NEWFOUNDLAND POWER
A FORTIS COMPANY

Newfoundland Power Inc.

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DELIVERED BY HAND

March 20, 2015

Board of Commissioners
of Public Utilities
P.O. Box 21040
120 Torbay Road
St. John's, NL A1A 5B2

Attention: Ms. Cheryl Blundon
Director of Corporate Services
and Board Secretary

Ladies & Gentlemen:

Re: The Board's Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System (the "Investigation") – Phase Two RFIs

A. The Application

Enclosed are the original and 12 copies of:

1. an application by Newfoundland Power (the "Application") for an order compelling Newfoundland and Labrador Hydro ("Hydro") to provide full and adequate responses to Requests for Information Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 (the "RFIs") which were filed in the Investigation; and

2. an affidavit of Elias Ghannoum, transmission engineering expert, (the "Ghannoum Affidavit"), supporting the Application.

The Application seeks full and adequate responses to the RFIs filed by Newfoundland Power on September 19th, 2014. Hydro's responses to the RFIs did not provide any of the mathematical calculations, design specifications or supporting documents requested.

In its response to RFI No. NP-NLH-018, Hydro cited portions of Order No. P.U. 41 (2014) and indicated that:

> "Hydro does not believe that a review of the design specifications and design parameters for transmission line hardware and components for either the Labrador Island Transmission Link or the new Bay d'Espoir to Western Avalon line informs the matter currently before the Board."

Newfoundland Power disagrees with this assessment.

B. The Appropriate Disclosure Standard

In Order No. P.U. 41 (2014), the Board indicated that:

> "Although an evaluation of the Muskrat Falls Project is not a part of this proceeding, the Board believes that ***information which goes to the risks of timely delivery of reliable and adequate power to the Island Interconnected System is relevant to the issues in this proceeding and should be produced***."
> (page 4, lines 29-32, emphasis added)

It was further indicated in Order No. P.U. 41 (2014) that:

> "***…some parties may be interested in the most detailed information available*.** Each request for information must be considered in all of the circumstances, balancing the interests of full disclosure and participation with an efficient process and the potential for undue burden on the parties."
> (page 4, lines 35-39, emphasis added)

Amongst other things, the Ghannoum Affidavit filed in support of the Application provides evidence that:

1. the mathematical calculations, design specifications and supporting documents sought in the RFIs (collectively, the "Information") are typical in engineering practice and are used by engineers in the design of transmission systems;

2. the Information will disclose the extent to which the chosen design of a transmission system addresses structural and mechanical risks to transmission system reliability;

3. the Information is typically comprised of documentation and software files which are commonly used in transmission engineering design; and

4. the Information is requested to permit Ghannoum to evaluate, and provide an opinion concerning, the degree to which Hydro and its affiliates have addressed the risks to supply presented by electrical transmission systems serving the island of Newfoundland.

The Information will provide evidence relating to the assessment of risks to reliable electricity supply on the island of Newfoundland. Risks to reliable long-term supply to the island of Newfoundland are the primary focus of Phase Two of the Investigation. Furthermore, the Ghannoum Affidavit provides the Board with assurance that the Information should be available and not unduly burdensome to provide.

Accordingly, for the Board to require disclosure of the Information as sought in the Application would, in Newfoundland Power's view, be consistent with the standard set by the Board in Order No. P.U. 41 (2014). In particular, such an order would ensure (i) full disclosure and participation; (ii) efficient process; and (iii) the avoidance of undue burden on any party.

C. Concluding

We trust the foregoing and enclosed are found to be in order.

If the Board or any intervenor has questions or comments, they should feel free to contact the Company.

Yours very truly,

Peter Alteen, QC
Vice President,
Regulation & Planning

c. Geoffrey Young
Newfoundland and Labrador Hydro

Thomas Johnson
O'Dea Earle Law Offices

Danny Dumaresque

Paul Coxworthy
Stewart McKelvey Stirling Scales

Roberta Frampton Benefiel
Grand Riverkeeper Labrador, Inc.

Telephone: (709) 737-5859 *Email: palteen@newfoundlandpower.com* *Fax: (709) 737-2974*

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 (the "*EPCA*"), and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF an Investigation and Hearing into supply issues and power outages on the Island Interconnected system; and

IN THE MATTER OF an application for an order concerning full and adequate responses to information requests including the disclosure and production of documents, reports and records.

TO: The Board of Commissioners of Public Utilities (the "Board")

THE APPLICATION OF Newfoundland Power Inc. ("Newfoundland Power") **SAYS THAT**:

1. Newfoundland Power is a corporation duly organized and existing under the laws of the Province of Newfoundland and Labrador, is a public utility within the meaning of the *Act*, and is subject to the provisions of the *EPCA*.

2. On or about January 6th, 2014, the Board commenced an investigation into supply issues and power outages on the Island Interconnected system in late December 2013 and early January 2014.

3. On or about January 17th, 2014, Newfoundland Power and Newfoundland and Labrador Hydro ("Hydro") were each advised by the Board that they were considered parties in the Board's investigation and hearing into supply issues and power outages on the Island Interconnected system in late December 2013 and early January 2014 (the "Investigation and Hearing").

4. By Order No. P.U. 3 (2014), the Board determined that the issues to be considered in the Investigation and Hearing would include, amongst other things, an evaluation of Island Interconnected system adequacy and reliability up to and after the interconnection with the Muskrat Falls generating facility.

5. On September 19th, 2014, Newfoundland Power filed 35 information requests (the "RFIs") directed to Hydro seeking information to assist in the evaluation of the reliability of the Island Interconnected System after the interconnection with the Muskrat Falls generating facility.

6. Section 15 of the *Board of Commissioners of Public Utilities Regulations, 1996* (the "*Regulations*") provides, in effect, that where an RFI has been directed to a party, that party shall provide a full and adequate response to the RFI.

7. To the date hereof, Hydro has failed to provide full and adequate responses to the RFIs referred to in paragraph 5 of this Application. A description of the deficiencies in Hydro's responses in respect of which this Application seeks relief is provided in Schedule A to this Application.

8. As a result of the failure of Hydro to provide full and adequate responses to each of the RFIs as referred to in paragraph 5 of this Application, Newfoundland Power is not in a position to fully assess or evaluate Island Interconnected System adequacy and reliability after interconnection with the Muskrat Falls generating facility as provided by Order No. P.U. 3 (2014).

9. Newfoundland Power will require further information concerning the design of the Labrador-Island HVdc transmission system (the "Labrador-Island HVdc Link") to assess and evaluate Island Interconnected system adequacy and reliability after interconnection with the Muskrat Falls generating facility as provided by Order No. P.U. 3 (2014).

10. Section 93 of the *Act* provides, in effect, that a member of the Board, for the purposes mentioned in the *Act*, has the power to compel the production of books, accounts, papers, records and documents.

11. Production of documents, reports and records in Hydro's possession, power or control that are related to the design of the Labrador-Island HVdc Link all as requested in the RFIs referred to in Schedule A to this Application will provide an efficient means to permit assessment and evaluation of Island Interconnected system adequacy and reliability after interconnection with the Muskrat Falls generating facility.

12. Newfoundland Power requests that, pursuant to the provisions in Section 93 of the *Act* and the *Regulations*, the Board or a commissioner make an order compelling Hydro to forthwith provide full and adequate responses (including mathematical calculations, design specifications and supporting documents) to the RFIs referred to in Schedule A to this Application.

13. The Board should make the order requested in this Application because:

    a) it is consistent with the Board's fulfillment of its duties and obligations under the *EPCA* and the *Act*;

    b) it is consistent with the fair and efficient conduct of the Investigation and Hearing including, without limitation, the Board's consideration of the issues determined in Order No. P.U. 3 (2014); and

c) it is necessary and reasonable to enable Newfoundland Power, a party to the Investigation and Hearing, to fully and meaningfully participate in the Investigation and Hearing.

14. Communications with respect to this Application should be forwarded to the attention of Ian F. Kelly, Q.C. and Gerard M. Hayes, Counsel to Newfoundland Power.

DATED at St. John's, Newfoundland, this 20th day of March, 2015.

NEWFOUNDLAND POWER INC.

Ian F. Kelly, Q.C. and Gerard M. Hayes
Newfoundland Power Inc.
P.O. Box 8910
55 Kenmount Road
St. John's, NL A1B 3P6

Telephone: (709) 737-5609
Telecopier: (709) 737-2974
Email : ghayes@newfoundlandpower.com

RFI No.	**Description of Deficiency**
NP-NLH-004:	This RFI requested, amongst other things, "…the mathematical calculations supporting…" the return period of climatic loads used in design of the Labrador-Island HVdc Link and all detailed ice and wind weather cases as well as suspension tower load cases. **No mathematical calculations were provided.**
NP-NLH-005:	This RFI requested, amongst other things, "…the mathematical calculations supporting…" the return period of climatic loads used in design of the proposed 230 kV transmission line from Bay d'Espoir to Western Avalon and all detailed ice and wind weather cases as well as suspension tower load cases. **No mathematical calculations were provided.**
NP-NLH-018:	This RFI requested a copy of the design specifications of the Labrador-Island HVdc Link and the proposed 230 kV line from Bay d'Espoir to Western Avalon and supporting documents. **No design specifications or supporting documents were provided.**

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 (the "*EPCA*"), and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF an Investigation and Hearing into supply issues and power outages on the Island Interconnected system; and

IN THE MATTER OF an application for an order concerning full and adequate responses to information requests including the disclosure and production of documents, reports and records.

AFFIDAVIT

I, Peter Alteen, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. That I am Vice-President, Regulation and Planning, of Newfoundland Power.

2. To the best of my knowledge, information and belief, all matters, facts and things set out in this Application are true.

SWORN before me at St. John's in the Province of Newfoundland and Labrador this 20th day of March, 2015:

Barrister

Peter Alteen

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 (the "*EPCA*"), and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF an Investigation and Hearing into supply issues and power outages on the Island Interconnected system; and

IN THE MATTER OF an application for an order concerning full and adequate responses to information requests including the disclosure and production of documents, reports and records.

AFFIDAVIT

I, ELIAS GHANNOUM, of the City of Montreal, in the Province of Quebec, Canada, Professional Engineer, make oath and say as follows:

1. I practice as a consultant in matters relating to the engineering, design and construction of overhead electrical transmission lines. My *curriculum vitae* is attached as Schedule A to this Affidavit.

2. I have been informed by Newfoundland Power Inc. ("Newfoundland Power"), and do believe, that the reliability of electrical service to the eastern portion of the Island of Newfoundland is a primary focus of an investigation and hearing by the Board of Commissioners of Public Utilities for Newfoundland and Labrador (the "Board") into supply issues on the island interconnected system (the "Investigation").

3. I have been retained by Newfoundland Power to evaluate, and provide an opinion concerning, the degree to which the Newfoundland and Labrador Hydro Corporation ("Hydro") and its affiliates, including Nalcor Energy ("Nalcor"), have addressed the risks to supply presented by electrical transmission systems serving the island of Newfoundland following the construction of the Labrador-Island HVdc transmission system and after interconnection with the Muskrat Falls generating facility. In particular, Newfoundland

Power has requested my professional opinion concerning the structural and mechanical risks to the reliability of electrical transmission systems serving the eastern portion of the island of Newfoundland following the construction of the Labrador-Island HVdc transmission system and after interconnection with the Muskrat Falls generating facility.

4. I have been informed by Newfoundland Power and do believe that the electrical transmission systems serving the eastern portion of the Island of Newfoundland are owned and operated or are being designed and constructed by Hydro, or affiliates of Hydro, including Nalcor.

5. I provided advice to Newfoundland Power to assist in the development of requests for information (the "RFIs") which I understand were submitted by Newfoundland Power to Hydro in the Investigation by the Board. A copy of the RFIs is attached as Schedule B to this Affidavit.

6. I have reviewed the responses by Hydro to the RFIs. Amongst other things, the responses to the RFIs generally did not provide (i) mathematical calculations or (ii) design specifications and supporting documents as requested. The responses to RFI Nos. NP-NLH-004 and NP-NLH-005 did not provide the requested, or any, mathematical calculations. The response to RFI No. NP-NLH-018 did not provide the requested, or any, design specifications or supporting documents.

7. In RFI Nos. NP-NLH-004 and NP-NLH-005 detailed ice and wind weather cases as well as suspension tower load cases, including the mathematical calculations supporting them, were requested for the Labrador-Island HVdc Link and the proposed 230 kV line from Bay d'Espoir to Western Avalon, respectively. Such mathematical calculations are a requirement of transmission line and tower design and would show how weather loads were used to generate tower loading cases used for design of transmission towers. These mathematical calculations, which are part of engineering practice, disclose the extent to which a chosen design addresses the structural and mechanical risks to the reliability of electrical transmission systems.

8. In RFI No. NP-NLH-018 design specifications of all line components of the Labrador-Island HVdc Link and the proposed 230 kV line from Bay d'Espoir to Western Avalon, including tower loads, conductor sag-tensions and any other supporting documents were requested. In engineering practice, such design specifications would disclose the extent to which a chosen design addresses the structural and mechanical risks to the reliability of an electrical transmission system.

9. Engineering design specifications for electrical transmission systems typically include, but are not limited to, tower loads and conductor sag-tensions, tower types, spans, tower top geometry, tower heights and extensions, load factors, strength factors, and similar requirements as applicable related to foundations, conductors, and insulator strings. In transmission line engineering practice, supporting documents which reflect detailed design are typically comprised of (i) Microsoft Excel files, (ii) back-up files of all tower models created using engineering software such as Power Line Systems TOWER and (iii) back-up files created using engineering software such as Power Line Systems PLS-CADD, including all profiles with tower spotting using M1 and M4 tower models. I am a licensed user of Microsoft Excel and all Power Line Systems software and use them routinely in my consulting practice. Power Line Systems' website indicates that Hydro and SNC-Lavalin, Hydro's consultant for the Labrador-Island HVdc Link, are also licensed users of Power Line Systems software.

10. The mathematical calculations and design specifications, which I require to provide the professional opinion requested by Newfoundland Power, include those calculations and specifications related to structural and mechanical design of the electrical transmission systems specified, whether these were prepared by Hydro, Nalcor, their affiliates or consultants.

11. The mathematical calculations, design specifications and supporting documents requested in RFI Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 are types of information which are, in my experience and professional opinion, typically used by engineers in the design of overhead electrical transmission systems. In my experience, the requested information

should be readily available and easily transmittable in electronic format. The information in electronic format would be sufficient for my purposes.

12. The mathematical calculations, design specifications and supporting documents requested in RFI Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 are types of information which are, in my experience and professional opinion, typically reviewed by engineers for the purposes of evaluating the reliability and security of overhead electrical transmission systems.

13. Without the information referred to in RFI Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 and further described in this Affidavit, I am unable to properly evaluate the degree to which Hydro and its affiliates, including Nalcor, have addressed the risks to supply presented by electrical transmission systems serving the eastern portion of the island of Newfoundland following the construction of the Labrador-Island HVdc transmission system and after interconnection of the Muskrat Falls generating facility. Access to the mathematical calculations, design specifications and documents requested in RFI Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 are necessary for me to provide my expert opinion in the Investigation as described in this Affidavit.

14. This Affidavit is sworn in support of an application by Newfoundland Power for an order requiring Hydro to provide the mathematical calculations, design specifications and supporting documents requested in RFI Nos. NP-NLH-004, NP-NLH-005 and NP-NLH-018 for the purposes of the reliability evaluation and expert opinion as described in this Affidavit.

SWORN before me at the City of St. John's in the Province of Newfoundland and Labrador this 18th day of March, 2015.

Barrister

Elias Ghannoum

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 (the "*EPCA*"), and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF an Investigation and Hearing into supply issues and power outages on the Island Interconnected system; and

IN THE MATTER OF an application for an order concerning full and adequate responses to information requests including the disclosure and production of documents, reports and records.

Schedule A
To Affidavit of Elias Ghannoum

Name: **GHANNOUM, Elias**

Experience: 43 years in Overhead Transmission Lines (Engineering, Design and Construction)

Nationality: Canadian

Membership of Technical-Professional Societies-Standardization Committees: 15

Reports and Publications in International Journals and Conferences: more than 40

EDUCATION

1971	Master's degree in Civil Engineering (structural) University of Sherbrooke, Canada	M.A.Sc.
1968	Bachelor in Civil Engineering University of Aleppo	B.A.Sc.
1974, 1984, 1995	Courses in project management University of Montreal, and other seminars	

EMPLOYMENT RECORD

Since 1998 **CONSULTANT**

Mills Shirley: Expert witness for litigation between CenterPoint Utilities (Texas) and American Electric Power (ongoing work started in 2012)

Transelec-Chile: Engineering of 1200 km of 500 kV HVDC line and 230 kV double circuit AC lines for the Energy Austral project in South Chile. Work includes review and validation of Consutant work and proposals of special engineering solutions for extreme weather and access locations of this project. (2010 to 2012)

National Electric Power Company (NEPCO), Jordan: Design of steel towers and specialized courses in overhead line and lattice tower designs. (2011-2012)

SNC-Lavalin: transmission line and software courses in Toronto and Calgary (2011-2012) and review of specifications for Togo-Benin transmission line (2011)

Manitoba Hydro: Consultancy services for the design and optimization of 1350 km of ±500 KV HVDC Bipole III (ongoing work started in 2008), assignments include the selection of reliability levels, weather loads, conductors, structure types, loading cases, specifications, detailed design of structures, tower spotting, etc.)

PowerGrid Corporation of India: Technical advisor and consultant for the design and optimization of the following projects:

- UHVDC ± 800 kV,
- 1200 kV AC,
- Double circuit 800 kV AC lines
- Failure investigations of line failures,

- Optimization and Design of 1600m long central span of the Hoogly river crossing. Assignment includes selection of crossing location, clearance above high water levels, conductor and OPGW optimization and selection, design criteria and structure loading cases, preliminary design of suspension and anchor towers, etc. (ongoing project started in 2009).

Nova Scotia Power: Review of the design of a 138 kV line (in 2010) and related technical support

Transelec (Chile): Technical advisor and consultant for the design and optimization of a 2100 km HVDC ± 500 line (assignment form early 2008 to end of 2009).

Hidro-Aysen (Chile): Audit of detailed design of 500 kV AC lines (2009)

ESKOM, South Africa, Design of double circuit 800 kV AC structures and lines (2007-2008). Review of the proposed South African design standard of overhead lines (2009); Consultancy services for lines located in high wind areas (2009-2010)

Canadian Electricity Association Technologies Inc. (CEATI). CEATI REPORT No. T063700-3335: Comparison between unbalanced ice loads and security loads and assessment of their impact on line/structure designs

Transmission line courses on design of overhead lines and use of PLS-CADD, TOWER and PLS-POLE software: Vatech (Austria), EOS and BKW (Switzerland) Terna (Italy), Dubai, Abu Dhabi, Sonelgaz, France (EDF/RTE, Transel, Hecla, etc.), Electricity Authority of Cyprus, Sonelgaz (Algeria), Egypt EEC), Manitoba Hydro, Serbia, Spain, Malaysia, Bangladesh, STEG (Tunisia), ONE (Morocco), Saudi Arabia, Germany, Canada (BBA, Hydro-Quebec, Hydro-One, Teshmont, Manitoba Hydro), USA (San-Antonio, Oklahoma city), Courses in Montreal almost on a yearly basis, etc. since 1998.

Power Line Systems (USA), Technical support for line software such as PLS-CADD, TOWER, PLS-POLE since 1998

ESKOM, South Africa, Audit of design and construction practices and standards of TransAfrica Projects (ESKOM engineering branch), and Failure investigation of Matimba line (2006)

Principal Lecturer in Workshops: Belgrade (2002) on Transmission lines revitalization and Netherlands (2004) on Integration of Laser airborne survey techniques (LiDAR) in the design of overhead lines. (2005)

World Bank, Review of the design and construction of 161 kV line in Sierra Leone, (2005)

Canadian Electricity Association Technologies Inc. (CEATI). Comparison of Wind Load Methodologies for Lattice Transmission Line Towers, PROJECT NO.: T053700 – 3324 (2005),

Hydro-Quebec TransÉnergie, Canada, various consultancy works and expertise, contributor to the 2004 Revision of HQ transmission line design standard (2000-2004)

CHILE, Technical audit of 220 kV line Quillota - Los Piuquenes in Chili (2004)

Electricité de France (EDF/RTE), Review of the Utility's design criteria in the wake of the 1999 wind storms and application of probabilistic methods on three transmission projects, Failure investigation of lines that failed in 1999 wind storms and recommendations for improving reliability of the Network (2002)

Electricité de France (EDF/RTE), Assessment of security of 90 kV lines with concrete pole and assessment of means to increase the reliability and security of these lines (2003-2004)

KEC (India), Investigation of 400 kV tower failures (2002-2003)

World Bank: Umpire of a Disputes Review Board for a major 800 kV World Bank transmission project in India (1998-2002)

Hydro-Quebec Distribution: Basic and advanced course on design of distribution lines (2004)

ESKOM, South Africa, review of design practices and advanced courses on design and optimization of lines and towers. (2003)

University of Sherbrooke, Canada, first Chairperson (2002), "Hydro-Quebec Chair on design of Overhead Transmission Lines**" (2002)**

Hydro-Quebec, Canada, "Principal investigator of the 114 transmission lines that failed during the 1998 ice storm in North-America" and Principal Author of the official Diagnostic Report. Submitted to the Warren Committee and the Nicolet Commission (1998-1999)

Law firm Ogilvy-Renault, Canada, Expert witness in a major litigation involving transmission line failures due to the 1998 ice storm in Canada (1999-2001)

Canadian Electricity Association (CEA), Technical Coordinator in charge of the Interest Group composed of 15 major utilities on mitigation of Ice storm effects on overhead lines (1999-2000)

RSW, Canada, "Feasibility Studies of UHV lines in Labrador". (1999)

Phillips-Fitel, Canada, "Expertise related to OPGW and its installation". (1999)

HQI, Canada, "Specialized studies on overhead lines in North-Africa" (1999)

PTI/GAI, USA, "Expertise related to line failure in Argentina**" (1999)**

1977 to date: **UNIVERSITY OF MONTREAL (École Polytechnique)**

Lecturer graduate level (Master's and Ph.D. level), Engineering Faculty, course title "Structural analysis of transmission lines"

Lecturer of a course on basic design of overhead lines (2005-2006)

Lecturer of a course on advanced design of overhead transmission line (2005-2006)

Lecturer of a two-part course on design and construction of overhead transmission lines

1971 to 1998 **HYDRO-QUÉBEC**

1989 to 1998 *Transmission line Specialist*

Project Director of the Interconnection between Tunisia and Libya (≈ 80 millions USD project): Responsible for technical studies, optimization, preparation of technical specifications, General/Special Contract documents, Invitation to Bidders, Bids analysis, contract negotiations, etc.

Transmission Line expertise in international projects: involves design, technical studies, optimization, and specifications of international transmission line projects. Partial list: ± 500 kV Chandrapur-Padghe, India, Chili 220 kV, Libya 230 kV and 400 kV, Tunisia 230 kV, Interconnection studies (transmission lines) of 5 Middle-Eastern countries (Turkey, Iraq, Syria, Jordan, Egypt), 500 kV Ertan project in China, 765 kV Venezuela, 500 kV Colombia, Mali, Burkina Faso (analysis of tower failures), etc.

Consultant to the World Bank for review of transmission line projects and tender documents.

Technical spokesperson for Hydro-Quebec during the Jan. 1998 ice storm.

Technical advisor to Electric Power Research Institute (EPRI), USA, for projects 1352 (reliability based design of overhead lines) and 1277 (wind loads).

Research projects on line rehabilitation and upgrading, compact conductors, wind loads on transmission lines.

Transmission Line Expert representing Hydro-Quebec in a Supreme Court litigation in Canada.

Optical ground wire (OPGW) studies, design, testing and installation of OPGW on 2000 km of 120 kV to 735 kV transmission lines.

Principal Lecturer-and Organizer of Technical seminars in various countries, namely: Brazil, Morocco, Columbia, Argentina, USA, Thailand, China, etc.

Principal Author of Hydro-Quebec's transmission lines design standard.

1983 to 1989 *Group Leader*

Design of towers and foundations Design of 1100 km of ± 450 kV DC line for 6th James Bay line.

Design of ± 500 kV, 1000 km Rihand-Delhi line in India (Project leader, responsible for optimization all technical studies and specifications related to overhead lines).

International consultant for various transmission lines projects.

1977 to 1983 *Division Head (Chief Engineer)*
Transmission Lines, Engineering Department.

Design criteria for line components based on reliability concepts.

Design of transmission towers, voltage levels from 120 kV to 735 kV such as chainette tower, suspension tower, long span tower, anti-cascade tower, angle and anchor tower, for the 735 kV Bay James Project.

Supervise the work of Hydro-Quebec's engineers in the design of towers, foundations, conductors and hardware.

Preparation of supply and construction specifications for transmission lines.

1971 to 1976 *Project Engineer*

Responsible for numerous projects covering all transmission voltage levels (69 kV, 120 kV, 161 kV, 230 kV, 345 kV, 735 kV). Work involves selection of line routes of transmission lines, soil studies for foundations, budgeting, design of structures (wood and steel), tower spotting and supervision of construction. Specialized engineering studies, supervision of technical work performed by consulting firms and technical assistance during construction. Project Engineer of 735 kV river crossing over the St. Lawrence River, using 600 tons self-supporting towers of a height of 185 m.

LANGUAGES

	Spoken	***Read***	***Written***
French	Excellent	Excellent	Excellent
English	Excellent	Excellent	Excellent
Arabic	Excellent	Excellent	Excellent
Spanish	Fair	good	-
Italian	-	Fair	-
German	(some knowledge)		

PROFESSIONAL ASSOCIATIONS

- Chair of the International Electrotechnical Commission (IEC), Technical Committee 7 "Overhead Conductors"

- Fellow, Institute of Electrical and Electronics Engineers (IEEE) since 1994
- Chair of Subcommittee of Canadian Standards Committee CSA-C22.3 on reliability based design of overhead transmission lines
- Chair of Canadian Committee of IEC TC-11, sponsored by the Standards Council of Canada
- Past-Convenor (1988-2000) and currently member, of CIGRÉ WG 6 of Committee B2 "Overall line Design". Also member of the Strategic advisory group of B2 Committee
- Chair of Working Group MT1 of IEC/TC11 "Loading and Strength of Overhead Transmission Lines"
- Past Chair of Working Group MT4 of IEC/TC7 "Aluminum and Aluminum alloy stranded Conductors"
- Past Chair of the Canadian Standards Committee on IEC/TC86A "Fiber Optic Cables"
- Member and past Chairman of IEEE Task Force "Line Assessment-Service Experience" (1995-2001)
- Past Convenor of CIGRÉ Task on High surge impedance loading lines
- Member of (4) IEEE Sub-Committees, "Loading and strength of overhead lines", Construction of lines", "Line Assessment", "Towers, Poles and Conductors".
- Member of Canadian Standards Committee CSA-C49
- Member of the Canadian Electrical Association
- Member of the Order of Engineers of Quebec
- Registered professional engineer in the province of Manitoba

AWARDS

2010 IEC Award for outstanding contributions to international standards

2004, Award of Merit from the Canadian Standards Association "For his dedication, expertise and leadership of more than 25 years that were instrumental in writing national and international standards in the areas of overhead line design and overhead electrical conductors"

1997 CIGRÉ (Conférence Internationale des Grands Réseaux Electriques) Technical Award for outstanding contributions to technical work on overhead lines.

1993 The Institute of Electrical and Electronic Engineers, IEEE FELLOW "For contributions to the reliability-based design and leadership in international standardization of transmission line design".

1984 IEEE Transmission and Distribution Award for the best Technical Paper.

PUBLICATIONS (PARTIAL LIST)

Ghannoum, E., Gopal Ji, Kumar, R., "Selection of Conductors and OPGW for the Hoogly River Crossing in India". To be presented to CIGRE B-2 session, New Delhi, Oct. 2013

Kieloch, Z, Ghannoum, E., Design of the ±500 kV HVDC Bipole III line in Manitoba, Canada, CIGRE paper B2-101, Paris, Aug. 2012

Ghannoum, E., Zibby Kieloch, "Use of Modern Technologies and Software to Deliver Efficient Design and Optimization of 1380 km Long Bipole III ± 500 kV HVDC Transmission Line, Manitoba, Canada", IEEE Transmission and Distribution conference, May 9, 2012

Rogier, E., Fronek, Ghannoum, E., and WG B2-06, "Tower Top Geometry and Mid Span Clearances", CIGRE Brochure 348, CIGRE 2008

Rogier, E., Ghannoum, E., and WG B2-06, "Reliability Based Design Methods for Overhead Lines, Advantages, Applications, and Comparisons", CIGRE Brochure 344, CIGRE 2008

Ghannoum, E., -- Assessment of the impacts of increasing structural reliability and security by designing lines for longitudinal broken conductor and unbalanced icing loads, CIGRE Paper B2-204, Aug. 2008

Ghannoum, E., "Tutorial on Cascading Structure Failures", IEEE Tower, Poles, and Conductors, Las-Vegas, Jan. 2008

Ghannoum, E., "Comparison Between Unbalanced Ice Loads and Security Loads and Assessment of their Impact on Line/Structure Designs", CEATI Publication T063700 3335, 2008

Ghannoum, E. and al., "Reliability Based Design Methods for Overhead Lines Advantages, Applications and Comparisons", CIGRE Brochure 289, Working Group 22-06, 2006

Ghannoum, E., "Comparison of Wind Load Methodologies for Lattice Transmission Line Towers", CEATI Publication T053700 3324, 2005

Ghannoum, E. "Increasing structural Reliability and Security Using IEC 60826 Principles", CIGRÉ Symposium on line revitalization, Belgrade, Serbia, May 2003.

Ghannoum, E., "Evolution of IEC 60826 -Loading and Strength of Overhead Lines-", ASCE, 2002 Omaha conference.

GHANNOUM et Al., "Use of Reliability Techniques in the Design of Hydro-Quebec's 1100 km Radisson-Nicolet-Des Cantons ±450kV DC Line", CIGRÉ Paris Meeting, Sept. 1996.

GHANNOUM et Al., "Fiber Optic Ground Wire for Hydro-Québec's Telecommunication Network", IEEE, Winter Power Meeting, 1995.

GAUDRY, M., GHANNOUM, E., "Increasing power transfer of overhead lines by using homogenous compact conductors", CIGRÉ, Paris, Sept. 1998.

GHANNOUM, E., "State of the Art Report on Compact Conductors", CEA, June, 1992.

GHANNOUM, E., YAACOUB, S.J., "Optimization of Transmission Towers and Foundations Based on Their Minimum Installed Cost", IEEE/PES 1988 Winter Meeting, Paper 88 WM 072-1.

GHANNOUM, E., Orawski, G., "Reliability Based Design of Transmission Lines According to Recent Advances by IEC and CIGRÉ", International Symposium of Probabilistic Design of Transmission Lines, Toronto, June 1986.

GHANNOUM, E., et al, "The Use of Probability Techniques in the Design and Uprating of Transmission Lines in Hydro-Québec", Symposium on Probabilistic Design of transmission lines, Toronto, June 1986.

GHANNOUM, E., and Tupula, F., "The Design of 500 kV HVDC Rihand-Delhi Transmission Line", Symposium on Trends in Transmission Line Technology, Delhi, 1985.

GHANNOUM, E., and Lamarre, M., "Hydro-Québec's Experience with the Design and Construction of 1500 km of 735 kV Chainette Transmission Lines", IEEE, Vol. PAS-104, no. 10, October 1985.

GHANNOUM, E., "Reliability and Security Concepts Applied to Structural - Design of Transmission Lines", 1983, International Symposium on Reliability, Availability and Maintainability, Montréal, June 1983.

GHANNOUM, E., "Probabilistic Design of Transmission Lines - Part I : Probability Calculations and Structural Reliability", IEEE/PES 1983 Winter Meeting, New-York.

GHANNOUM, E., "Probabilistic Design of Transmission Lines - Part II : Design Criteria Corresponding to a Target Reliability", IEEE/PES 1983 Winter Meeting, New-York.

GHANNOUM, E., "Improving Transmission Line Design by Using Reliability Techniques", IEEE/PES 1984 Winter Meeting, Dallas. (Award Winning Paper)

GHANNOUM, E., "Hydro-Québec Designs 735 kV Towers", Transmission and Distribution, December 1982.

GHANNOUM, E., "Design of 450 kV Des Cantons - New England DC Transmission Lines", CEA, Mars 1985.

GHANNOUM, E., "Design Criteria of Transmission Lines in Icing Areas", CHINA-HYDRO-QUÉBEC Symposium, Beijing' November 1981.

GHANNOUM, E., "A Rational Approach to Structural Design of Transmission Lines", IEEE Power Engineering Society, Winter Meeting, Atlanta, February 1981, and IEEE Transaction on Power Apparatus and Systems, PAS-100, July 1981, pp. 3506-3511.

GHANNOUM, E. et Al, "Discussion of Hydro-Québec's Design Approach to Structural Design of Transmission Lines",

Canadian Electrical Association, March 1981.

GHANNOUM, E. "Une Nouvelle Approche de la Conception des Pylônes des Lignes de Transport d'Énergie", Canadian Structural Engineering Conference, Montreal, February 1980.

ELLYN F. and GHANNOUM, E. "An assessment of reliability of structures", Transactions of the Engineering Institute of Canada, Feb. 1972.

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IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 (the "*EPCA*"), and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF an Investigation and Hearing into supply issues and power outages on the Island Interconnected system; and

IN THE MATTER OF an application for an order concerning full and adequate responses to information requests including the disclosure and production of documents, reports and records.

Schedule B
To Affidavit of Elias Ghannoum

IN THE MATTER OF
the *Electrical Power Control Act, 1994*,
SNL 1994, Chapter E-5.1 (the "*EPCA*")
and the *Public Utilities Act*, RSNL 1990,
Chapter P-47 (the "*Act*"), as amended; and

IN THE MATTER OF the Board's Investigation
and Hearing into Supply Issues and Power Outages
on the Island Interconnected System.

Requests for Information by
Newfoundland Power Inc.

NP-NLH-1 to NP-NLH-35

September 19, 2014

Requests for Information

NP-NLH-001 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 54.

"MHI finds that Nalcor currently does not comply with North American Electric Reliability Corporation (NERC) standards. A majority of utilities in Canada have adopted the definition of "good utility practice" that incorporates adherence to NERC standards. Also, should the Maritime Link proceed, and Nalcor participates in the electricity marketplace, NERC standards will ultimately apply. MHI recommends that Nalcor complete a self-assessment and prepare for compliance to NERC standards with or without the Maritime Link."

Please confirm Nalcor/Hydro is not currently NERC compliant and outline what measures would be required for Nalcor/Hydro's generation and transmission system to achieve and maintain NERC compliance following interconnection to the North American grid.

NP-NLH-002 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 54.

"MHI finds that Nalcor currently does not comply with North American Electric Reliability Corporation (NERC) standards. A majority of utilities in Canada have adopted the definition of "good utility practice" that incorporates adherence to NERC standards. Also, should the Maritime Link proceed, and Nalcor participates in the electricity marketplace, NERC standards will ultimately apply. MHI recommends that Nalcor complete a self-assessment and prepare for compliance to NERC standards with or without the Maritime Link."

Has Nalcor/Hydro completed the self-assessment referred to by MHI? If so, please provide a copy. If not, please explain why not.

NP-NLH-003 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 54.

"MHI finds that Nalcor currently does not comply with North American Electric Reliability Corporation (NERC) standards. A majority of utilities in Canada have adopted the definition of "good utility practice" that incorporates adherence to NERC standards. Also, should the Maritime Link proceed, and Nalcor participates in the electricity marketplace, NERC standards will ultimately apply. MHI recommends that Nalcor

complete a self-assessment and prepare for compliance to NERC standards with or without the Maritime Link."

What are the current and future reliability consequences for the Island Interconnected System of Nalcor/Hydro not being NERC compliant?

NP-NLH-004 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 11.

"Design Loading Criteria – Nalcor has selected a 1:50-year reliability return period (basis for design loading criteria) for the HVdc transmission line, which is inconsistent with the recommended 1:500-year reliability return period outlined in the International Standard CEI/IEC 60826:2003 with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06, for this class of transmission line without an alternate supply."

Please confirm the return period of climatic loads used in the design of the Labrador – Island HVdc Link and provide all the detailed ice and wind weather cases as well as suspension tower load cases, including the mathematical calculations supporting them.

NP-NLH-005 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 11.

"Design Loading Criteria – Nalcor has selected a 1:50-year reliability return period (basis for design loading criteria) for the HVdc transmission line, which is inconsistent with the recommended 1:500-year reliability return period outlined in the International Standard CEI/IEC 60826:2003 with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06, for this class of transmission line without an alternate supply."

Please confirm the return period of climatic loads used in the design of the proposed 230kV transmission line from Bay d'Espoir to Western Avalon and provide all the detailed ice and wind weather cases as well as suspension tower load cases, including the mathematical calculations supporting them.

NP-NLH-006 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 11.

"Design Loading Criteria – Nalcor has selected a 1:50-year reliability return period (basis for design loading criteria) for the HVdc transmission line, which is inconsistent with the recommended 1:500-year reliability

return period outlined in the International Standard CEI/IEC 60826:2003 with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06, for this class of transmission line without an alternate supply."

Please describe in detail how the design of the Labrador – Island HVdc Link and the proposed 230kV transmission line from Bay d'Espoir to Western Avalon each correspond to weather data for rime, glaze icing and wind derived from available weather studies. The description should address all climatic zones each transmission line traverses.

NP-NLH-007 Reference: GRK-NLH-038 (Revision 1, July 28-14)

"In its second report prepared in October 2012, Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options, MHI completed a thorough assessment of Nalcor's updated work and made the following observations:

> *"[i]t is MHI's opinion Nalcor undertook appropriate due diligence selecting the weather loads for this transmission line" and "[t]he climatic loadings for each line section are approximately equivalent to the climatic loadings calculated assuming Canadian Standards Association (CSA) 1:500 year return period*."

Please provide mathematical calculations to demonstrate that the climatic glaze ice loadings, say for St. John's and the Long Range Mountains, used for designing the Labrador-Island HVdc Link are approximately equivalent to the climatic loadings calculated assuming the Canadian Standards Association (CSA) 1:500 year return period.

NP-NLH-008 Reference: GRK-NLH-038 (Revision 1, July 28-14)

"In its second report prepared in October 2012, Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options, MHI completed a thorough assessment of Nalcor's updated work and made the following observations:

> *"[i]t is MHI's opinion Nalcor undertook appropriate due diligence selecting the weather loads for this transmission line" and "[t]he climatic loadings for each line section are approximately equivalent to the climatic loadings calculated assuming Canadian Standards Association (CSA) 1:500 year return period*."

CSA standard CAN/CSA-C22.3 No. 60826 does not provide values for rime icing in Newfoundland and Labrador. Nalcor Exhibit, Muskrat Falls Exhibit 97 , Revision 1 states that the icing mechanism considered as limiting design load for Zones 2a, 2b, 2c, 5, 7a, 7b, and 7c is rime icing.

Please provide the return periods of rime icing measurements considered in each of these zones along with the mathematical calculations supporting these load selections and return periods.

NP-NLH-009 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 97, *Review of Existing Meteorological Studies Conducted on the Labrador Island Transmission Link - Appendix A (R1) – Ice Loading Region Maps*.

Did Nalcor/Hydro use the weather loading data provided in Appendix A (R1) of Nalcor Exhibit 97 to design the Labrador-Island HVdc Link?

NP-NLH-010 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 97, *Review of Existing Meteorological Studies Conducted on the Labrador Island Transmission Link - Appendix A (R1) – Ice Loading Region Maps.*

Please confirm the climatic return period for the weather data given below each figure of Exhibit 97, Appendix A (R1).

NP-NLH-011 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 97*, Review of Existing Meteorological Studies Conducted on the Labrador Island Transmission Link - Appendix A (R1) – Ice Loading Region Maps.*

Please provide in tabular format a comparison of (i) the weather data given below each figure of Exhibit 97, Appendix A (R1), and (ii) corresponding 1:500 year return period values calculated using the space and height factor, as well as the incremental factor, for a 1:500 year return period in accordance with CSA standard CAN/CSA- C22.3 No. 60826 for the same data.

NP-NLH-012 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92, *DC1070 Preliminary Meteorological Load Review*, Tables 1 and 2, page vi.

Did Nalcor/Hydro use the weather loading data provided in Nalcor Exhibit 92, Tables 1 and 2 in the design of the Labrador-Island HVdc Link? If the data was used, please provide a detailed description of how it was used. If the data was not used, please provide a detailed explanation of why it was not used.

NP-NLH-013 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92, *DC1070 Preliminary Meteorological Load Review*, page 7-1.

"Due to a lack of statistical data, the meteorological regional loads contain uncertainty."

Given the uncertainty of predicting ice accretion in areas severely exposed to incloud/rime ice and glaze ice, particularly for high return periods, does Nalcor/Hydro agree that, at best, the predicted icing values represent average expected loads for the selected return period of loads and that the range of icing loads for a 1:500 year return period can easily fall within a range of ± 20% or more for a 90% confidence interval? Please fully explain the response.

NP-NLH-014 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92, *DC1070 Preliminary Meteorological Load Review*, Appendix D, page D-2.

"Topographical effects should be added to the basic meteorological loads taking into account statistical variations within each climatic region, which is individually determined from general climate and geographical features."

Please describe in detail how topographical effects were added to the basic meteorological loads in the design of the various components of the Labrador-Island HVdc Link, including the transmission structures. If such effects were not added, please explain why they were not.

NP-NLH-015 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92, *DC1070 Preliminary Meteorological Load Review*, Appendix D, page D-2.

"Topographical effects should be added to the basic meteorological loads taking into account statistical variations within each climatic region, which is individually determined from general climate and geographical features."

Does Nalcor/Hydro agree that topographical amplification factors to be applied to 1:500 year return period climatic loads would be different than the factors applied to 1:50 year return period climatic loads, in order to have a true 1:500 year return period design?

NP-NLH-016 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 44.

"From extensive meteorological research, Nalcor determined that the transmission line would require 11 unique weather zones, with a number of subzones, to adequately model the ice-and-wind loading on line structures."

Was the statistical independence of ice occurrence in the various weather zones of the Labrador-Island HVdc Link considered in establishing the design ice loads? For example, in determining the design return period, did Hydro consider that a weather event in the Long Range Mountains would be independent of a weather event on the Avalon Peninsula? If so, please provide the calculations of return period of loads taking into account the statistical independence of the various weather zones in the design of the Labrador-Island HVdc Link.

NP-NLH-017

Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 32.

"The report characterized the 1:50 return period being for ice-loading only but Nalcor clarified that this was for both wind and ice-loading."

Did Nalcor/Hydro design the Labrador-Island HVdc Link for the combined ice and wind specified in the CSA standard, i.e., using the 1:50 or 1:500 year ice in combination with the average winds occurring during ice persistence as required in CAN/CSA- C22.3 No. 60826? If so, please provide the supporting calculations for the design. If not, please explain the reliability implications of not complying with the CAN/CSA Standard?

NP-NLH-018

Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 44.

"MHI Reviewed Nalcor's design specification documents which outlined in detail the approach determining the tower design and geometry, span spacing, load capacity, and other detailed engineering criteria pertinent to the proposed HVdc transmission system."

Please provide a copy of the design specifications of all line components of the Labrador-Island HVdc Link and the proposed 230 kV line from Bay d'Espoir to Western Avalon, including tower loads, conductor sag-tensions and any other supporting documents.

NP-NLH-019

Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 44.

"MHI reviewed Nalcor's design specification documents which outlined in detail the approach determining the tower design and geometry, span spacing, load capacity, and other detailed engineering criteria pertinent to the proposed HVdc transmission system."

Does the design for the Labrador-Island HVdc Link include consideration of ice accumulation on the transmission tower structures? If so, please describe in detail these design considerations. If not, provide the explanation for not including this consideration in the design.

NP-NLH-020 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 47.

"The climatic loadings for each line section were selected based on Nalcor's past research studies and statistical analysis of the climate data. Extreme values based upon historical data and observations on ice accumulation and wind speed were implemented in the line regions through the Long Range Mountains and other regions in Labrador."

Has Hydro experienced buildup of ice on overhead lines as a result of successive storms or icing events? If so, how was this experience considered in designing the Labrador-Island HVdc Link or any other transmission line?

NP-NLH-021 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 37.

"Development of a good emergency response plan is recommended by MHI as part of the operational stage of the project post Decision Gate 3. Nalcor has committed to have this emergency response plan developed prior to in-service."

Following the 1998 ice storm in Quebec, some lines required periods of up to 12 weeks to repair and restore to service.

Please indicate the reliability impact to customers of the Island Interconnected System of the unavailability of the Labrador-Island HVdc Link for 12 weeks due to a widespread extreme icing event in excessive design loads.

NP-NLH-022 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 61.

"The appropriate design criteria for the proposed Labrador-Island Link HVdc transmission line is the "Design Criteria of Overhead transmission Lines" code (International Standard CEI/IEC 60826:2003) with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06."

In the CSA standard referenced above, clause No. 6.3.2 states that "The experience of some Canadian utilities is that in some locations the ground wire (GW) accretes as much radial ice weight as the larger-diameter conductors. This is partly due to the higher elevation of the GW, the higher temperature of the phase conductor, and possibly the comparative torsional stiffnesses. In such locations, it is recommended to design the GW for the same linear unit weight of ice as for the phase conductor."

Please describe how this recommendation was followed in the design of the ground wire (GW) or optical power ground wire (OPGW) of the Labrador-Island HVdc Link. If the recommendation was not followed, please explain why it was not.

NP-NLH-023 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92: *DC1070 Preliminary Meteorological Load Review*, Nalcor Exhibit 94: *HVdc Lab-NL Trans Link Ice Loading on HVdc Line Crossing Long Range Mountains,* and Nalcor Exhibit 95: *Evaluation of in-cloud icing in the Long Range Mountain Ridge.*

In Nalcor Exhibits 92, 94 and 95, the importance of wet snow accretion has been indicated to be not large enough to be the limiting design value. It is noted that none of the above reports has provided any details about the calculated amount of wet snow icing.

Please indicate whether wet snow accretion calculations were performed to support the decision to not consider wet snow accretion in the design of the Labrador-Island HVdc Link? If it was considered, please provide the associated mathematical calculations and estimates for 1:50 and 1:500 year return period events.

NP-NLH-024 Please indicate whether wet snow accretion calculations were performed as part of the design process for the proposed 230 kV transmission line from Bay d'Espoir to Western Avalon. If such calculations were performed, please provide the associated mathematical calculations and estimates for 1:50 and 1:500 year return period events.

NP-NLH-025 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 61.

"The appropriate design criteria for the proposed Labrador-Island Link HVdc transmission line is the "Design Criteria of Overhead Transmission Lines" code (International Standard CEI/IEC 60826:2003) with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06."

Confirm and provide the mathematical calculations that demonstrate the conversion from wind speed to wind pressure on structures and conductors used for the design of the Labrador-Island HVdc Link is compliant with the CSA standard CAN/CSA-C22.3 No 60826.

NP-NLH-026 Reference: Public Utilities Board Muskrat Falls Review, *Manitoba Hydro International: Report on Two Generation Expansion Alternatives for the Island Interconnected Electrical System*, January 2012, page 61.
"The appropriate design criteria for the proposed Labrador-Island Link HVdc transmission line is the "Design Criteria of Overhead transmission Lines" code (International Standard CEI/IEC 60826:2003) with Canadian deviations in CSA Standard CAN/CSA-C22.3 No. 60826:06."

For ambient temperatures below 15°C, CSA standard CAN/CSA-C22.3 No 60826 requires an air density correction factor to be used in order to account for the higher density of cold air. Was such a factor applied in the design of the Labrador-Island HVdc Link?

NP-NLH-027 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 46.

"Nalcor has selected a large 3650 MCM 91-Strand all-aluminum conductor (AAC) family for the entire transmission line, and is currently investigating the use of high-strength aluminum alloy conductors of identical size for use in the extreme ice regions required to maintain reliability."

Provide copies of all reports regarding the selection of the 3650 MCM 91-Strand all-aluminum conductor (AAC) and any current carrying conductor on the Labrador-Island HVdc Link.

NP-NLH-028 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 46.

"Nalcor has selected a large 3650 MCM 91-Strand all-aluminum conductor (AAC) family for the entire transmission line, and is currently investigating the use of high-strength aluminum alloy conductors of identical size for use in the extreme ice regions required to maintain reliability."

Please describe in detail how the maximum elongation at failure of the AAC conductor chosen for the Labrador-Island HVdc Link, and the conductor's relative softness, have been taken into account in assessing the extent of conductor damage in the event of a transverse failure of a

transmission line tower that could stretch the conductor beyond its elongation limit.

NP-NLH-029 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 46.

"Nalcor has selected a large 3650 MCM 91-Strand all-aluminum conductor (AAC) family for the entire transmission line, and is currently investigating the use of high-strength aluminum alloy conductors of identical size for use in the extreme ice regions required to maintain reliability."

Please provide a detailed assessment of the suitability of the conductor selected for the Labrador-Island HVdc Link in light of corona activity, audible noise, and other such electrical and magnetic effects.

NP-NLH-030 Reference: (http://www.powerinourhands.ca/pdf/MHI.pdf) *Manitoba Hydro International: Review of the Muskrat Falls and Labrador Island HVdc Link and the Isolated Island Options*, October 2012, page 46.

"Nalcor has selected a large 3650 MCM 91-Strand all-aluminum conductor (AAC) family for the entire transmission line, and is currently investigating the use of high-strength aluminum alloy conductors of identical size for use in the extreme ice regions required to maintain reliability."

Please advise whether Nalcor/Hydro has completed its investigation of the use of high-strength aluminum alloy conductors of identical size for use in the extreme ice regions required to maintain reliability. If so, what were the results of that investigation?

NP-NLH-031 Reference: Public Utilities Board Muskrat Falls Review, Nalcor Exhibit 92: *DC1070 Preliminary Meteorological Load Review*, page 7-1.

"Due to a lack of statistical data, the meteorological regional loads contain uncertainty."

In light of the uncertainty in predicting ice loads and the extreme severity of glaze ice and incloud/rime ice accretion in this project, has there been any assessment of de-icing methods that can be used on the Labrador-Island HVdc Link? If so, please provide copies of any assessment reports.

NP-NLH-032 In the case of an electrode failure can the Optical Power Ground Wire (OPGW) described in the response to Request for Information

CA-NLH-051 be used as a return conductor? If so, are there any requirements to insulate the OPGW for a low voltage such as 50kV in order to be able to use it for such purpose?

NP-NLH-033 Reference: CA-NLH-030, Page 3 of 8, Table 2

Please provide a revised table that shows the Island Interconnected System contingency loss of one pole of the Labrador-Island HVdc Link with the additional contingency of the loss of Hydro's largest generator on the Island Interconnected System.

NP-NLH-034 Reference: CA-NLH-030, Page 3 of 8, Lines 4-6

"For loss of the entire Labrador-Island Link, Hydro will import up to 300MW of power from the Maritime Provinces over the Maritime Link to the Island."

Please provide copies of any reports or assessments undertaken to review the availability of 300 MW of import power from the Maritime Provinces over the Maritime Link to the Island?

NP-NLH-035 Reference: PUB-NLH-214, Page 1 of 2, Lines 13-16.

"The loss of power transfer capacity during a single pole outage will discontinue exports of power on the Maritime Link as necessary to ensure system stability and to prevent loss of load on the Island Interconnected System."

Please provide a detailed explanation as to whether exports of power on the Maritime Link will be discontinued in the event of *any* supply shortage on the Island Interconnected System.

RESPECTFULLY SUBMITTED at St. John's, Newfoundland and Labrador, this 19th day of September, 2014.

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