to occur during the loading event. This case will be used to simulate two different conditions.

The first condition is any one phase conductor or shield wire snubbed. This condition is meant to simulate conductors being pulled through the stringing blocks and subsequently snubbed.

The second condition is any combination of phase conductors and shield wires snubbed. This condition is meant to simulate any combination of wires snubbed.

Table 8-4. Construction Load Cases

LC	Case Description	Temperature (°C)	Radial Ice Thickness (mm)	Unit Action Wind Pressure (Pa)[a]
C1	Construction Snub	-20	0	100

[a] Unit action pressure defined as resultant basic pressure of the wind on a surface not accounting for drag coefficient, shape factors, etc.

8.5 Concentrated Loads

Concentrated loads due to marker balls, mid-span transposition hardware, or other similar items will be considered when spotting structures around spans containing such equipment.

8.6 Application of Design Loads

All structures are designed for three types of loading: intact, security and construction. Deadend structures are designed for one-side only loading, in addition to intact, security and construction loading. Intact loading are loading conditions in which all the wires on the structure are intact. The loading specified in Table 8-1 and Table 8-2 will be applied under intact conditions. Security loading is loading conditions that apply unbalanced longitudinal loads to the structures. Security loading conditions are specified in Table 8-3. Construction loading is loading conditions that are expected during assembly and erection of the structures and stringing of wires. Construction loading conditions are specified in Table 8-4. One-side only loading are loading conditions in which all the wires on one side of the structure are not-installed or broken and the wires on the other side are intact. The discussion below provides a brief description of the application of the design loads to each structure type. The discussion below provides a brief description of the application of the design loads to each structure type.

8.6.1 Tangent Structures

Tangent structures shall be designed for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 and X2) and Table 8-4 (C1). All load cases are applied under intact conditions.

8.6.2 Running Angle Structures

Running angle structures shall be designed for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 & X2) and Table 8-4 (C1). All load cases are applied under intact conditions.

8.6.3 Strain Structures

Strain structures shall be designed for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 – X5) and Table 8-4 (C1). Strain structures are not designed for one-side only loading.

8.6.4 Deadend Structures

Deadend structures shall be designed for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 – X5) and Table 8-4 (C1). Deadend structures are designed for one-side only loading for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 – X5) and Table 8-4 (C1).

8.6.5 Non-Deadend Failure Containment Structures

ASCE Manual 74, “Guidelines for Electrical Transmission Line Structural Loading”, Section 3.3.2 states “cascading failure risk of a transmission line can be reduced by several methods.” These methods are 1) design of all structures for longitudinal load, 2) installing failure containment structures, or 3) installing release mechanisms. In the context of this document and Project, failure containment structures refer to tangent and running angle structures designed for additional loading not considered in the design of the normal tangent and running angle structures.

Failure containment structures are being assessed to prevent long cascade failures of the transmission line. While failure containment will be evaluated further during detailed design of the facilities, for the purposes of structure evaluation, these structures are designed for the following load cases: Table 8-1 (S1 - S12), Table 8-2 (W1 - W14), Table 8-3 (X1 – X5) and Table 8-4 (C1). Failure containment structures will not be designed for one side only loading conditions.

8.6.6 Strength Reduction Factors and Overload Factors

Design requirements for the OEWTL Project are derived from various sources, both deterministic and reliability-based. Deterministic and reliability-based design philosophies differ in their treatment of safety factors to account for variability in material quality and construction. Deterministic design criteria are typically accompanied by overload factors (OLFs) which are used to increase the design load in order to provide for a safety factor in the finished product. Reliability-based methods, on the other hand, apply strength reduction factors (SRFs) to the strength of materials to which loads are applied.

OLFs and SRFs associated with the Project requirements specified by the OEB Minimum Technical Requirements and CSA 22.3 No. 60826 are presented in Table 8-5.

Table 8-5. Overload and Strength Reduction Factors

Material	Reference	OLF	SRF
Steel Towers, Vertical	OEB Min. Tech. Req. App. A Table 6	1.15	-
Steel Towers, Transverse	OEB Min. Tech. Req. App. A Table 6	1.10	-
Steel Towers, Longitudinal	OEB Min. Tech. Req. App. A Table 6	1.10	-
Guy Wire	OEB Min. Tech. Req. App. A Table 6	-	0.90
Guy Assemblies	OEB Min. Tech. Req. App. A Table 6	1.25	-
Insulators	OEB Min. Tech. Req. App. A Table 6	2.00	-
Anchor Rod	OEB Min. Tech. Req. App. A Table 6	1.25	-
Anchor In Soil	OEB Min. Tech. Req. App. A Table 6	2.00	-
Suspension Towers, Intact Loading	CSA 22.3 No. 60826 §7.3.3	-	0.9
Suspension Towers, Failure Loading	CSA 22.3 No. 60826 §7.3.3	-	1.0
Angle Towers, Intact Loading	CSA 22.3 No. 60826 §7.3.3	-	0.8
Angle Towers, Failure Loading	CSA 22.3 No. 60826 §7.3.3	-	0.9
Deadend Towers, Intact Loading	CSA 22.3 No. 60826 §7.3.3	-	0.8
Deadend Towers, Failure Loading	CSA 22.3 No. 60826 §7.3.3	-	0.9
Steel Towers, Construction Loading	CSA 22.3 No. 60826§6.5	2/1.5	-

8.7 Guying

Guy stranding shall conform to the requirements of CAN/CSA G12. The maximum guy load shall not exceed 90 percent of the rated breaking strength of the guy strand with the appropriate structure strength reduction factor applied. The lattice tower manufacturer is responsible for determining the guy type, size, and angles. Lattice towers will be designed to support a deviation from the design guying angle ranging from 0 to +5 degrees in the vertical and/or horizontal planes, as required.

8.8 Deflection Limits

Lattice towers typically exhibit minimal deflections even under their most extreme loading conditions. Because of this, deflection limits for lattice towers are not specified. At this time, the Project does not require monopole or H-frame type supporting structures, and thus there are no specified deflection limits.

8.9 Nonlinear Analysis

This Project will apply nonlinear analysis for design of supporting structures. If existing structures require modification, linear analysis may apply in certain cases. All design of new supporting structures for the Project will be by nonlinear analysis.

9.0 REFERENCES

9.1 Safety Codes

- Overhead Systems, CSA 22.3 No. 1-10, Canadian Standards Association, July 2010.

9.2 Design Standards

- Minimum Technical Requirements for the Reference Option of the E-W Tie Line (including Appendix A), Ontario Energy Board, November 9, 2011.
- Design Criteria of Overhead Transmission Lines, CSA 22.3 No. 60826:10, Canadian Standards Association, December 2010.
- Cigre Technical Brochure #322: State of the Art of Conductor Galloping, Task Force B2.11.06, June 2007.
- Conductor Galloping, D. G. Havard, IEEE ESMOL and TP&C Meeting, Las Vegas, Nevada, January 2008.
- ASCE 74 Guidelines for Electrical Transmission Line Structure, 3rd Edition, 2010

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