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July 25, 2011

BY COURIER AND EMAIL

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
P.O. Box 2319, 27th Floor
2300 Yonge Street
Toronto, ON M4P 1E4

Dear Ms. Walli:

Re: Haldimand County Hydro Inc. ("HCHI")
Interrogatories for Grand Renewable Wind LP
Board File No.: EB-2011-0063

We are counsel to HCHI in this proceeding.

Pursuant to Procedural Order No. 1, please find attached the interrogatories of HCHI in this proceeding. A electronic copy has been sent to the Applicant and Intervenors and filed on the Board's RESS.

If there are any questions please contact the undersigned.

Yours truly,

AIRD & BERLIS LLP

Scott A. Stoll
SS/hm

cc: Jeong Tack Lee, Grand Renewable Wind LP
James Cho, Samsung Renewable Energy Inc.
George Vegh, McCarthy Tetrault LLP
Kirstyn Annis, McCarthy Tetrault LLP
Don Boyle, Corporation of Haldimand County
Woodward McKaig, Sullivan, Mahoney LLP

Frank Sommer, Haldimand Federation
Anne-Marie Reilly, Hydro One Networks Inc.
Carl Burrell, IESO
Glenn Zacher, Stikeman Elliott LLP
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Bruce Genery
Lee & Geraldine Russell
Norm & Valerie Negus
Quinn Felker
Lonny Bomberry, Six Nations Council of the Six nations of the Grand River

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GRAND RENEWABLE ENERGY PARK
LEAVE TO CONSTRUCT
EB-2011-0063

HALDIMAND COUNTY HYDRO INC.
(“HCHI”)
THE INTERROGATORIES FOR
THE APPLICANT:
GRAND RENEWABLE WIND LP

July 25, 2011

Interrogatories of HCHI to Grand Renewable

TOPIC: PROJECT DESCRIPTION

For the purpose of these interrogatories, the Grand Renewable Wind LP is referred to as Grand Renewable or the Applicant.

HCHI Interrogatory # 1:

Preamble:

HCHI has distribution facilities located within the municipal right-of-way, Haldimand Road 20, proposed to be used during by Grand Renewable. HCHI is interested in understanding more details of the proposed project to enable it to understand the potential to impact HCHI, HCHI's distribution system and HCHI's ratepayers.

Reference:

Exhibit A, Tab 2, Schedule 1, page 2, para. 5

"approximately 19 kilometres of 230kV transmission line (the "Transmission Line"), of which 95% (~18kilometres) will be built along the municipal right of way known as Regional Road 20 (the "Haldimand ROW"), which is owned by Haldimand County;

Exhibit B, Tab 1, Schedule 1.

Exhibit B, Tab 3, Schedule 5.

"...electrical collector lines, a 30km transmission line"

Questions:

(a) Please confirm the project as currently proposed is approximately 19 kilometres.

(b) Will the transmission line be located on one side of Haldimand Road 20 for the full 19 km and if so is it the north or south side? If not please provide a drawing showing where along Haldimand Road 20 the transmission line will be on the north side and where it will be on the south side.

(c) Has Grand Renewable determined where within the road allowance the proposed transmission line is to be located? If so, please provide a map, plan or description of the location including the side of the roadway on which it is to be located and distance from the travelled portion of the road, as well as the property line. If not, has Grand Renewable determined a minimum separation distance from HCHI's distribution system

(d) Is the proposed location of the transmission line to be on the same side of the roadway as the existing HCHI distribution system? If the answer depends upon the location, please provide a map or plan showing the location.

(e) Does Grand Renewable plan to have joint use poles or co-locate its proposed transmission facilities with the distribution facilities of HCHI or any other party? If so, what type of arrangements is Grand Renewable intending to enter and with which other party.

(f) Would any co-location with HCHI also involve the 34.5kV collector lines proposed by Grand Renewable as part of the Grand Renewable Energy Park?

(g) Exhibit B, Tab 1, Schedule 1, para. 31(d) identifies two transition stations. Will any portion of the transition stations be located within the municipal right-of-way?

TOPIC: PROJECT DESCRIPTION

HCHI Interrogatory # 2:

Preamble:

HCHI is interested in understanding the development of the route selection and the various roles of participants in ensuring the rational, cost-effective expansion of the transmission system consistent with the Board's objectives in section 1 of the OEB Act.

Evidence from OEB proceeding EB-2011-0027 states that Summerhaven Wind LP ("**Summerhaven**") is proposing to build a 9 km 230 kV transmission line to end at their proposed transformer station located on Concession Road 5, east of Cheapside Road. The proposed Summerhaven transmission line ends approximately 13.5 km (straight line distance) from the proposed location of the Grand Renewable transformer station. If Grand Renewable was to not use the proposed route but rather coordinate the development with Summerhaven, HCHI would expect the following benefits: (1) shorten the 230 kV transmission line necessary for this project by approximately 5 km (from 19 km to say 14 km); (2) eliminate the need for a separate transmission interconnection station on Haldimand Road 20 beside the existing Hydro One transmission lines; (3) eliminate the need for passing through Nelles Corners where buildings exist very close to the road; (4) avoid building a transmission line along a relatively busy roadway, Haldimand Road 20; and (5) offer a more cost effective and reliable alternative for the transmission pool funded by Ontario ratepayers.

References:

Ontario Energy Board Act, 1998, section 1.

EB-2011-0027, The "Submissions of the Independent Electricity Operator – Revised" dated June 22, 2011, reproduced below:

7) While it was determined that the single switching station option did not have a material impact on reliability requirements, the IESO believes that where there is a superior connection option or solution (e.g., it is conclusive that the solution will materially improve reliability, provides for increased efficiency and operational control and flexibility, as well as result in overall cost savings), this should be acted on where it can be reasonably accommodated in the transmission development and expansion plan. Among the other benefits that are discussed elsewhere in the record of this proceeding (e.g., SIA, Hydro One's interrogatory responses), this will also provide an incentive to encourage greater collaboration between developers, transmitters and the IESO to ensure that the most efficient outcome is achieved to the extent possible. Additionally, this will enable more effective expansion or reinforcement of transmission facilities resulting in a more robust and flexible integrated power system.

8) It is expected that there will be numerous similar situations going forward, especially given the number of projects that are currently in the pipeline and planned. The IESO's current mandate doesn't specifically empower it to enforce or impose an optimum connection alternative or solution in respect of connection assessment proposals that are carried out by the IESO. Given this gap in the planning process, the IESO would encourage the Board to take a holistic approach to its review and consideration of this issue, with the aim of providing a "balanced" outcome in this proceeding, but more importantly, provide clearer guidance for how such issue should be dealt with in the future when parties are faced with such situations. Also, the IESO encourages the Board, as deemed necessary, to consider the most appropriate regulatory mechanism by which this should be instituted (e.g., Compliance Bulletin)."

Questions:

(a) Does the Applicant have any responsibility for coordination of transmission facilities with other wind generation proponents in order to ensure these are constructed in the most cost efficient manner from the perspective of costs absorbed by the transmission pool?

(b) Does the Applicant have any responsibility for coordination of transmission facilities with other wind generation proponents or transmitters (licensed or unlicensed) in order to ensure these are constructed with due regard to optimizing the reliability of the transmission network?

(c) Does the Applicant consider itself bound to connect third parties that request connection to the proposed transmission system? If not, why not? If the response depends upon whether the third party request is from a distributor, generator or transmitter, please provide a complete explanation for the different treatments.

(d) Which agency or corporate entity is most responsible for coordination of wind and other generation proponents to ensure that transmission facilities are planned and constructed in the most cost effective and reliable manner?

(e) What is the estimated cost of the transmission interconnection station and what portion of this estimate is expected to be contributed by the Applicant?

(f) Has the Applicant considered the possibility of extending the Summerhaven transmission line as described in the Preamble above? If yes was this option discussed with Summerhaven, the IESO or Hydro One? If so what reasons were given for or against this alternative?

(g) If the Applicant has not considered the possibility of extending the Summerhaven transmission line or has not discussed this possibility with the IESO or Hydro One why has this not occurred?

(h) Did the Applicant consider other alternatives to the currently proposed transmission project? Please describe each such alternative, why it was not chosen and whether such alternative would have provided improved reliability and quality of service for customers as compared to the current proposal in this Proceeding.

TOPIC: LAND ISSUES

HCHI Interrogatory # 3:

Preamble:

Grand Renewable has proposed the use of an Easement Agreement between the County of Haldimand and Grand Renewable in respect of the portion of the project to be located within the municipal right-of-way. HCHI and other utilities currently use the right-of-way for infrastructure. HCHI is interested in how the desired land rights, and the included easement, may impact existing HCHI's rights in respect of HCHI's existing and future infrastructure.

Reference:

Exhibit A, Tab. 2, Schedule 1, Paras. 13 and 14, Footnote 1.

Exhibit B, Tab 3, Schedule 1

"47) The Applicant will be using the Haldimand ROW for the purposes of -95% of the linear length of the Transmission Corridor. The Applicant took into account several design parameters and standards in locating and designing the Transmission Corridor. In particular, the following criteria were used to decide the width of the above-ground portion of the Transmission Corridor, which will be 10 meters:

- *CAN/CSA-C22.3 NO. 1-06 and AEUC horizontal clearances and conductor swing under moderate wind pressure of 230Pa.*
- *60 Hz flashover clearances and conductor swing under high wind.*
- *Switching surge flashover clearance and conductor wing under five year return wind.*

48) Existing structures (pipelines) within the Transmission Corridor may have to be relocated in order to achieve the proper clearances. The extent of relocations necessary has yet to be determined as the Transmission Line pole placement is still being finalized."

Exhibit B, Tab 3, Schedule 3 Form of Easement – Haldimand ROW

"*9) provided that without the prior written consent of the Transferee, the Transferor shall not excavate, drill install, erect or permit to be excavated, drilled, installed or erected in, on, over or through the said Easement Lands any pit, well, foundation, pavement, building or other structure or installation. Notwithstanding the foregoing, the Transferee upon request shall consent to the Transferor erecting or repairing fences, constructing or* *repairing his tile drains and domestic sewer pipes, water pipes and utility pipes and constructing or repairing his lanes, roads, driveways.....”*

and....

“12) The Transferor hereby covenants that:

> *a) it has the right to convey this Easement and Right-of-Way to the Transferee;*
>
> *b) the Transferee shall have quiet enjoyment of the rights, privileges, easement and right-of-way hereby granted;........*
>
> *d) the Transferor has not done, omitted or permitted anything whereby the Easement Lands are or may be encumbered (except as the records of the appropriate land registry office disclose).”*

Questions:

(a) Is the Applicant aware of any instance where a municipality has granted an easement to a utility for the locating of plant along a municipal road right-of-way? Please do not include road crossings.

(b) Did the Applicant consider another form of agreement such as a road use agreement? If so, please indicate what form and why such form is not being proposed.

(c) Is the easement to be registered on title?

(d) What is the width of the right-of-way of Haldimand Road 20? If the width varies along the proposed 19 km transmission line, what is the minimum width at any point, what is the maximum width at any point, and what is the most common width?

(e) What is the width of the easement sought? Please specify for both above ground and underground sections and identify any temporary easements beyond the permanent easement sought.

(f) Is the Applicant seeking exclusive rights to the area within the Easement Lands?

(g) Please confirm the period of the easement is intended to last for 50 years.

(h) How does the location of the easement relate to the right-of-way (i.e. does it extend beyond the right-of-way)? Please provide a cross-section of the right-of-way showing the proposed location of the easement and the location of the transmission line. Please show for both the above ground and underground sections of the transmission line.

(i) Exhibit A, Tab 2, Schedule 1, page 4, Footnote 1 indicates that "*consent of the owner or (or any other person having interest) of the public street or highway is not required in order to erect the transmission line*." Does the Applicant agree that the right of occupation described above is subject to either agreement with the owner of the public street or requires the order of the Ontario Energy Board? If the Applicant does not agree, please explain the basis for such disagreement.

(j) The proposed Easement Agreement, Clause 9, cited from page 4, see above, does not refer to any wires, cables or infrastructure of HCHI or any person other than Haldimand County. Is Grand Renewal's position that HCHI and other utilities receive no protection or benefit from the form of easement agreement or are prohibited from using the municipal right-of-way?

(k) Is Grand Renewable's position that HCHI would have to obtain approval from Grand Renewable to locate HCHI infrastructure within the municipal right-of-way? If so, upon what basis would such approval be approved or rejected.

(l) The easement agreement, clause 2, provides the Transferee with a right to blast. Has the Applicant done any studies regarding the need for blasting? If so, please provide such studies. What precautions will Grand Renewable take to ensure that these activities do not impact HCHI, its infrastructure and ratepayers?

(m) Clause 12(b), of the form of easement agreement requires the Transferor to covenant that "*the Transferee shall have quiet enjoyment of the rights, privileges, easement and right-of-way hereby granted*". Is this clause intended to give Grand Renewable an exclusive right to the easement lands? If not, please explain the intent of this covenant.

(n) Clause 12(d), of the form of easement agreement requires the Transferor to covenant that "*the Transferor has not done, omitted or permitted anything whereby the Easement Lands are or may be encumbered (except as the records of the appropriate land registry office disclose).*" How does this covenant reconcile with the rights of HCHI, including statutory rights provided by section 41 of the Electricity Act, and any other utility that may have a franchise or similar agreement with Haldimand County either through the Municipal Franchises Act or otherwise?

TOPIC : DESIGN SPECIFICATIONS

HCHI Interrogatory # 4:

Preamble:

HCHI is interested in understanding the proposed design of the transmission line and related facilities so it may understand the potential impact on the HCHI infrastructure and on the ability of HCHI to avoid being adversely impacted in terms of reliability, quality of service and cost. The issues of interest to HCHI include the description of the proposed facilities, the potential for joint use of poles and induction, stray voltage and lightning impacts.

Reference:

Exhibit B, Tab 3, Schedule 1, paras. 47 through 56 and para. 60.

"*60)...The electrical influences on the environment caused by high voltage power transmission lines include:*

- *The effects of electric fields;*
- *The effects of magnetic fields;*
- *Radio interference;*
- *Audible Noise; and*
- *Ground currents and corrosion effects."*

Exhibit B, Tab 4, Schedules 1 and 5

"70) This section provides a general description of the major equipment and infrastructure associated with the Proposed Facility. A single line diagram of the Proposed Facility including the proposed tap connection to the IESO-controlled grid, is included at Exhibit B-4-2.

Collector Substation

71) The Collector Substation will be built to accumulate the power circuits from the Wind Project and Solar Project outlined above. A single line diagram of the Collector Substation is at Exhibit B-4-3. The accumulated power of approximated 250 MW at 34.5 kV will arrive via both underground cable collector circuits and overhead pole line conductor circuits. The power will be transformed from a 34.5 kV collection voltage to a 230 transmission voltage."

Questions:

(a) Exhibit B, Tab 3, Schedule 1, Paras. 48 and 56 indicate that existing HCHI infrastructures will have to be relocated.

(i) Has Grand Renewable determined the extent of HCHI's infrastructure that it would desire to see moved? Please provide a plan indicating the location of potential conflicts between the proposed transmission facility and the existing HCHI distribution system, including to where it proposes HCHI facilities will be located.

(ii) Please describe the discussions that have taken place with HCHI regarding any such relocation.

(iii) Has any agreement with HCHI been entered into by the Applicant?

(iv) Who would bear the cost(s) of any relocation of HCHI facilities? Please be specific about the type of cost and responsibility.

(b) Has the Applicant performed any studies for the proposed transmission line regarding the potential for electric or magnetic fields, induced or stray voltage to impact the HCHI distribution system? If so, please provide the studies.

(c) If there is an impact (i.e. induced voltage), would Grand Renewable be responsible for paying for the elimination or mitigation of such impact? Please explain.

(d) Is Grand Renewable aware of a study prepared for the British Columbia Ministry of Transportation entitled "Effects of High Voltage Transmission Line In Proximity of Highways" dated September 30, 2005 which includes a survey of "*Utility Policies from other States and Provinces*" (see attached) and notes that in Quebec a transmission line above 50 kV is "*not allowed in ROW*" and "*BC Hydro policy would not permit placing a distribution circuit (25 kV or less) on the same structures as 138 kV and higher voltage lines*."

(e) Is Grand Renewable aware of any location in Canada where a 230 kV transmission line is built parallel to and within a municipal road right-of-way for a distance greater than 5km?

(i) If so, please provide the name of the street, municipality, and province.

(ii) If so, does it involve joint use of the poles:

(iii) If so, is a distribution line located within the same right-of-way and at the same location as the 230 kV transmission line.

(f) Please provide a proposed cross-section of the road showing the proposed location of the transmission line and the location of existing roadway, HCHI distribution facilities, other utilities (gas, sewer, water, telephone, and communications) and the 34.5kV collector lines.

(g) Please confirm the separation distance for the proposed transmission poles from HCHI distribution lines and poles?

(h) How was the 28m pole height determined?

   (i) Did it take into account the proposed facilities, two 27.6kV distribution circuits, of HCHI?

   (ii) Did it take into consideration any future space requirements for communications or other potential users? If yes, please specify which requirements and users. If not, why not?

(i) How large are the concrete foundation for the proposed poles?

(j) How close will the concrete foundation be located to HCHI facilities?

(k) Will the proposed transmission poles require guying? If so, please specify type and location of such guying.

(l) What are the distribution supply needs of the transformer stations and the transmission interconnection station from HCHI as the local distributor? Please indicate the demand, single or three phase and any other information needed to provide service.

(m) HCHI has requested Grand Renewable to provide space on all new collector poles for two HCHI 3-phase 27.6 kV circuits everywhere its collector lines are built in order to facilitate HCHI's current and potential future needs to supply its load and distribution connected generation customers. If Grand Renewable is proposing a joint use arrangement, we ask that detailed pole configuration drawings be provided to show how it intends to accommodate the two 27.6 kV circuits of HCHI as well as its own collector line(s) and an overhead transmission line along municipal right-of-ways?

(n) Does Grand Renewable agree that locating a pole within the municipal right-of-way increases the risk of damage from vehicles greater than either (i) locating the poles on private lands; or (ii) burying the transmission line?

(o) Does Grand Renewable agree that locating a transmission pole within the municipal right-of-way increases the risk of damage to HCHI infrastructure?

(p) The existence of both distribution lines and a transmission line on the same poles would be expected to require shorter span lengths than a transmission line without distribution.

(i) What span lengths has the Grand Renewable planned for the transmission line along municipal road rights-of-way?

(ii) Please provide a drawing showing the exact plan view with span lengths and pole locations for the entire distance of the transmission line along municipal road rights-of-way?

(q) Will the proposed transmission line be built to the Hydro One Networks Inc. standard for a 230kV line?

(r) Does Grand Renewable or any of its affiliates own or have planned any 230 kV underground lines utilizing XLPE cable?

(s) If the answer to (q) is yes please identify the locations, lengths, and completion date of these transmission lines.

(t) Has Grand Renewable considered placing a greater length of its transmission line underground? If not why not?

(u) If the reason for rejecting underground 230 kV for the full length of Haldimand Road 20 includes cost please provide cost estimates for both overhead and underground for the sections which are proposed parallel to and within a road right-of-way.

(v) Cost estimates can be prepared with different degrees of accuracy or quality. Please provide the relative accuracy of each of the estimates in question (t) above including the contingency amount in each.

(w) Grand Renewable notes that the transmission line will be designed to meet "*galloping recommendations*". What specific galloping mitigation measures are planned for those sections of the overhead transmission line which are parallel to and within a municipal road right-of-way?

(x) Has Grand Renewable considered that HCHI and its ratepayers may be subjected to additional costs related to the cost of distribution service related to the use of the municipal right-of-way for a 230kV transmission line? If so, please specify type and estimated amount of such costs.

(y) What considerations for ice-loading have been taken into account for the design of the 230kV transmission line? If joint use pole arrangements are intended what other ice loading design of the distribution and communication wires has been used in the selection of the poles?

(z) Is the Applicant planning to build its extensive 34.5 kV collector line system overhead or underground where these will occur along and within municipal road rights-of-way?

(aa) If a combination of overhead and underground collector lines along and within road rights-of way is expected, under what circumstances will it be overhead and under what circumstances will it be underground?

(bb) Are overhead collector lines planned for anywhere long and within the road right-of-way for Haldimand Road 20 or along any road which intersects Haldimand Road 20?

(cc) Is the Applicant planning its transmission line height and location relative to the existing single circuit 8/4.8 kV and 27.6/16 kV lines along Haldimand Road 20 or is it planning relative to HCHI's potential need for two 27.6 kV three phase circuits along the full 19 km transmission line and along any roads crossed by the transmission line? If the applicant is not building relative to the potential needs of HCHI, why not?

TOPIC: PROJECT SCHEDULE

HCHI Interrogatory # 5:

Preamble:

HCHI is interested in understanding the proposed design of the transmission line and related facilities. Further evidence indicates that the applicant anticipates the relocation of HCHI infrastructure. Any re-location work would impact HCHI's resources and would need to be coordinated with HCHI's work.

The Applicant has included a proposed work schedule for the Project which includes approval of the Application in August 2011 and provides details in respect of certain aspects of the project.

Reference:

Exhibit B, Tab 6, Schedule 1

Questions:

(a) Does the Applicant anticipate receiving Board approval for this Application during August 2011? If not, when does the Applicant anticipate receiving such approval?

(b) The schedule does not include any reference to the relocation work for HCHI. Please indicate when it is anticipated that such work would be completed. Include the timeframe when HCHI is anticipated to have entered into an agreement with Grand Renewable regarding such work.

(c) The schedule does not include any reference to the new distribution work for HCHI to service any of Grand Renewable's stations. Please indicate when it is anticipated that such work would be completed. Include the timeframe when HCHI is anticipated to have entered into an agreement with Grand Renewable regarding such work.

(d) Has the Applicant received approval from the Ministry of the Environment for the Renewable Energy Approval? If not, when does the Applicant anticipate receiving such approval?

(e) The Proposed Schedule does not indicate when the proposed transmission line would be constructed. Please identify when the above ground transmission line would be constructed and also identify the period during which the underground transmission line would be constructed.

(f) Please provide a complete, up to date revised project schedule that incorporates the responses to (a) thru (e) this interrogatory.

TOPIC: OPERATION OF THE TRANSMISSION FACILITIES

HCHI Interrogatory # 6:

Preamble:

A transmission line requires specialized linemen and specialized equipment in order to perform necessary maintenance and emergency repairs. There are requirements to maintain certain clearances during maintenance and repair work. The project also indicates the installation of 34.5kV collector lines. The form of Easement Agreement provides that it may be assigned or transferred without notice to Haldimand County which would appear to give a the Applicant the ability to introduce a third party.

HCHI has an interest in ensuring the planned method of operating the proposed transmission line is carried out to the necessary standard and properly coordinated with HCHI.

References:

Exhibit B, Tab 3, Schedule 3, clause 5.

Questions:

(a) What is the expected response time between event occurrence and linemen being present on site in order to perform emergency work particularly when the problem may cause a power interruption or hazard to distribution connected generation customers or distribution customers?

(b) Where will the responding linemen and equipment be located? How far is this location from the transmission line?

(c) Will such linemen be located at the operations centre or on call, requiring travel to get to the operations centre to respond? If the linemen will be on call what is the mandated response time to arrive on site?

(d) As an unlicensed transmitter and distributor, will Grand Renewable abide by the response times and service standards required for licensed distributors and transmitters in the Distribution System Code and the Transmission System Code?

(e) If the Easement Agreement is assigned or transferred without notice, how is Haldimand County, HCHI or any other party to ascertain who is responsible for the transmission line?

(f) Has Grand Renewable considered potential hazards to distribution linemen (or other utility workers such a telecommunications) working in the vicinity of a transmission line? If so, please explain what has been considered. If not, please explain why not.

STUDY

Effects of High Voltage Transmission Line In Proximity of Highways

Submitted to

BRITISH COLUMBIA

Ministry of Transportation

Submitted By

DMD

DMD & Associates Ltd.
Surrey, BC

1369-05
September 30, 2005

STUDY

Effects of High Voltage Transmission Line In Proximity of Highways

BC Ministry of Transportation

Executive Summary

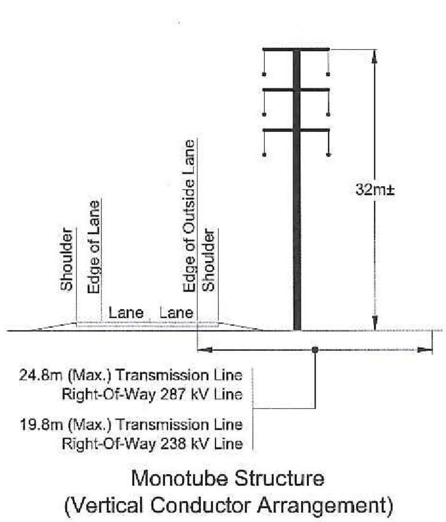
This study is a follow-up to the 2001 *Review of Overhead Transmission Lines in Highway Right-of-Ways* report undertaken by DMD and Associates Ltd. The original report reviewed issues and impacts of locating 138kV (and smaller) transmission lines within Ministry right-of-way's. The purpose of this follow-up report is to define impacts and required clearances from 230 kV and 287 kV transmission lines to Ministry roadways and buildings.

This study is a joint effort between DMD and Associates Ltd and Lex Engineering Ltd with design calculations undertaken by Detmold Consulting Ltd. Calculations were undertaken to verify corona inception, radio interference, audio noise, magnetic field and electric field so clearance from transmission lines to the traveled roadway can be defined. Results calculated were within industry standards and practice.

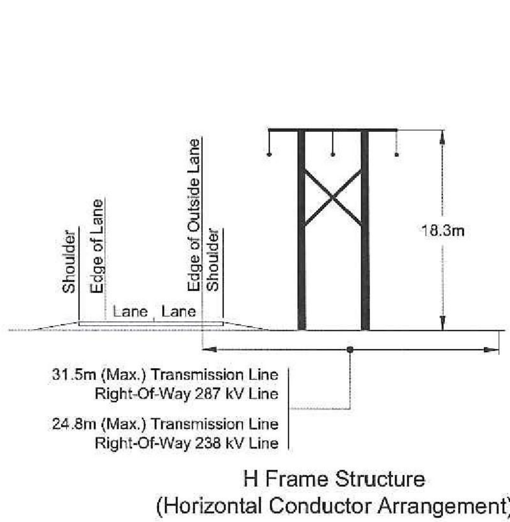
Relaxing MoT's policy to allow transmission lines rated at 230kV and 287kV within a highway right-of-way should have little effect on normal highway operations and the general public. However, the existence of a transmission line within the highway right-of-way will effect the placement of parallel utilities, mainly communications systems. Future building placement will also be impacted.

Based on calculations for single circuit transmission, for a transmission line with the conductors arranged horizontally on an 18m high structure, the right-of-way requirements would be approximately 24.8m for a 238kV line and 31.5m for a 287kV line assuming a tangent road cross-section. If the conductors are arranged vertically, on a 32m high mono-tube structure the requirements would be 19.8m for a 238kV Line and 24.8m for a 287kV line. These right-of-way distances would be measured from the edge of travel lanes. Additional right-of-way will be required for curved road sections.

A formal submittal shall be made where there is a request for placement of a transmission line within a MoT right-of-way or in proximity to a highway. Calculations and designs should be undertaken based on established design criteria (copy in appendix) and submitted for review. The design criteria would serve as a basis for acceptance.



Monotube Structure
(Vertical Conductor Arrangement)



H Frame Structure
(Horizontal Conductor Arrangement)

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STUDY

Effects of High Voltage Transmission Line In Proximity of Highways

BC Ministry of Transportation

1. Introduction

This study is a follow-up to the 2001 *Review of Overhead Transmission Lines in Highway Right-of-Ways* report undertaken by DMD and Associates Ltd. The original report reviewed issues and impacts of locating 138kV (and smaller) transmission lines within Ministry right-of-way's. The purpose of this follow-up report is to define impacts and required clearances from 230 kV and 287 kV transmission lines to Ministry roadways and buildings. We have undertaken calculations to verify required horizontal clearance between transmission lines and the traveled roadway.

The information in this report is a joint effort between DMD and Associates Ltd. and Lex Engineering Ltd. Calculations were undertaken by Detmold Consulting Ltd.

2. Define pole/structure and line configurations

Various pole configurations exist for supporting transmission lines of 138 kV or greater. Some example configurations are lattice towers, steel mono-tube structures and wood H-frame structures as shown in the photos below.

Overhead transmission lines require a separation between the overhead conductors which transmit the power in separate three phase circuits. Each of these three phase circuits will typically require a minimum of 6.7m separation for voltages of 230 kV and above. This separation can be achieved by stacking the conductors vertically or horizontally. The photographs on page 2 show various scenarios. The arrangement of the conductors typically defines the type of structure.

There is no simple method for determining what configuration is used in any given area, without going through a detailed design. Each pole line is designed for the specifics of the area, voltage and number of conductors and circuits. Some factors which impact the type of structure are soils, grades, right-of-way width, wind pressures, ambient temperature range, seismic zone, etc.

Steel mono-tube structures are typically used in an urban setting where development is located on one side of the pole line and the road is on the other side. These structures have three groups of conductors stacked vertically above each other. This requires a very tall pole to provide the required vertical clearances. The main advantage of mono-tube structures is that they can be set at greater distance apart requiring fewer poles. As well, the horizontal foot-print of the structure is relatively small and as such can be used in narrow urban right-of-ways. The disadvantages are the relatively high cost and tall poles which are typically more visible. Steel mono-tube Y type structures will allow conductors to be arrayed horizontally and as such may reduce structure height.

Wood H-frame structures are typically used in rural areas where lower mounting heights and shorter spans between poles can be applied. Wood H-frame structures are far cheaper than steel mono-tube or lattice type structures and as such are typically the most cost effective option. Conductors are only arrayed horizontally thus reducing the required mounting heights.

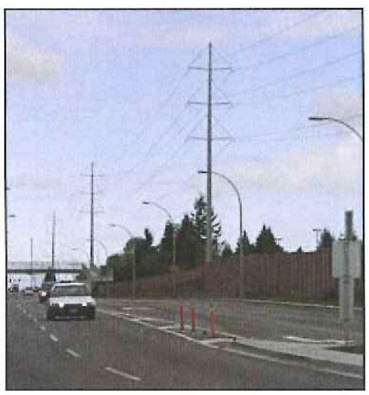
Lattice type structures are typically used in both mono-tube and wood H-frame structure applications. They will typically have a much larger foot print than mono-tube or H frame structures. Conductors can be arrayed vertically or horizontally with a lattice structure.

An order of magnitude installation cost per kilometer with wood H-structures would be approximately $200K to $400K per kilometer. In comparison, an installation with steel mono-tube or lattice poles would be approximately $300K to $600K per kilometer. We would caution that the above costs may vary drastically depending on the type of soils, grades, right-of-way width, wind pressures, seismic zone, etc and should not be used for cost estimation. These costs are for the installation of the poles and conductors only and don't include right-of-way costs, cost for clearing, etc.

Poles with a vertical conductor arrangement will require higher mounting heights than those with horizontal conductor arrangement.

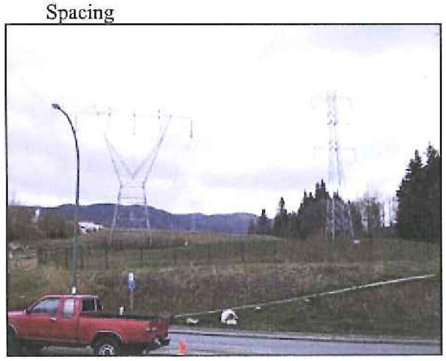
A line constructed with mono-tube structures will typically be more expensive to construct, however, this type of structure has advantages in urban areas with limited right-of-way, or where longer spans between poles are required, or where additional vertical clearances are required for highway crossings.

In terms of maintaining the required clear zone, a Y or Mono-tube structure will be much better suited to narrow urban right-of-ways. The clear zone should apply not only to the transmission structures, but also to the associated guys and anchors. The selection of a particular structure design should be the responsibility of the transmission line designer.



230kV Double Cct Mono-tube Steel Pole (Right Side of Photo) – Vertical Conductor Spacing

230kV Single Circuit Wood Pole H-Frame – Horizontal Conductor Spacing



500kV Single Circuit Steel Lattice Tower (Left Structure) – Horizontal Conductor Spacing
230kV Double Circuit Steel Lattice Tower (Right Structure) – Vertical Conductor Spacing

500kV Single Circuit Steel 'Y' Structure – Horizontal Conductor Spacing

3. Electrical and Magnetic Effects

To verify the required offsets and clearances, we have undertaken transmission line calculations using transmission line design software. Calculations undertaken include corona inception, radio interference, audible noise, electric field and magnetic fields. In all cases, the results for both 238kV and 287kV transmission lines are within recommended guidelines based on offsets shown on sketches 1A, 1B, 2A and 2b which are in the Appendix.

Commentary on the calculations is as follows:

- **Corona Inception**: Corona is the ionization of the air close to an energized conductor caused when the voltage gradient of the conductor is high enough to pull the electrons of the air molecules out of their orbits (producing ions). The voltage gradient at which this happens is the corona inception gradient. This is why the maximum voltage gradient of the conductor should be below the corona inception gradient. This is to avoid radio interference. Based on our calculations, the maximum voltage gradients are below the positive corona inception.
- **Radio Interference**: Values were calculated at 15m outside the outer conductor (closest to the road) and meet CSA maximum allowable radio interference levels in fair weather (CSA doesn't define requirement in foul weather). Any MoT Guidelines should include a statement that the transmission line is to be designed to comply with CSA standards for Maximum Allowable Radio Interference (Fair Weather).
- **Audible Noise**: This would not be an issue on a typical highway. However, it could be of concern in residential areas where local noise bylaws are present. The calculations undertaken do include noise levels. However, the audible noise from the transmission lines would be far less impacting than the sound from the traffic itself.
- **Electric Field**: This is the most critical element. The electric field strength within the right-of-way has been calculated and is shown on each of the sketches attached. The calculated levels at the edge of the driving lanes are:

  i. Sketch 1A- 1.2kV/m

  ii. Sketch 2A- 1.1kV/m

  iii. Sketch 1B- 1.4kV/m

  iv. Sketch 2B- 1.7kV/m

  In our report, we will define maximum levels that would apply to the traveled portion of the roadway and pull-outs, parking areas, etc. It appears that a common standard in the US is a maximum 10kV/m at the edge of the roadway. The ***BC Hydro Transmission Engineering, Technical Procedures Manual*** recommends the electric field at the edge of the right-of-way shall not exceed 10kV/m. We recommend the electrical field not exceed 5kV/m at edge of roadway and / or right-of-way which in this case would be met.

Vehicle fueling could be an issue only for large vehicles parked parallel to the transmission line. The induced voltage between a large transport truck and a fuel truck could conceivably be large enough to cause a spark. This problem can easily be eliminated by attaching a ground wire between the two vehicles during refueling. In general, we would not recommend locating vehicle fueling facilities under or immediately adjacent to power lines.

- **Magnetic Field**: This is another key element to consider. The magnetic field strength within the right-of-way has been calculated and is shown on sketches 1A, 1B, 2A and 2b. The calculated levels at the edge of the driving lanes are:

  v. Sketch 1A- 95 milliGauss

  vi. Sketch 2A- 65 milliGauss

  vii. Sketch 1B- 125 milliGauss

  viii. Sketch 2B- 85 milliGauss

  US Standards appear to be a maximum of 150 or 200 milliGauss at the edge of the highway right-of-way. To put this in perspective, 1000 milliGauss is the maximum general public exposure where interference with human heart pacemakers can occur.

  The magnetic field is another safety issue, and as such the maximum field level that would apply to the traveled portion of the roadway and pull-outs, parking areas, etc should not exceed 200 milliGauss which in this case would be met.

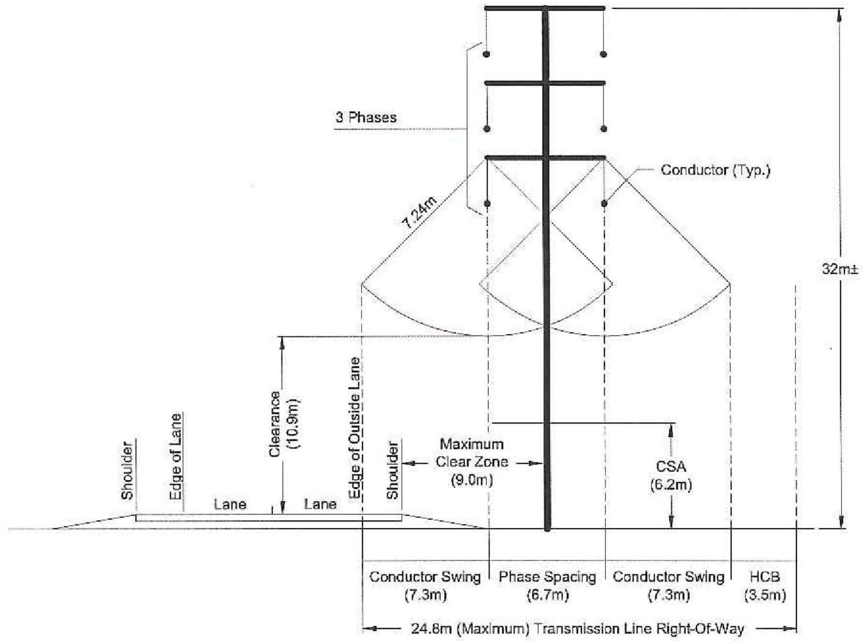
As with all these effects, it is critical that calculations be undertaken on a per project basis to verify impacts.

4. Right of Way Requirements

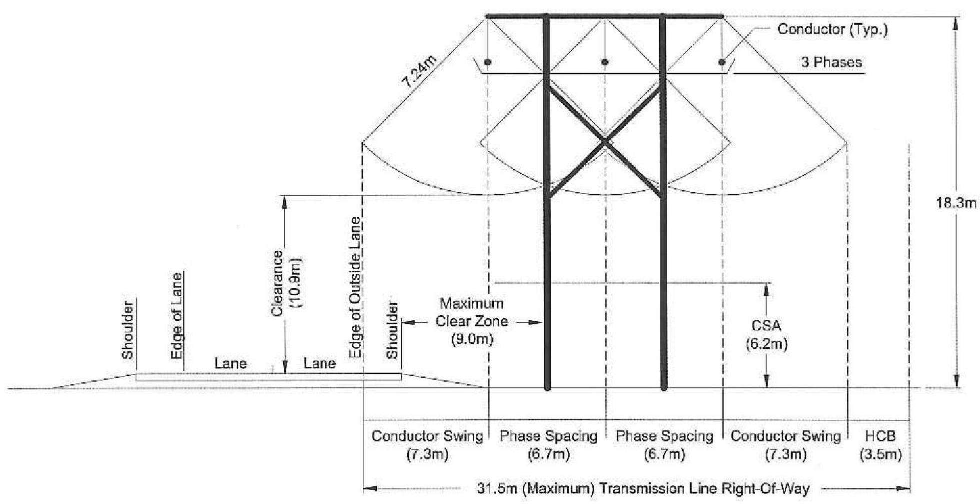
The main issues in determining the right-of-way is determining the horizontal and vertical clearances from the traveled portion of the roadway, including allowance for conductor swings out over the roadway. To determine this clearance, we have retained the services of a transmission line designer to undertaken calculations using transmission design software. Based on calculations for single circuit transmission, for a transmission line with the conductors arranged horizontally, the right-of-way requirements would be approximately 24.8m for a 238kV line and 31.5m for a 287kV line assuming a tangent road cross-section. If they conductors are arranged vertically, on a mono-tube structure the requirements would be 19.8m for a 238kV Line and 24.8m for a 287kV line.

These right-of-way distances would be measured from the outside edge of travel lanes. Additional right-of-way will be required for curved road sections.

Typical road cross sections with mono-tube and H-frame structures are defined below.



Monotube Structure (Vertical Conductor Arrangement)
HCB - Horizontal Building Clearance



H Frame Structure (Horizontal Conductor Arrangement)
HCB - Horizontal Building Clearance

1. Power lines crossing highways must meet highway vertical clearance over driving lanes under worst sag conditions.
2. Power lines paralleling highways must meet highway vertical clearances over driving lanes under all conductor conditions.
3. Power lines paralleling highways must provide CSA horizontal clearance to buildings (HCB) from swung conductors to edge of driving lanes.
4. Power lines paralleling highways must meet CSA vertical clearances over highway rights of way.
5. Clearance over roadway is based on BC Hydro Power line Design Manual 5.2 Table K, Minimum Clearance for New Construction on AC Power lines.

Typical Cross Sections (287kV)

All poles, guys, anchors and other power line components subject to physical damage should be installed beyond the MoT designated clear zone for the roadway in question.

Design AADT	Minimum Clear Zone Width (m)				
	Design Speed (km/h)				
	60	70 to 80	90	100	110 to 120
Under 750	2.0	3.0	4.0	5.0	6.0
750-1500	3.0	4.0	5.0	6.0	7.0
1501-6000	4.0	5.0	6.0	8.0	9.0
over 6000	5.0	6.0	7.0	9.0	9.0

MoT Clear Zone (from Tech Bulletin DS96001)

5. Vertical Transmission Clearances

Overhead transmission can run parallel with the road or highway and cross the road or highway provided the required vertical clearances listed below are achieved and poles are located outside of the MoT clear zone. Note that running transmission lines over buildings will require special permission from the ***British Columbia Safety Authority*** which is not typically granted.

Vertical clearances of overhead lines from ground surface or pavement crown shall conform to **BC Hydro Transmission Engineering, Technical Procedures Manual** – ***5.2 Table K Minimum Clearances for New Construction on AC Power Lines***. The clearances specified in ***CAN/CSA-C22.3 No. 1-01*** are minimum requirements and in certain situations these standards are considered too low and have therefore been modified by BC Hydro to suit conditions in BC. Vertical clearances should be increased accordingly if there is any possibility of future under building with another power line or a communications line. A copy of the ***BC Hydro Transmission Design Manual – 5.2 Table K*** is located in the appendix.

Crossing Over	Voltage Class (Phase to Phase) 230kV	287kV
Land Accessible to:		
Vehicles and Equipment -	7.1m	7.5m
Pedestrians Only -	6.0m	6.4m
Roads – where no provision is made for future power lines along:		
Minor Roads	7.9m	8.3m
Highways	10.5m	10.9m
Roads – where provision is made for future power lines up to 25kV along:		
Minor Roads and Highways	13.6	14.1m
Logging and Mining Roads (L = load height)	L + 3.5m	L + 3.9

Minimum Vertical Clearance of Transmission Lines (From BCH 5.2 Table K)

Minimum distances between electrical power lines and any highway structure shall conform to WCB regulations; the distances are summarized below. Special precautions and proper work procedure must still be followed even if minimum clearance distances are maintained. WCB clearances would also be an issue where transmission lines run over buildings or MoT signal, lighting and sign poles.

Voltage (Phase to Phase)	Minimum Distance (Meters)
0 to 750	1.0
Over 750 to 75,000	3.0
Over 75,000 to 250,000	4.5
Over 250,000 to 550,000	6.0

Minimum WCB Clearances from Overhead Lines

When defining vertical clearances future development as well as other utilities will impact clearances and must be considered.

6. Impacts on Other Utilities

BC Hydro policy would not permit placing a distribution circuit (25kV or less) on the same structures as 138kV and higher voltage lines. The distribution line would have to be on the opposite side of the highway.

Communications lines along the power line would have to be ADSS (all dielectric).

The purpose of the two requirements above is to avoid unsafe induction voltages on the distribution or communications systems.

Pipelines would have to be separated from any transmission line 66kV and up by 10m minimum horizontally as per ***CAN/CSA22.3 No.6***. This is to provide adequate working space for pipeline maintenance.

7. Impacts on Highways Maintenance

In very heavy snow areas, snow removed from the road should not be piled directly under the transmission line to a depth which would reduce clearances below code clearances for a person standing on the snow bank.

Over height equipment moved along the highway could be a problem for the line designs relying on vertical separation. The problems that normally relate to line crossings would now also be a concern continuously along one side of the highway.

We had contacted various MoT District Highway Operations staff and the Road and Bridge Maintenance Contractor, Yellowhead Road and Bridge in Fort St John, where recent 138kV transmission lines have been installed to discuss concerns / issues. No maintenance issues or concerns where registered.

Power line maintenance should have little impact on highway operations and maintenance as any work to the line would be done off the highway.

8. Review of all Applicable Codes and Regulations

The Provincial and National standards that regulate and/or recommended minimum standards for the design, construction, operation and maintenance of transmission lines and other utilities and structures in the vicinity of transmission lines are as follow:

- ***CAN/CSA-C22.3 No. 1-01 Overhead Systems*** which covers the requirements for construction of overhead systems. The ***BC Hydro Transmission Engineering: Technical Procedures*** would normally be used for design purposes because it has more stringent requirements than *CAN/CSA 22.3*. The BC Hydro standards are also more detailed than the *CAN/CSA 22.3* and as such are an excellent guideline for those designing a transmission line.
- ***BC Hydro Transmission Engineering: Technical Procedures - Vertical Clearances for Overhead Lines on BC Hydro Transmission Systems*** covers the minimum vertical clearance of AC transmission lines crossing over land, roads, railways, pipelines and other wires. Since BC Hydro's standards for vertical clearance are more stringent than ***CAN/CSA-C22.3 No. 1-01***, BC Hydro Technical Procedures are recommended.
- ***Industrial Health and Safety Regulations, Workers Compensation Board (WCB)*** covers minimum distances between exposed, energized high voltage electrical equipment and conductors and any worker, work, tool, machine, equipment or material. This will typically apply to signal and lighting poles.
- ***CAN/CSA-C22.3 No. 3-98 Electrical Coordination*** which covers the principles and practices applicable for the purpose of effecting electrical coordination between organizations that operate electrical supply or communication systems. It addresses power system influences due to electrical, magnetic and conductive coupling between the two systems during normal power system operation as well as abnormal or fault conditions. This Standard also provides guidelines to mitigate these power system influences thereby reducing shock hazards and equipment failures. When dealing with transmission lines 230kV and above it is likely only fibre optic cables can be installed in the right-of-way as they will not be impacted by the transmission lines
- ***CAN/CSA-C22.3 No. 5.1-93 Recommended Practices for Electrical Protection - Electric Contact Between Overhead Supply and Communication Lines*** covers the principles and general practices of electrical protection applicable to overhead supply systems operating at more than 750V but less than 50kV phase to phase and communication systems. When these principal are applied it is intended to minimize the risk associated with electrical contact. However, if contact does occur it ensures that the contact voltage does not exceed a predetermined limit therefore providing a degree of protection to people, property and equipment. When dealing with transmission lines 230kV and above it is likely only fibre optic cables can be installed in the right-of-way as they will not be impacted by the transmission lines.

- *CAN/CSA-C22.3 No. 6-M91 Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines* which covers methods of electrical coordination between pipelines and power lines having line-to-ground voltages greater than 35kV (60kV phase to phase). This Standard describes mutual interference effects and specifies methods that will reduce these effects.

9. Survey of the Practice of Other Jurisdictions in North America

Numerous surveys and information collection was undertaken as part of the 2001 DMD Transmission Line Study. In the 2001 study, we determined that the only jurisdictions in Canada which regulate voltages of transmission lines in right-of-ways were Quebec and British Columbia. In the United States, each state has different policies regarding locating transmission lines in their right-of-ways. Most states review applications on an individual basis.

Based on a brief internet search and some basic research, listed below are some specific requirement from other jurisdictions:

Electric Field

- Several US states guidelines - 10kV/m
- ESB (Ireland) Guidelines - 5kV/m general public exposure
- BC Hydro Transmission Design Standards – 5kV/m at edge of the right-of-way

Magnetic Fields

- Transmission Line Guideline (Florida) - 150mG at edge of ROW
- Transmission Line Guideline (New York) - 200mG at edge of ROW
- ESB (Ireland) Guidelines - 1000mG general public exposure

Radio Interference

- CSA Maximum allowable RI (Fair Weather) - 50.0 dB

10. Impacts on Other Utilities & Crossings

Copper conductors for telephone, cable TV or other similar services would not be placed on the same poles or structures as the transmission conductors. Copper communication cables have serious restrictions when placed on or near transmission lines. Sufficient horizontal separation does allow installation on the same right of way. ADSS cables are the preferred communication cable for placement on transmission lines. All communications conductors in the same right-of-way as a transmission line should be ADSS (all dielectric) fibre cables.

Metallic pipelines should be adequately separated from the transmission line, preferably by locating the pipeline on the opposite side of the roadway. The recommendations of Standard CAN/CSA-22.3 No.6-M91 are that any pipeline be located a minimum of 10m from power line footings and other below-ground fault current discharge facilities.

Access roads to a highway will require a vertical clearance to a transmission line consistent with BC Hydro standards, WCB and CSA codes. This could limit locations of access roads to the highway if the transmission line is not designed with adequate vertical clearance. It is important to note that transmission lines will have to be installed high enough to permit the installation of new access roads wherever they may be required or planned.

11. 500kV Transmission Lines

The electrical and magnetic fields associated with transmission lines increase with the operating voltage of the line. It is recommended that 500kV transmission lines be avoided in common right-of-ways with highways however if it can't be avoided they must be reviewed on a per project basis.

12. Highway 37 Corridor

As requested we have contacted the Stikine District regarding installing a transmission line on Highway 37. We have had some discussions with Fred Saychuck of the Stikine District Office. However, he advised that we should talk to Sheri Applegate as she has been the most involved with transmission lines. Fred did advise that the right-of-way on Highway 37 varies from as narrow as up to the edges of the road shoulder to as wide as 100m. Additional right-of way would therefore be required to construct a transmission adjacent to Highway 37. Sheri offered the following comments:

- Consideration should be given to the impacts on the aesthetics of the highway corridor with the installation of a transmission line. Designated view points should be maintained.
- Avalanche zones should be considered and may be an issue.
- Archeological as well first nations concerns were issues with the construction of the 138kV Coast Mountain Transmission Line and should be investigated.
- A full environmental impact study (EIS) should be undertaken prior to approving the transmission line adjacent to any highway.
- Transmission lines may have impacts on roads used for aviation landing. Areas where aircraft are allowed to land on roads should be reviewed taking into account potential hazard to aircraft.

13. Conclusions

The use of 230kV or 287kV transmission lines would require greater vertical clearances specified in the standards than for lower voltages as noted in this study. Otherwise, there are no special requirements for 230kV or 287kV lines. Issues to be considered are:

- Building transmission lines will ultimately open the door to development. However, the line itself will limit development adjacent to the highway. Provisions would have to be made to accommodate access and future access roads.
- Advance planning should take into account other potential utilities which may be installed in the right-of-way.
- Transmission line clearances should be increased for those lines that cross the highway at cross roads to accommodate signals and roadway lighting which has specific clearance requirements.

- Electric and magnetic fields at the edge of the traveled portion of the roadway, including pull-outs, shoulders and other areas likely to be used for parking of vehicles should not exceed the following at a height of one metre above finished grade:

  1. Electric Field — Not to exceed 5kV rms/ meter
  2. Magnetic Field — Not to exceed 200 milliGauss

- Radio interference at the edge of the traveled portion of the roadway, including pull-outs, shoulders and other areas likely to be used for parking of vehicles should not exceed CSA Maximum Allowable RI (fair weather) of 50dB.
- For Corona inception the maximum voltage gradients (kV/cm) for each conductor shall be below the corona inception gradient (kV/cm). This is to avoid radio interference.

APPENDIX

Design Criteria

BC Hydro Standards

Utility Policies Survey

Calculations

Sketches 1A, 1B, 2A & 2B

APPENDIX

Design Criteria

Design Criteria for 230kV and 287kV Transmission Lines Adjacent to Highways

1. Agency requesting transmission lines in MoT right-of-way shall obtain the appropriate permit from MoT prior to proceeding. As part of the approval process the agency requesting the transmission lines shall retain an APEGBC registered electrical engineer qualified in transmission line design to undertake calculations and verify that all of the pertinent criteria listed below have been addressed.

2. The transmission line design shall comply with the requirements of :

    - BC Hydro Transmission Engineering: Technical Procedures - Vertical Clearances for Overhead Lines on BC Hydro Transmission Systems
    - CAN/CSA-C22.3 No. 3-98 Electrical Coordination
    - CAN/CSA-C22.3 No. 1-M87 Overhead Systems
    - Industrial Health and Safety Regulations, Workers Compensation Board (WCB)
    - CAN/CSA-C22.3 No. 5.1-93 Recommended Practices for Electrical Protection - Electric Contact Between Overhead Supply and Communication Lines
    - CAN/CSA-C22.3 No. 6-M91 Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines

3. Clearances shall meet BC Hydro required vertical clearances over the traveled portion of the roadway, including pull-outs, shoulders and other areas likely to be used for parking of vehicles. Vertical clearances should also be maintained where access roads enter the highway or where MoT envisions access roads could enter the highway in the future.

4. All poles, guys, anchors and other power line components should be installed beyond the MoT designated clear zone for the roadway in question.

5. In very heavy snow areas, snow removed from the road should not be piled directly under the line to a depth which would reduce clearances below code clearances for a person standing on the snow bank. Increase vertical clearance or move the line further out to compensate.

6. Electrical and magnetic fields at the edge of the traveled portion of the roadway, including pull-outs, shoulders, future access roads and other areas likely to be used for parking of vehicles should not exceed the following using a sensor height 1 metre above finished grade:

Electric Field	5kV rms per meter
Magnetic Field	200milliGauss

7. Radio interference at the edge of the traveled portion of
   the roadway, including pull-outs, shoulders and other areas likely to be
   used for parking of vehicles should not exceed CSA Maximum Allowable RI (fair
   weather) of 50dbu.

8. For Corona inception the maximum voltage gradients (kV/cm) for each conductor shall be below the corona inception gradient (kV/cm). This is to avoid radio interference.

APPENDIX

BC Hydro Standards

(a) The existence of an angle greater than zero between the centre lines of the power line and the parked vehicle.

(b) The fact that the vehicle may be restricted to locations where the electric field is less than the maximum value for the subject span.

(c) In some cases, the maximum sag condition and the associated maximum electric field occur only under an emergency loading condition which can exist only for a few hours per year. Care should be exercised in exploiting such a feature, however, because loading conditions may change over the life of the plant.

Table 1 shows the effect of vehicle size on the maximum permissible electric field.

3.0 ELECTRIC FIELDS AT THE EDGE OF RIGHTS-OF-WAY

The maximum electric field at the edge of the right-of-way shall be limited to 5 kV rms/m.

4.0 CALCULATING THE ELECTRIC FIELD

(a) When calculating the electric fields, the conductor voltages shall be taken as the maximum continuous values, e.g. $550/\sqrt{3}$ kV in case of 500 kV class lines.

(b) The electric fields may be calculated using a computer program based on the method given by Deno et al (1982), or by using the graphical method given by Mousa (1982, 1985).

TABLE 1

The Electric Field Limits Imposed by the

5 mA Induced Current Rule

Item	Transport Truck	Farm Machinery	Farm Tractor	Pickup With Camper	Full Size Sedan	School Bus
Size(m)	20.0 x 2.4	7.6 x 2.4	3.7 x 1.5	6.4x2.3	5.3x2	10.7x2.4
Height(m)	4.15	4.15	2.1	2.9	1.4	2.7
Electric Field (kV/m)	6.2	11.4	38.5	15.6	45.5	12.8

TABLE H

HIGHWAY CLEARANCES

(When no allowance is made for underbuilding of future powerlines)

Nominal Voltage	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
Basic Clearance (m)	9.0	9.0	9.0	9.0	9.0	
Electrical Clearance (m)	0.6	0.9	1.5	1.9	2.2	
Total (m)	9.6	9.9	10.5	10.9	11.2	14.2*1

*1 This clearance is due to induction from a tractor trailer assuming a 525 kV normal operating voltage and a 5 mA "let go" current.

(c) Other Crossings

For all other crossings, the MOC is considered sufficient for new construction.

5.1 - TABLE J

MINIMUM OPERATING CLEARANCES FOR UPRATING OF AC TRANSMISSION LINES (m)

Crossing Over*1 *10	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
			Nominal Line to Line Voltage			
GROUND*6 Accessible to:						
Vehicles & Equipment*11	5.2	5.5	6.1	6.5	6.8	9.6*8
Pedestrians Only*2 *9	5.0	5.4	6.0	6.4	6.7	7.7
ROADS						
Minor Roads & Highways	6.9	7.3	7.9	8.3	9.4*8	14.2*8
Logging & Mining Roads*3	L+2.5	L+2.9	L+3.5	L+3.9	L+4.2	L+5.2
RAILWAYS*7	8.4	8.7	9.3	9.7	10.0	11.0
PIPELINES	8.6	9.0	9.6	10.0	10.3	11.3
WIRES*4 (STRUCTURES)*5						
0 - 25 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
69 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
138 kV		1.5(2.3)	2.1(2.9)	2.7(3.4)	3.0(3.8)	4.2(4.5)
230 kV			2.4(2.8)	3.0(3.3)	3.4(3.7)	4.5(4.4)
287 kV				3.1(3.3)	3.6(3.7)	4.7(4.4)
345 kV					3.7(3.3)	4.9(4.0)
500 kV						5.4(3.7)

*1 The crossing conductors are considered to be in their maximum final sag position. Additional clearance must be provided for survey and construction tolerances.

*2 This is generally ground where the slope is greater than 30° to the horizontal.

TABLE J - (cont'd)

*3 Some judgement must be exercised when determining the value of L (load height). The travelling load height must be obtained from the companies involved. If it is not possible to determine the height, use a value of 7.6 m for L. Regardless of the value used for L, the clearance over main haul roads cannot be less than the value required for minor roads crossed by lines of that voltage class.

*4 Upper conductors at final sag shall be above the straight line between the support points of the lower wire. Where the sag of the lower wire exceeds 6 m, the clearance may be reduced by one half the difference between this sag and 6 m.

*5 These clearances apply if the upper conductor in the swung position, as determined in Note 6, is within 3 m horizontally of a structure.

*6 To determine clearances to sidehills, horizontal deviation shall be calculated using the non-sheltered span curve from Table 1 of CAN/CSA-C22.3 No. 1-M87 and applying the design clearance requirements for ground normally accessible to pedestrians only (Table 2).

*7 These clearances also apply where the conductors are along roads or railway tracks, if the conductors in the swung position as calculated in Note 6 are closer than the horizontal distances shown below, to the vertical projection of edge of travelled way or closest rail. Reference CAN/CSA-C22.3 No. 1-M87 Clauses 4.4 (Table 6), 4.7.3.2 and 4.7.3.3 (Table 9).

	Voltage					
Location	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
Roads	1.8	2.2	2.8	3.2	3.5	4.5*
Main Rail	4.0	4.3	4.9	5.3	5.6	6.6
Sidings	3.4	3.7	4.3	4.7	5.0	6.0

* Or 12 m from the rest position, whichever is the greater.

*8 Values apply only to the structure configurations shown in Fig. 1.

*9 Where snow depths are known to be greater than 1 m, the clearance shall be increased accordingly.

*10 For elevations over 1000 m, increase the electrical component of the clearances (see Table A) by 1 percent for each additional 100 m.

*11 When it is determined that higher objects will be present, the clearances shall be increased by the amount that the object height exceeds 4.15 m. In the case of high pressure irrigation systems, the object height to be used is 6 m. For 345 kV and 500 kV, a study of electrostatic induction effects may be required.

5.2 - TABLE K

MINIMUM CLEARANCES FOR NEW CONSTRUCTION ON AC TRANSMISSION LINES (m)

	Nominal Line to Line Voltage					
Crossing Over*1 *10	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
LAND*6 Accessible to:						
Vehicles & Equipment*11	6.2	6.5	7.1	7.5	7.8	9.6*8
Pedestrians Only*2 *9	5.0	5.4	6.0	6.4	6.7	7.7
ROADS						
Where no provision is made for future powerlines along:						
• Minor Roads	6.9	7.3	7.9	8.3	9.4*8	14.2*8
• Highways	9.5	9.9	10.5	10.9	11.2	14.2*8
Where provision is made for future powerlines up to 25 kV along minor roads and highways:	12.4	13.0	13.6	14.1	14.6	15.2
• Logging & Mining Roads*3	L+2.5	L+2.9	L+3.5	L+3.9	L+4.2	L+5.2
RAILWAYS*7	8.4	8.7	9.3	9.7	10.0	11.0
PIPELINES	8.6	9.0	9.6	10.0	10.3	11.3
WIRES*4 (STRUCTURES)*5						
0 - 25 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
69 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
138 kV		1.5(2.3)	2.1(2.9)	2.7(3.4)	3.0(3.8)	4.2(4.5)
230 kV			2.4(2.8)	3.0(3.3)	3.4(3.7)	4.5(4.4)
287 kV				3.1(3.3)	3.6(3.7)	4.7(4.4)
345 kV					3.7(3.3)	4.9(4.0)
500 kV						5.4(3.7)

Refer to Table J for notes.

APPENDIX

Utility Policies Survey

UTILITY POLICIES FROM OTHER PROVINCES AND STATES

The survey of jurisdictions listed below was undertaken in 2001. From discussions with the Transportation Departments of other Provinces and review of available documents, it was determined that very little information was available and minimal guidance is given for the installation of power lines within highway right-of-ways. For example, in Alberta's Utility Guidance Manual it allows single poles to parallel the highway and to be located within the ROW. The Provinces of PEI and Newfoundland didn't even have a utility policy in place. Only Quebec mentioned that 50kV and above is considered a transmission and is therefore not allowed in the ROW. Many of the Provinces just deals with the installation of utility poles within the ROW on an individual and first come first served basis and are not concerned with voltage. A summary of these finding are detailed below.

Province	Voltage Limit	Location Within Right-Of-Way	Other Restrictions
Alberta	None	- Within 1m of edge of ROW	- Single wood poles - Based on a first come first served basis - Double pole transmission lines and tower mounted transmission lines paralleling highway should normally be positioned outside and beyond 30m of the ROW
Manitoba		- Within 0.6m of ROW	- No policy in place - Generally only allow single pole lines
New Brunswick			- NB Power transmission lines not normally located on highway ROW - Transmission lines defined as lines above 25kV phase to phase
Newfoundland			- No policy in place
Nova Scotia	None	- 20m ROW: within 1.5m of boundary line with min. 4.5m from shoulder line - 30m ROW: min. 4.5m from shoulder line, min. 12m from centre line preferred	- Not allowed on controlled access highways - Permit required for utility lines within 60m of boundary of controlled access highway - Permit not normally approved for utility lines within 15m of outside limit of boundary of controlled access highway
PEI			- No policy in place
Quebec	50kV		- If above voltage limit not allowed in ROW
Saskatchewan	None		- If there is sufficient room within ROW

Yukon			- Policy does "not address transmission lines, which will be dealt with on an individual basis"

Summary of Utility Polices from Other Provinces as it Relates to Transmission Lines

The Federal Highway Administration (FHWA) has a document which deals with utility use of freeway right-of-ways. It stipulates that "each State must decide, as part of its utility accommodation plan, whether or not to allow longitudinal utility installation within the access control line of freeways and under what circumstances". This utility accommodation plan applies to Federal-aid projects, however each State Transportation Department found it difficult to adopt two policies, one for Federally funded highway projects and the other for State funded highway projects. As a result each State Transportation Department have generally adopted only one policy to cover all highway projects whether federally funded or State funded.

After reviewing many different State utility accommodation policies, the information from State to State varied. Some States do not allow longitudinal installation of utilities at all, some States only disallow longitudinal installation of utilities along interstates, freeways and expressways and some States had no restrictions. What was fairly consistent was that when longitudinal installations were allowed on highway right-of-ways they were limited to single pole construction and that they encouraged the joint use of poles. The only constant from policy to policy was there was no maximum voltage applied to power lines located within the highway right-of-way. A summary of these finding are detailed in Table 3.

State	Location Within Right-Of-Way	Restrictions
California (Caltrans)	- Generally located as close as possible to ROW line and outside slope limits or behind curbs - Minimum desirable setback from clear zone is 6.09m - Not closer than 0.45m behind a curb face or less than 0.60m from edge of a slope catch point or a driveway, or within a drainage ditch	- Not permitted within access control line of any freeway or expressway - Prohibit installation in scenic highway corridors

Kansas (KDOT)	- Locate on uniform alignment and preferably within 2.1m of ROW line - Rural areas: outer limits of ROW, preferably within 0.6m or less of ROW line and as a minimum not closer than the clear zone - Suburban areas with rural type highways and speeds 70km/h or lower: at least 4.5m from edge of travelled lane with preferred location near ROW line - Curbed sections: at least 1.8m back of curb, 2.4m is desirable and near the ROW line preferred	- Along interstates and fully controlled access highways only if determined that denial would result in severe hardship or is contrary to the public interest - Use durable materials designed for long service life expectancy and relatively free from routine servicing and maintenance - Location in scenic areas reviewed on an individual basis - Locate to minimize need for later adjustment to accommodate future highway improvements, to permit servicing with minimal interference to highway traffic and without increasing the difficulty or cost to highway maintenance - Only single pole type construction allowed with vertical configuration of conductors - Joint use of poles encouraged
Montana (MDT)	- Rural areas: preferably along outer portion of ROW but in no case within the clear recovery area without prior approval - Urban areas: outer edge or ROW, behind sidewalk, or a minimum of 0.61m behind face of curb - Clear recovery area defined as min. of 12.8m from centreline on unpaved roads, and 9.2m from outer edge of outside-travelled lane on paved roads, or the clear zone, whichever is greater.	- Not permitted on interstates - Not permitted in scenic areas, historic sites, public parks, archaeological sites, wet lands or any other environmentally sensitive area
Nebraska (NDOR)	- Rural areas: beyond the clear zone, if insufficient ROW use breakaway design or regrade the ROW - Suburban areas with rural-type roadways and and speed limits of 72km/h and lower: at least 4.5m from edge of paved travel way with preferred location near ROW line - Urban areas with curb sections: back of sidewalk or a minimum 1.8m back of curb	- Joint use of poles encouraged - Within Interstate or Freeway may be considered as a last resort - Avoid scenic byways, scenic strips, overlooks, rest areas, recreation areas, wildlife and waterfowl refuges, public parks and historic sites

Nevada (NDOT)	- Outside the clear recovery area and at or as near to the ROW as possible - In areas with curbs, gutters and sidewalks, locate behind or at back edge of sidewalk if possible and not closer than 0.6m behind face of curb	- Allow longitudinal encroachment only if utility provides service to the general public or a significant segment thereof - Not permitted on controlled access freeways - Only self-supporting armless, single-pole construction allowed with vertical configurations of conductors and cables - Not within ROW adjacent to areas of scenic or natural beauty, including public parks and recreation lands, wildlife and waterfowl refuges, historic sites, scenic strips, overlooks, rest areas or landscaped areas
Oregon (ODOT)		- May impose joint use occupancy
Utah (UDOT)	- Locate on a uniform alignment within 0.9m to the ROW line and as a minimum outside the recovery and clear zone area - If installed behind curb and gutter shall be minimum 0.46m behind front face of curb when no sidewalk exists or preferably 0.46m behind the sidewalk when both barrier curb and gutter and sidewalk exist when ROW is available	- Locate to minimize need for later adjustment to accommodate future highway improvements - Use durable materials designed for long service life expectancy and relatively free from routine servicing and maintenance - Only single pole type construction allowed - Joint use of poles encouraged - Avoid scenic strips, overlooks, rest areas, recreation areas, public parks and historic sites
Washington (WSDOT)	- Outside control zone	- Reduce number of poles through joint use of poles and increasing span lengths - Avoid placing poles on outside of horizontal curves - Consider alternate pole designs to allow construction at/or close to ROW line
Wyoming (WYDOT)	- As close as possible to the highway ROW line - Outside clear recovery area unless using an approved breakaway design	- Only single pole type construction allowed - Joint use of poles encouraged - No poles located within inslopes or back slopes of 2:1 and steeper

Summary of Utility Accommodation Polices from Other States as it Relates to Transmission Lines

In general each State Transportation Department has variances to their guidelines because they recognize that conditions may arise which make it impractical, infeasible or unreasonably costly to comply with the guidelines. In these situations variances must be adequately supported and justified while also considering traffic safety.

Examples of conditions that make it impractical to comply with utility offset guidelines include:

- Right-of-way that is not adequate to accommodate utilities outside of the clear zone. In these situations the safety of the motorist is provided by the breakaway design of the utility structure or the installation of guard rails or other protective devices or structures;
- Terrain or other features that do not warrant full compliance with clear zone, such as the top of cut slopes;
- In timbered areas, adherence to the principles of occupying the outer portion of the ROW or adherence to the clear recovery area distance may result in unwarranted cutting of trees along the highway or cutting of a new path along the ROW line.

Variances to the avoidance of scenic areas are considered only where:

- Other locations are unusually difficult and unreasonably costly, or more desirable from the standpoint of visual quality;
- Underground installation is not technically feasible or is unreasonably costly or is more detrimental to the scenic appearance of the area;
- The proposed installation can be made at a location and will employ suitable designs and materials, which give it adequate attention to the visual qualities of the area being traversed; and
- Utility installation is needed for highway purposes, such as for continuous highway lighting or to serve a weigh station, rest or recreational area.

APPENDIX

Calculations

ELECTRICAL EFFECTS PROGRAM

Rogers Engineering Inc.
(403) 282-4750

Input Data File Information

Date: 2005-07-12
Name: M2TH230.DAT
Desc: MoTH Study - Bluebell - 230 (2)

	Dist. from Tower C-L (metre)	Height to Bdl Mid Pt (metre)	Subcon Diam. (cm.)	Subcon Spacing (cm.)	Voltage L-G (kV)	Current (Amps)	Phase Angle (degrees)
PHA	-5.50	14.15	2.971	.00	132.80	665.0	.00
PHB	.00	14.15	2.971	.00	132.80	665.0	120.00
PHC	5.50	14.15	2.971	.00	132.80	665.0	240.00

CORONA INCEPTION CALCULATION

Altitude	:	500.0 (m)
Temperature	:	65.0 (deg C)
Relative air density (RAD)	:	.830
Conductor Surface Factor	:	.8
Radius of Conductor	:	1.485 (cm)

Conductor Surface Gradient for
Positive Corona Inception : 17.895 (kV/cm)

MAXIMUM VOLTAGE GRADIENTS
(kV/cm)

PHA	14.4062
PHB	15.4354
PHC	14.4062

RADIO INTERFERENCE SPECIFICATIONS

Antenna Height	=	1.000 m
RI Frequency	=	1.00 MHz
Altitude	=	500.0 m
Ground Conductivity	=	20.00 mmho/m
Lateral Dist From Outside Phase	=	15.0 m

Values at Standard Distance (15 m) from Outer Phase

Foul Weather Radio Interference (L50)	=	54.3 dbu
Fair Weather Radio Interference (L50)	=	37.3 dbu
CSA Maximum Allowable RI (Fair Weather)	=	50.0 dbu

Maximum Radio Interference (dbu)

Lateral Dist. (m)	Phase	Rain L50	Fair L50
.0	PHB	64.4	47.4
2.0	PHB	64.2	47.2
4.0	PHB	63.6	46.6
6.0	PHB	62.8	45.8
8.0	PHB	61.7	44.7
10.0	PHB	60.6	43.6
12.0	PHB	59.3	42.3
14.0	PHB	58.1	41.1
16.0	PHB	56.9	39.9
18.0	PHB	55.7	38.7
20.0	PHB	54.6	37.6
22.0	PHB	53.6	36.6
24.0	PHB	52.5	35.5
26.0	PHB	51.6	34.6
28.0	PHB	50.7	33.7
30.0	PHB	49.9	32.9
32.0	PHB	49.1	32.1
34.0	PHB	48.3	31.3
36.0	PHB	47.6	30.6
38.0	PHB	47.0	30.0
40.0	PHB	46.3	29.3
42.0	PHB	45.7	28.7
44.0	PHB	45.2	28.2
46.0	PHB	44.6	27.6
48.0	PHB	44.1	27.1
50.0	PHB	43.6	26.6
52.0	PHB	43.2	26.2
54.0	PHB	42.7	25.7
56.0	PHB	42.3	25.3
58.0	PHB	41.9	24.9
60.0	PHB	41.5	24.5

AUDIBLE NOISE SPECIFICATIONS

Antenna Height = 1.524 m
Altitude = 500.0 m
Lateral Distance From Center of Tower = 30.5 m

Values at Standard Distance (30.5 m) from Centerline

Audible Noise (Rain L50) = 40.4 DBA
Audible Noise (Fair Weather L50) = 15.4 DBA

Audible Noise (Rain L5) = 49.3 DBA
Audible Noise (Fair Weather L5) = 24.3 DBA

AUDIBLE NOISE (Values DBA)

Lateral Dist. (m)	L50 Rain	L50 Fair	L5 Rain	L5 Fair
.0	44.9	19.9	53.6	28.6
2.0	44.8	19.8	53.6	28.6
4.0	44.7	19.7	53.4	28.4
6.0	44.5	19.5	53.2	28.2
8.0	44.2	19.2	53.0	28.0
10.0	43.9	18.9	52.7	27.7
12.0	43.5	18.5	52.3	27.3
14.0	43.2	18.2	52.0	27.0
16.0	42.8	17.8	51.6	26.6
18.0	42.4	17.4	51.3	26.3
20.0	42.0	17.0	50.9	25.9
22.0	41.7	16.7	50.6	25.6
24.0	41.4	16.4	50.3	25.3
26.0	41.0	16.0	49.9	24.9
28.0	40.7	15.7	49.6	24.6
30.0	40.4	15.4	49.3	24.3
32.0	40.2	15.2	49.1	24.1
34.0	39.9	14.9	48.8	23.8
36.0	39.6	14.6	48.5	23.5
38.0	39.4	14.4	48.3	23.3
40.0	39.2	14.2	48.0	23.0
42.0	38.9	13.9	47.8	22.8
44.0	38.7	13.7	47.6	22.6
46.0	38.5	13.5	47.4	22.4
48.0	38.3	13.3	47.1	22.1
50.0	38.1	13.1	46.9	21.9
52.0	37.9	12.9	46.7	21.7
54.0	37.8	12.8	46.5	21.5
56.0	37.6	12.6	46.4	21.4
58.0	37.4	12.4	46.2	21.2
60.0	37.3	12.3	46.0	21.0

File: M2TH230.DAT 2005-07-12

================[EEFFECTS (V2.2C) - Detmold Consulting] ================

ELECTRIC FIELD (E-FIELD) CALCULATIONS

Sensor Height = 1 metre

X (m)	E-FIELD (kV/m)	THETA	E-FIELD X (kV/m)	THETA X	E-FIELD Y (kV/m)	THETA Y
	E-FIELD RESULTANTS		E-FIELD XY VECTOR COMPONENTS			
.0	.26	90.0	.21	30.0	.26	-60.0
2.0	.49	70.8	.20	41.1	.46	2.0
4.0	.78	79.6	.16	51.8	.77	21.5
6.0	1.01	84.7	.11	63.3	1.00	30.7
8.0	1.13	88.1	.06	83.7	1.13	36.1
10.0	1.15	90.5	.03	148.2	1.15	39.5
12.0	1.10	92.1	.04	-160.5	1.10	41.6
14.0	1.00	93.2	.06	-146.6	1.00	43.0
16.0	.88	93.9	.06	-141.2	.88	43.8
18.0	.76	94.4	.06	-138.5	.76	44.4
20.0	.65	94.6	.05	-137.0	.65	44.7
22.0	.55	94.7	.04	-136.2	.55	44.9
24.0	.47	-85.3	.04	-135.7	.47	45.1
26.0	.40	-85.4	.03	-135.4	.40	45.2
28.0	.34	-85.5	.03	-135.3	.34	45.3
30.0	.29	-85.6	.02	-135.2	.29	45.3
32.0	.25	-85.8	.02	-135.2	.25	45.4
34.0	.22	-85.9	.02	-135.2	.22	45.5
36.0	.19	-86.0	.01	-135.2	.19	45.6
38.0	.16	-86.2	.01	-135.2	.16	45.7
40.0	.14	-86.3	.01	-135.2	.14	45.8
42.0	.13	-86.4	.01	-135.2	.13	46.0
44.0	.11	-86.6	.01	-135.2	.11	46.1
46.0	.10	-86.7	.01	-135.2	.10	46.3
48.0	.09	-86.8	.00	-135.2	.09	46.5
50.0	.08	-86.9	.00	-135.1	.08	46.7
52.0	.07	-87.0	.00	-135.1	.07	46.9
54.0	.06	-87.1	.00	-135.0	.06	47.1
56.0	.06	-87.2	.00	-135.0	.06	47.3
58.0	.05	-87.3	.00	-134.9	.05	47.5
60.0	.05	-87.4	.00	-134.8	.05	47.8

File: M2TH230.DAT 2005-07-12

=================[EEFFECTS (V2.2C) - Detmold Consulting] ================

MAGNETIC FIELD (B-FIELD) CALCULATIONS

Sensor Height = 1 metre

	B-FIELD RESULTANTS		B-FIELD XY VECTOR COMPONENTS			
X (m)	B-FIELD (mGauss)	THETA	B-FIELD X (mGauss)	THETA X	B-FIELD Y (mGauss)	THETA Y
.0	62.36	90.0	15.06	120.0	62.36	30.0
2.0	61.55	104.3	20.69	169.4	59.75	35.6
4.0	59.15	118.4	30.41	191.9	52.38	40.8
6.0	55.35	132.3	38.11	203.1	41.62	45.6
8.0	50.52	145.4	41.89	209.4	29.58	50.5
10.0	45.16	157.5	41.82	213.2	18.36	56.8
12.0	39.75	168.5	38.96	215.4	9.42	69.4
14.0	34.66	178.1	34.64	216.7	4.03	110.4
16.0	30.09	-173.5	29.89	217.4	4.45	176.7
18.0	26.10	-166.2	25.36	217.7	6.56	197.9
20.0	22.70	-159.9	21.33	217.8	7.93	205.2
22.0	19.81	-154.5	17.89	217.8	8.60	208.6
24.0	17.37	-149.7	15.02	217.6	8.79	210.4
26.0	15.31	-145.6	12.64	217.5	8.67	211.5
28.0	13.57	-141.9	10.69	217.2	8.37	212.1
30.0	12.08	-138.7	9.09	217.0	7.98	212.5
32.0	10.82	-135.9	7.77	216.8	7.53	212.8
34.0	9.73	-133.3	6.68	216.5	7.08	212.9
36.0	8.79	-131.0	5.77	216.3	6.63	213.0
38.0	7.97	-128.9	5.02	216.1	6.20	213.1
40.0	7.26	-127.1	4.38	215.8	5.80	213.1
42.0	6.64	-125.4	3.85	215.6	5.42	213.0
44.0	6.09	-123.8	3.39	215.5	5.06	213.0
46.0	5.61	-122.4	3.01	215.3	4.74	213.0
48.0	5.18	-121.0	2.67	215.1	4.44	212.9
50.0	4.80	-119.8	2.39	214.9	4.16	212.9
52.0	4.45	-118.7	2.14	214.8	3.90	212.8
54.0	4.14	-117.7	1.93	214.6	3.67	212.7
56.0	3.87	-116.7	1.74	214.5	3.45	212.7
58.0	3.61	-115.8	1.57	214.4	3.25	212.6
60.0	3.39	-114.9	1.43	214.2	3.07	212.6

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ELECTRICAL EFFECTS PROGRAM

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Rogers Engineering Inc.
(403) 282-4750

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Input Data File Information

Date: 2005-07-11
Name: MOTH230.DAT
Desc: MoTH Study - Bluebell - 230

	Dist. from Tower C-L (metre)	Height to Bdl Mid Pt (metre)	Subcon Diam. (cm.)	Subcon Spacing (cm.)	Voltage L-G (kV)	Current (Amps)	Phase Angle (degrees)
PHA	-5.50	11.25	2.971	.00	132.80	665.0	.00
PHB	.00	11.25	2.971	.00	132.80	665.0	120.00
PHC	5.50	11.25	2.971	.00	132.80	665.0	240.00

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CORONA INCEPTION CALCULATION

Altitude	:	500.0 (m)
Temperature	:	65.0 (deg C)
Relative air density (RAD)	:	.830
Conductor Surface Factor	:	.8
Radius of Conductor	:	1.485 (cm)

Conductor Surface Gradient for
Positive Corona Inception : 17.895 (kV/cm)

MAXIMUM VOLTAGE GRADIENTS
(kV/cm)

PHA	14.4668
PHB	15.4323
PHC	14.4668

RADIO INTERFERENCE SPECIFICATIONS

Antenna Height = 1.000 m
RI Frequency = 1.00 MHz
Altitude = 500.0 m
Ground Conductivity = 20.00 mmho/m
Lateral Dist From Outside Phase = 15.0 m

Values at Standard Distance (15 m) from Outer Phase

Foul Weather Radio Interference (L50) = 53.6 dbu
Fair Weather Radio Interference (L50) = 36.6 dbu

CSA Maximum Allowable RI (Fair Weather) = 50.0 dbu

Maximum Radio Interference (dbu)

Lateral Dist. (m)	Phase	Rain L50	Fair L50
.0	PHB	66.6	49.6
2.0	PHB	66.3	49.3
4.0	PHB	65.4	48.4
6.0	PHB	64.1	47.1
8.0	PHC	62.7	45.7
10.0	PHC	61.7	44.7
12.0	PHC	60.3	43.3
14.0	PHC	58.8	41.8
16.0	PHC	57.2	40.2
18.0	PHC	55.6	38.6
20.0	PHC	54.0	37.0
22.0	PHC	52.6	35.6
24.0	PHB	51.3	34.3
26.0	PHB	50.2	33.2
28.0	PHB	49.3	32.3
30.0	PHB	48.3	31.3
32.0	PHB	47.5	30.5
34.0	PHB	46.7	29.7
36.0	PHB	45.9	28.9
38.0	PHB	45.2	28.2
40.0	PHB	44.6	27.6
42.0	PHB	44.0	27.0
44.0	PHB	43.4	26.4
46.0	PHB	42.8	25.8
48.0	PHB	42.3	25.3
50.0	PHB	41.8	24.8
52.0	PHB	41.3	24.3
54.0	PHB	40.9	23.9
56.0	PHB	40.4	23.4
58.0	PHB	40.0	23.0
60.0	PHB	39.6	22.6

File: MOTH230.DAT 2005-07-11

================[EEFFECTS (V2.2C) - Detmold Consulting] ================

AUDIBLE NOISE SPECIFICATIONS

Antenna Height = 1.524 m
Altitude = 500.0 m
Lateral Distance From Center of Tower = 30.5 m

Values at Standard Distance (30.5 m) from Centerline

Audible Noise (Rain L50) = 40.6 DBA
Audible Noise (Fair Weather L50) = 15.6 DBA

Audible Noise (Rain L5) = 49.5 DBA
Audible Noise (Fair Weather L5) = 24.5 DBA

AUDIBLE NOISE (Values DBA)

	L50		L5	
Lateral Dist. (m)	Rain	Fair	Rain	Fair
.0	46.1	21.1	54.8	29.8
2.0	46.1	21.1	54.7	29.7
4.0	45.9	20.9	54.5	29.5
6.0	45.6	20.6	54.3	29.3
8.0	45.2	20.2	53.9	28.9
10.0	44.8	19.8	53.5	28.5
12.0	44.3	19.3	53.1	28.1
14.0	43.8	18.8	52.6	27.6
16.0	43.3	18.3	52.2	27.2
18.0	42.9	17.9	51.8	26.8
20.0	42.5	17.5	51.4	26.4
22.0	42.1	17.1	51.0	26.0
24.0	41.7	16.7	50.6	25.6
26.0	41.4	16.4	50.3	25.3
28.0	41.0	16.0	49.9	24.9
30.0	40.7	15.7	49.6	24.6
32.0	40.4	15.4	49.3	24.3
34.0	40.1	15.1	49.0	24.0
36.0	39.9	14.9	48.8	23.8
38.0	39.6	14.6	48.5	23.5
40.0	39.4	14.4	48.2	23.2
42.0	39.1	14.1	48.0	23.0
44.0	38.9	13.9	47.8	22.8
46.0	38.7	13.7	47.5	22.5
48.0	38.5	13.5	47.3	22.3
50.0	38.3	13.3	47.1	22.1
52.0	38.1	13.1	46.9	21.9
54.0	37.9	12.9	46.7	21.7
56.0	37.7	12.7	46.5	21.5
58.0	37.6	12.6	46.3	21.3
60.0	37.4	12.4	46.1	21.1

File: MOTH230.DAT 2005-07-11

================[EEFFECTS (V2.2C) - Detmold Consulting] ================

ELECTRIC FIELD (E-FIELD) CALCULATIONS

Sensor Height = 1 metre

	E-FIELD RESULTANTS		E-FIELD XY VECTOR COMPONENTS			
X (m)	E-FIELD (kV/m)	THETA	E-FIELD X (kV/m)	THETA X	E-FIELD Y (kV/m)	THETA Y
.0	.60	90.0	.36	30.0	.60	-60.0
2.0	.89	75.0	.34	47.1	.86	-4.8
4.0	1.32	80.8	.28	61.7	1.30	20.1
6.0	1.64	85.9	.17	78.1	1.63	32.2
8.0	1.75	89.7	.07	121.5	1.75	38.6
10.0	1.68	92.4	.08	-166.3	1.68	42.1
12.0	1.49	94.1	.11	-145.7	1.49	44.0
14.0	1.26	95.1	.11	-139.2	1.26	45.0
16.0	1.04	-84.4	.10	-136.4	1.04	45.5
18.0	.85	-84.2	.09	-135.1	.85	45.7
20.0	.70	-84.2	.07	-134.4	.69	45.7
22.0	.57	-84.3	.06	-134.2	.57	45.7
24.0	.47	-84.5	.05	-134.1	.46	45.7
26.0	.39	-84.7	.04	-134.2	.38	45.7
28.0	.32	-84.9	.03	-134.2	.32	45.7
30.0	.27	-85.1	.02	-134.4	.27	45.7
32.0	.23	-85.3	.02	-134.5	.23	45.7
34.0	.20	-85.5	.02	-134.6	.19	45.7
36.0	.17	-85.7	.01	-134.7	.17	45.8
38.0	.14	-85.9	.01	-134.8	.14	45.8
40.0	.13	-86.1	.01	-134.9	.13	45.9
42.0	.11	-86.2	.01	-134.9	.11	46.1
44.0	.10	-86.4	.01	-135.0	.10	46.2
46.0	.09	-86.5	.01	-135.0	.09	46.4
48.0	.08	-86.6	.00	-135.0	.08	46.5
50.0	.07	-86.8	.00	-135.0	.07	46.7
52.0	.06	-86.9	.00	-135.0	.06	46.9
54.0	.05	-87.0	.00	-134.9	.05	47.1
56.0	.05	-87.1	.00	-134.9	.05	47.4
58.0	.04	-87.2	.00	-134.8	.04	47.6
60.0	.04	-87.3	.00	-134.7	.04	47.8

File: MOTH230.DAT 2005-07-11

================[EEFFECTS (V2.2C) - Detmold Consulting] ================

MAGNETIC FIELD (B-FIELD) CALCULATIONS

Sensor Height = 1 metre

	B-FIELD RESULTANTS		B-FIELD XY VECTOR COMPONENTS			
X (m)	B-FIELD (mGauss)	THETA	B-FIELD X (mGauss)	THETA X	B-FIELD Y (mGauss)	THETA Y
.0	93.63	90.0	29.01	120.0	93.63	30.0
2.0	92.27	106.2	36.89	168.1	88.92	38.6
4.0	88.03	122.8	51.56	194.0	75.09	46.2
6.0	80.91	139.2	62.44	207.0	54.62	52.8
8.0	71.67	154.8	65.11	213.8	32.85	60.7
10.0	61.65	168.8	60.51	217.2	15.19	77.1
12.0	52.08	-179.1	52.07	218.9	6.70	135.7
14.0	43.66	-168.9	42.87	219.7	9.51	190.0
16.0	36.61	-160.5	34.53	219.8	12.59	204.0
18.0	30.84	-153.5	27.62	219.7	13.92	209.1
20.0	26.17	-147.6	22.12	219.5	14.09	211.5
22.0	22.38	-142.6	17.81	219.1	13.61	212.7
24.0	19.30	-138.4	14.46	218.8	12.82	213.3
26.0	16.78	-134.8	11.84	218.4	11.91	213.7
28.0	14.70	-131.7	9.79	218.0	10.98	213.8
30.0	12.97	-129.0	8.17	217.7	10.08	213.9
32.0	11.52	-126.6	6.87	217.3	9.25	213.9
34.0	10.29	-124.4	5.82	217.0	8.49	213.9
36.0	9.24	-122.5	4.98	216.7	7.79	213.8
38.0	8.34	-120.8	4.28	216.4	7.16	213.7
40.0	7.57	-119.3	3.71	216.2	6.60	213.6
42.0	6.89	-117.9	3.23	215.9	6.09	213.5
44.0	6.31	-116.7	2.83	215.7	5.64	213.4
46.0	5.79	-115.5	2.49	215.5	5.22	213.3
48.0	5.33	-114.4	2.21	215.3	4.85	213.2
50.0	4.93	-113.5	1.96	215.1	4.52	213.2
52.0	4.56	-112.6	1.75	214.9	4.21	213.1
54.0	4.24	-111.7	1.57	214.8	3.94	213.0
56.0	3.95	-111.0	1.41	214.6	3.69	212.9
58.0	3.69	-110.2	1.28	214.5	3.46	212.8
60.0	3.45	-109.6	1.16	214.3	3.25	212.7

ELECTRICAL EFFECTS PROGRAM

Rogers Engineering Inc.
(403) 282-4750

Input Data File Information

Date: 2005-07-11
Name: MOTH287.DAT
Desc: MoTH Study - Columbine - 287

	Dist. from Tower C-L (metre)	Height to Bdl Mid Pt (metre)	Subcon Diam. (cm.)	Subcon Spacing (cm.)	Voltage L-G (kV)	Current (Amps)	Phase Angle (degrees)
PHA	-6.70	11.20	3.402	.00	165.70	780.0	.00
PHB	.00	11.20	3.402	.00	165.70	780.0	120.00
PHC	6.70	11.20	3.402	.00	165.70	780.0	240.00

CORONA INCEPTION CALCULATION

Altitude	:	500.0 (m)
Temperature	:	65.0 (deg C)
Relative air density (RAD)	:	.830
Conductor Surface Factor	:	.8
Radius of Conductor	:	1.701 (cm)

Conductor Surface Gradient for
Positive Corona Inception : 17.645 (kV/cm)

MAXIMUM VOLTAGE GRADIENTS
(kV/cm)

PHA	15.6849
PHB	16.6429
PHC	15.6849

RADIO INTERFERENCE SPECIFICATIONS

Antenna Height	=	1.000 m
RI Frequency	=	1.00 MHz
Altitude	=	500.0 m
Ground Conductivity	=	20.00 mmho/m
Lateral Dist From Outside Phase	=	15.0 m

Values at Standard Distance (15 m) from Outer Phase

Foul Weather Radio Interference (L50)	=	60.2 dbu
Fair Weather Radio Interference (L50)	=	43.2 dbu
CSA Maximum Allowable RI (Fair Weather)	=	50.0 dbu

Maximum Radio Interference (dbu)

Lateral Dist. (m)	Phase	Rain L50	Fair L50
.0	PHB	72.9	55.9
2.0	PHB	72.6	55.6
4.0	PHB	71.7	54.7
6.0	PHB	70.4	53.4
8.0	PHC	69.7	52.7
10.0	PHC	69.0	52.0
12.0	PHC	67.8	50.8
14.0	PHC	66.3	49.3
16.0	PHC	64.7	47.7
18.0	PHC	63.1	46.1
20.0	PHC	61.5	44.5
22.0	PHC	60.0	43.0
24.0	PHC	58.6	41.6
26.0	PHC	57.2	40.2
28.0	PHC	56.0	39.0
30.0	PHC	54.8	37.8
32.0	PHC	53.8	36.8
34.0	PHB	53.0	36.0
36.0	PHB	52.2	35.2
38.0	PHB	51.5	34.5
40.0	PHB	50.8	33.8
42.0	PHB	50.2	33.2
44.0	PHB	49.6	32.6
46.0	PHB	49.1	32.1
48.0	PHB	48.5	31.5
50.0	PHB	48.0	31.0
52.0	PHB	47.6	30.6
54.0	PHB	47.1	30.1
56.0	PHB	46.7	29.7
58.0	PHB	46.3	29.3

60.0	PHB	45.9	28.9

AUDIBLE NOISE SPECIFICATIONS

Antenna Height = 1.524 m
Altitude = 500.0 m
Lateral Distance From Center of Tower = 30.5 m

Values at Standard Distance (30.5 m) from Centerline

Audible Noise (Rain L50) = 48.0 DBA
Audible Noise (Fair Weather L50) = 23.0 DBA

Audible Noise (Rain L5) = 55.5 DBA
Audible Noise (Fair Weather L5) = 30.5 DBA

AUDIBLE NOISE (Values DBA)

	L50		L5	
Lateral Dist. (m)	Rain	Fair	Rain	Fair
.0	53.3	28.3	60.6	35.6
2.0	53.3	28.3	60.6	35.6
4.0	53.1	28.1	60.4	35.4
6.0	52.9	27.9	60.2	35.2
8.0	52.5	27.5	59.9	34.9
10.0	52.1	27.1	59.5	34.5
12.0	51.7	26.7	59.1	34.1
14.0	51.2	26.2	58.6	33.6
16.0	50.7	25.7	58.2	33.2
18.0	50.3	25.3	57.8	32.8
20.0	49.9	24.9	57.4	32.4
22.0	49.4	24.4	57.0	32.0
24.0	49.1	24.1	56.6	31.6
26.0	48.7	23.7	56.3	31.3
28.0	48.4	23.4	55.9	30.9
30.0	48.1	23.1	55.6	30.6
32.0	47.7	22.7	55.3	30.3
34.0	47.5	22.5	55.0	30.0
36.0	47.2	22.2	54.7	29.7
38.0	46.9	21.9	54.5	29.5
40.0	46.7	21.7	54.2	29.2
42.0	46.5	21.5	54.0	29.0
44.0	46.2	21.2	53.7	28.7
46.0	46.0	21.0	53.5	28.5
48.0	45.8	20.8	53.3	28.3
50.0	45.6	20.6	53.1	28.1
52.0	45.4	20.4	52.9	27.9
54.0	45.2	20.2	52.7	27.7
56.0	45.1	20.1	52.5	27.5
58.0	44.9	19.9	52.3	27.3
60.0	44.7	19.7	52.1	27.1

=================[EEFFECTS (V2.2C) - Detmold Consulting] ================

ELECTRIC FIELD (E-FIELD) CALCULATIONS

Sensor Height = 1 metre

	E-FIELD RESULTANTS		E-FIELD XY VECTOR COMPONENTS			
X (m)	E-FIELD (kV/m)	THETA	E-FIELD X (kV/m)	THETA X	E-FIELD Y (kV/m)	THETA Y
.0	1.14	90.0	.46	30.0	1.14	-60.0
2.0	1.34	81.5	.46	49.9	1.32	-16.8
4.0	1.79	81.8	.41	65.0	1.78	12.2
6.0	2.24	85.1	.30	78.2	2.24	28.5
8.0	2.49	88.6	.15	103.1	2.49	37.3
10.0	2.48	91.5	.10	172.1	2.48	42.0
12.0	2.26	93.5	.14	-150.3	2.26	44.5
14.0	1.95	-85.2	.16	-139.8	1.94	45.8
16.0	1.63	-84.5	.15	-135.8	1.62	46.4
18.0	1.33	-84.2	.13	-134.0	1.33	46.6
20.0	1.09	-84.2	.11	-133.2	1.08	46.6
22.0	.89	-84.2	.09	-132.9	.88	46.6
24.0	.73	-84.4	.07	-132.8	.73	46.4
26.0	.60	-84.6	.06	-132.9	.60	46.3
28.0	.50	-84.8	.05	-133.1	.50	46.1
30.0	.42	-85.0	.04	-133.3	.42	46.0
32.0	.35	-85.3	.03	-133.5	.35	45.9
34.0	.30	-85.5	.02	-133.7	.30	45.8
36.0	.26	-85.7	.02	-133.9	.26	45.7
38.0	.22	-85.8	.02	-134.1	.22	45.7
40.0	.19	-86.0	.01	-134.3	.19	45.7
42.0	.17	-86.2	.01	-134.4	.17	45.7
44.0	.15	-86.3	.01	-134.6	.15	45.7
46.0	.13	-86.5	.01	-134.7	.13	45.7
48.0	.12	-86.6	.01	-134.8	.12	45.8
50.0	.10	-86.7	.01	-134.9	.10	45.9
52.0	.09	-86.8	.01	-134.9	.09	46.0
54.0	.08	-87.0	.00	-135.0	.08	46.1
56.0	.07	-87.1	.00	-135.0	.07	46.2
58.0	.07	-87.2	.00	-135.1	.07	46.3
60.0	.06	-87.2	.00	-135.1	.06	46.5

File: MOTH287.DAT 2005-07-11

=================[EEFFECTS (V2.2C) – Detmold Consulting] ================

MAGNETIC FIELD (B-FIELD) CALCULATIONS

Sensor Height = 1 metre

	B-FIELD RESULTANTS		B-FIELD XY VECTOR COMPONENTS			
X (m)	B-FIELD (mGauss)	THETA	B-FIELD X (mGauss)	THETA X	B-FIELD Y (mGauss)	THETA Y
.0	121.56	90.0	46.10	120.0	121.56	30.0
2.0	120.59	104.0	51.54	159.2	117.49	39.9
4.0	117.14	118.9	65.55	187.9	104.18	48.3
6.0	110.31	134.5	80.25	204.6	81.48	55.2
8.0	100.15	150.0	87.46	213.5	53.82	62.4
10.0	87.89	164.4	84.77	218.1	28.40	74.9
12.0	75.25	177.1	75.16	220.4	12.13	112.9
14.0	63.57	-172.0	62.96	221.4	11.95	178.3
16.0	53.48	-162.9	51.15	221.7	16.64	200.8
18.0	45.09	-155.3	41.02	221.6	19.16	208.2
20.0	38.23	-149.1	32.83	221.4	19.81	211.5
22.0	32.66	-143.8	26.39	221.0	19.37	213.1
24.0	28.12	-139.3	21.36	220.6	18.36	214.0
26.0	24.41	-135.5	17.45	220.1	17.12	214.4
28.0	21.35	-132.3	14.38	219.7	15.81	214.7
30.0	18.81	-129.4	11.96	219.3	14.54	214.8
32.0	16.68	-126.9	10.04	218.9	13.34	214.8
34.0	14.89	-124.7	8.49	218.5	12.23	214.7
36.0	13.36	-122.8	7.24	218.1	11.23	214.6
38.0	12.05	-121.0	6.22	217.8	10.32	214.5
40.0	10.92	-119.5	5.38	217.5	9.51	214.4
42.0	9.94	-118.0	4.68	217.2	8.77	214.3
44.0	9.08	-116.7	4.09	216.9	8.11	214.2
46.0	8.33	-115.6	3.60	216.7	7.52	214.1
48.0	7.67	-114.5	3.18	216.4	6.98	214.0
50.0	7.08	-113.5	2.83	216.2	6.50	213.8
52.0	6.56	-112.6	2.52	216.0	6.06	213.7
54.0	6.09	-111.7	2.26	215.8	5.66	213.6
56.0	5.67	-111.0	2.03	215.6	5.30	213.5
58.0	5.30	-110.2	1.83	215.4	4.97	213.4
60.0	4.95	-109.6	1.66	215.3	4.67	213.3

ELECTRICAL EFFECTS PROGRAM

Rogers Engineering Inc.
(403) 282-4750

Input Data File Information

Date: 2005-07-12
Name: M2TH287.DAT
Desc: MoTH Study - Columbine - 287 (2)

	Dist. from Tower C-L (metre)	Height to Bdl Mid Pt (metre)	Subcon Diam. (cm.)	Subcon Spacing (cm.)	Voltage L-G (kV)	Current (Amps)	Phase Angle (degrees)
PHA	-6.70	14.10	3.402	.00	165.70	780.0	.00
PHB	.00	14.10	3.402	.00	165.70	780.0	120.00
PHC	6.70	14.10	3.402	.00	165.70	780.0	240.00

CORONA INCEPTION CALCULATION

Altitude	:	500.0 (m)
Temperature	:	65.0 (deg C)
Relative air density (RAD)	:	.830
Conductor Surface Factor	:	.8
Radius of Conductor	:	1.701 (cm)
Conductor Surface Gradient for Positive Corona Inception	:	17.645 (kV/cm)

MAXIMUM VOLTAGE GRADIENTS
(kV/cm)

PHA	15.5977
PHB	16.6365
PHC	15.5977

RADIO INTERFERENCE SPECIFICATIONS

Antenna Height	=	1.000 m
RI Frequency	=	1.00 MHz
Altitude	=	500.0 m
Ground Conductivity	=	20.00 mmho/m
Lateral Dist From Outside Phase	=	15.0 m

Values at Standard Distance (15 m) from Outer Phase

Foul Weather Radio Interference (L50)	=	60.4 dbu
Fair Weather Radio Interference (L50)	=	43.4 dbu
CSA Maximum Allowable RI (Fair Weather)	=	50.0 dbu

Maximum Radio Interference (dbu)

Lateral Dist. (m)	Phase	Rain L50	Fair L50
.0	PHB	70.7	53.7
2.0	PHB	70.5	53.5
4.0	PHB	69.9	52.9
6.0	PHB	69.1	52.1
8.0	PHB	68.0	51.0
10.0	PHB	66.8	49.8
12.0	PHC	66.0	49.0
14.0	PHC	65.0	48.0
16.0	PHC	63.9	46.9
18.0	PHC	62.7	45.7
20.0	PHC	61.4	44.4
22.0	PHC	60.2	43.2
24.0	PHC	59.0	42.0
26.0	PHC	57.9	40.9
28.0	PHB	56.9	39.9
30.0	PHB	56.1	39.1
32.0	PHB	55.3	38.3
34.0	PHB	54.6	37.6
36.0	PHB	53.9	36.9
38.0	PHB	53.2	36.2
40.0	PHB	52.6	35.6
42.0	PHB	52.0	35.0
44.0	PHB	51.4	34.4
46.0	PHB	50.9	33.9
48.0	PHB	50.3	33.3
50.0	PHB	49.9	32.9
52.0	PHB	49.4	32.4
54.0	PHB	48.9	31.9
56.0	PHB	48.5	31.5
58.0	PHB	48.1	31.1
60.0	PHB	47.7	30.7

AUDIBLE NOISE SPECIFICATIONS

Antenna Height = 1.524 m
Altitude = 500.0 m
Lateral Distance From Center of Tower = 30.5 m

Values at Standard Distance (30.5 m) from Centerline

Audible Noise (Rain L50) = 47.7 DBA
Audible Noise (Fair Weather L50) = 22.7 DBA

Audible Noise (Rain L5) = 55.2 DBA
Audible Noise (Fair Weather L5) = 30.2 DBA

AUDIBLE NOISE (Values DBA)

Lateral Dist. (m)	L50		L5	
	Rain	Fair	Rain	Fair
.0	52.1	27.1	59.4	34.4
2.0	52.0	27.0	59.4	34.4
4.0	51.9	26.9	59.3	34.3
6.0	51.7	26.7	59.1	34.1
8.0	51.4	26.4	58.9	33.9
10.0	51.1	26.1	58.6	33.6
12.0	50.8	25.8	58.3	33.3
14.0	50.4	25.4	57.9	32.9
16.0	50.1	25.1	57.6	32.6
18.0	49.7	24.7	57.2	32.2
20.0	49.3	24.3	56.9	31.9
22.0	49.0	24.0	56.5	31.5
24.0	48.6	23.6	56.2	31.2
26.0	48.3	23.3	55.9	30.9
28.0	48.0	23.0	55.6	30.6
30.0	47.7	22.7	55.3	30.3
32.0	47.4	22.4	55.0	30.0
34.0	47.2	22.2	54.7	29.7
36.0	46.9	21.9	54.5	29.5
38.0	46.7	21.7	54.2	29.2
40.0	46.4	21.4	54.0	29.0
42.0	46.2	21.2	53.7	28.7
44.0	46.0	21.0	53.5	28.5
46.0	45.8	20.8	53.3	28.3
48.0	45.6	20.6	53.1	28.1
50.0	45.4	20.4	52.9	27.9
52.0	45.2	20.2	52.7	27.7
54.0	45.0	20.0	52.5	27.5
56.0	44.9	19.9	52.3	27.3
58.0	44.7	19.7	52.1	27.1
60.0	44.5	19.5	51.9	26.9

File: M2TH287.DAT 2005-07-12

=================[EEFFECTS (V2.2C) - Detmold Consulting] ================

ELECTRIC FIELD (E-FIELD) CALCULATIONS

Sensor Height = 1 metre

	E-FIELD RESULTANTS		E-FIELD XY VECTOR COMPONENTS			
X (m)	E-FIELD (kV/m)	THETA	E-FIELD X (kV/m)	THETA X	E-FIELD Y (kV/m)	THETA Y
.0	.55	90.0	.28	30.0	.55	-60.0
2.0	.75	76.8	.27	43.4	.73	-11.0
4.0	1.10	80.6	.24	55.4	1.08	13.5
6.0	1.41	84.4	.18	66.8	1.40	26.4
8.0	1.61	87.5	.11	82.7	1.61	33.9
10.0	1.68	89.8	.05	123.4	1.68	38.5
12.0	1.63	91.6	.06	-173.7	1.63	41.4
14.0	1.51	92.9	.08	-150.6	1.51	43.2
16.0	1.34	93.7	.09	-142.4	1.34	44.2
18.0	1.17	94.2	.09	-138.5	1.16	44.9
20.0	1.00	-85.5	.08	-136.6	1.00	45.3
22.0	.85	-85.4	.07	-135.5	.85	45.5
24.0	.72	-85.3	.06	-134.8	.72	45.6
26.0	.62	-85.4	.05	-134.5	.61	45.6
28.0	.52	-85.5	.04	-134.4	.52	45.6
30.0	.45	-85.6	.03	-134.3	.45	45.6
32.0	.39	-85.7	.03	-134.3	.38	45.6
34.0	.33	-85.9	.02	-134.4	.33	45.6
36.0	.29	-86.0	.02	-134.5	.29	45.6
38.0	.25	-86.1	.02	-134.6	.25	45.6
40.0	.22	-86.3	.01	-134.7	.22	45.6
42.0	.19	-86.4	.01	-134.7	.19	45.6
44.0	.17	-86.5	.01	-134.8	.17	45.7
46.0	.15	-86.6	.01	-134.9	.15	45.8
48.0	.14	-86.8	.01	-134.9	.14	45.8
50.0	.12	-86.9	.01	-135.0	.12	45.9
52.0	.11	-87.0	.01	-135.0	.11	46.0
54.0	.10	-87.1	.01	-135.0	.10	46.2
56.0	.09	-87.2	.00	-135.1	.09	46.3
58.0	.08	-87.2	.00	-135.1	.08	46.4
60.0	.07	-87.3	.00	-135.1	.07	46.6

================[EEFFECTS (V2.2C) - Detmold Consulting] ===============

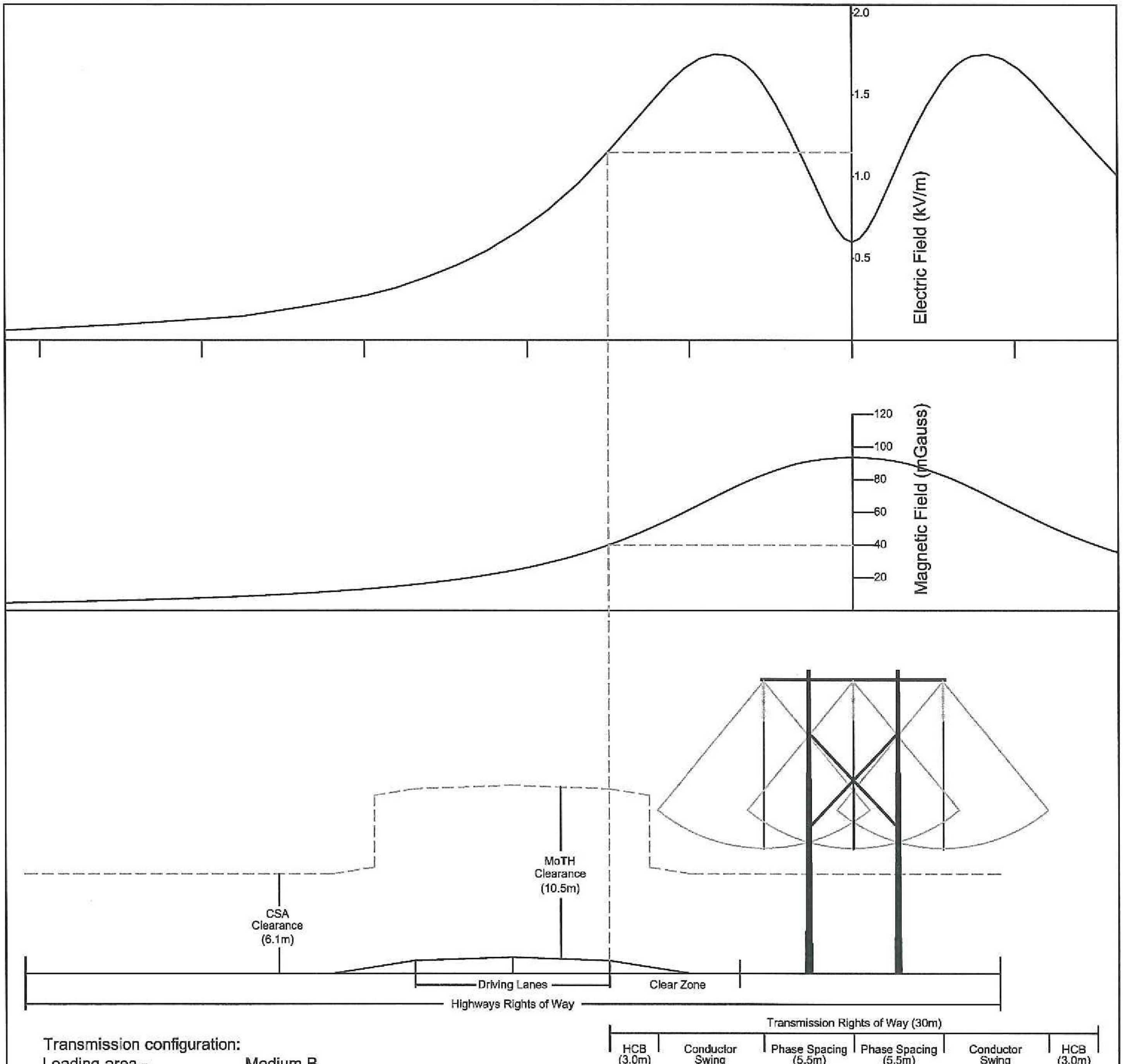
MAGNETIC FIELD (B-FIELD) CALCULATIONS

Sensor Height = 1 metre

	B-FIELD RESULTANTS		B-FIELD XY VECTOR COMPONENTS			
X (m)	B-FIELD (mGauss)	THETA	B-FIELD X (mGauss)	THETA X	B-FIELD Y (mGauss)	THETA Y
.0	83.62	90.0	24.69	120.0	83.62	30.0
2.0	82.80	103.0	29.83	161.6	80.84	36.6
4.0	80.31	116.2	40.41	186.5	72.67	42.6
6.0	76.13	129.4	50.37	200.4	59.96	48.0
8.0	70.47	142.3	56.49	208.5	44.68	53.1
10.0	63.80	154.5	57.79	213.4	29.43	59.3
12.0	56.73	165.6	55.00	216.3	16.49	70.1
14.0	49.82	175.6	49.68	217.9	7.70	99.1
16.0	43.45	-175.6	43.32	218.8	6.03	161.9
18.0	37.80	-168.0	36.98	219.3	8.70	192.9
20.0	32.91	-161.4	31.20	219.4	10.85	203.3
22.0	28.73	-155.7	26.19	219.4	12.00	207.9
24.0	25.19	-150.7	21.98	219.2	12.41	210.3
26.0	22.19	-146.4	18.49	219.0	12.33	211.7
28.0	19.64	-142.6	15.62	218.7	11.95	212.5
30.0	17.48	-139.3	13.26	218.5	11.42	213.1
32.0	15.64	-136.3	11.32	218.2	10.81	213.4
34.0	14.05	-133.7	9.71	217.9	10.17	213.6
36.0	12.69	-131.3	8.38	217.6	9.53	213.7
38.0	11.50	-129.2	7.28	217.4	8.92	213.7
40.0	10.47	-127.3	6.35	217.1	8.33	213.7
42.0	9.57	-125.5	5.57	216.9	7.79	213.7
44.0	8.77	-123.9	4.90	216.6	7.28	213.7
46.0	8.07	-122.5	4.34	216.4	6.81	213.6
48.0	7.45	-121.1	3.86	216.2	6.38	213.6
50.0	6.89	-119.9	3.44	216.0	5.98	213.5
52.0	6.40	-118.8	3.08	215.8	5.61	213.4
54.0	5.95	-117.7	2.77	215.6	5.27	213.4
56.0	5.55	-116.7	2.50	215.5	4.96	213.3
58.0	5.19	-115.8	2.26	215.3	4.67	213.2
60.0	4.86	-115.0	2.05	215.1	4.41	213.1

APPENDIX

Sketches 1A, 1B, 2A & 2B



Transmission configuration:

Loading area -	Medium B
Ruling span -	203m
Ruling sag (max) -	7.8m
Horizontal clearance to buildings -	3.0m
Required transmission RW -	30m

Notes:

1) Powerlines crossing highways must meet highway vertical clearances over driving lanes under worst sag conditions.
2) Powerlines paralleling highways must meet highway vertical clearances over driving lanes under all conductor conditions.
3) Powerlines paralleling highways must provide CSA horizontal clearance to buildings (HCB) from swung conductors to edge of driving lanes.
4) Powerlines paralleling highways must meet CSA vertical clearances over highway rights of way.

REVISIONS

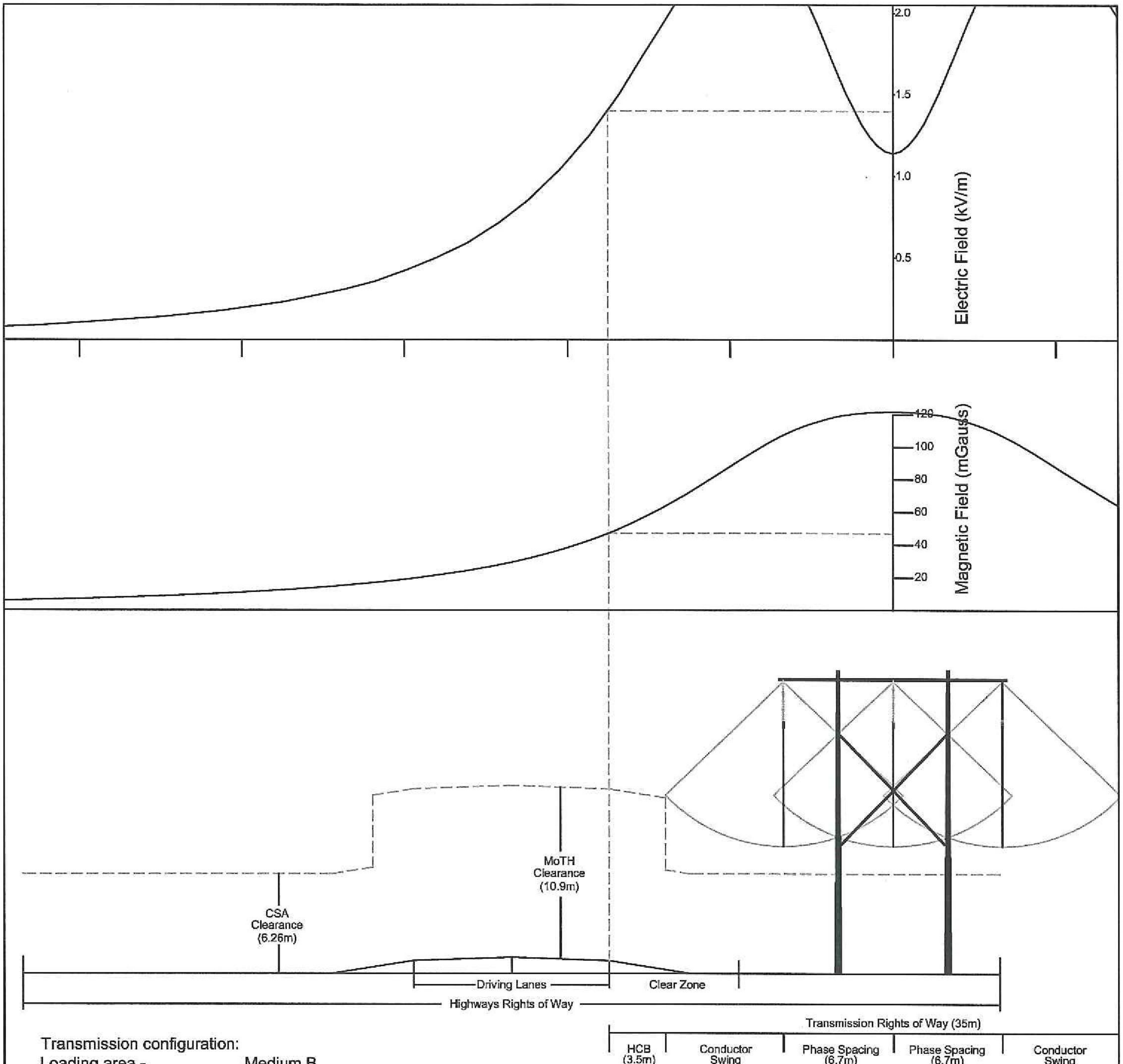
No.	BY	DATE	DESRIPTION	APP.
1	JMD	05/08/11	ADDED CLEARANCE DIMENSIONS	
0	JMD	05/07/12	NEW DRAWING	

Proposed Sharing of Rights of Way

(230 kV beside Highway)

Detmold Consulting Ltd.

DRAWING No.	REV.
Sketch 1A	1



Transmission configuration:
Loading area - Medium B
Ruling span - 195m
Ruling sag (max) - 7.24m
Horizontal clearance to buildings - 3.5m
Required transmission RW - 35m

Notes:
1) Powerlines crossing highways must meet highway vertical clearances over driving lanes under worst sag conditions.
2) Powerlines paralleling highways must meet highway vertical clearances over driving lanes under all conductor conditions.
3) Powerlines paralleling highways must provide CSA horizontal clearance to buildings (HCB) from swung conductors to edge of driving lanes.
4) Powerlines paralleling highways must meet CSA vertical clearances over highway rights of way.

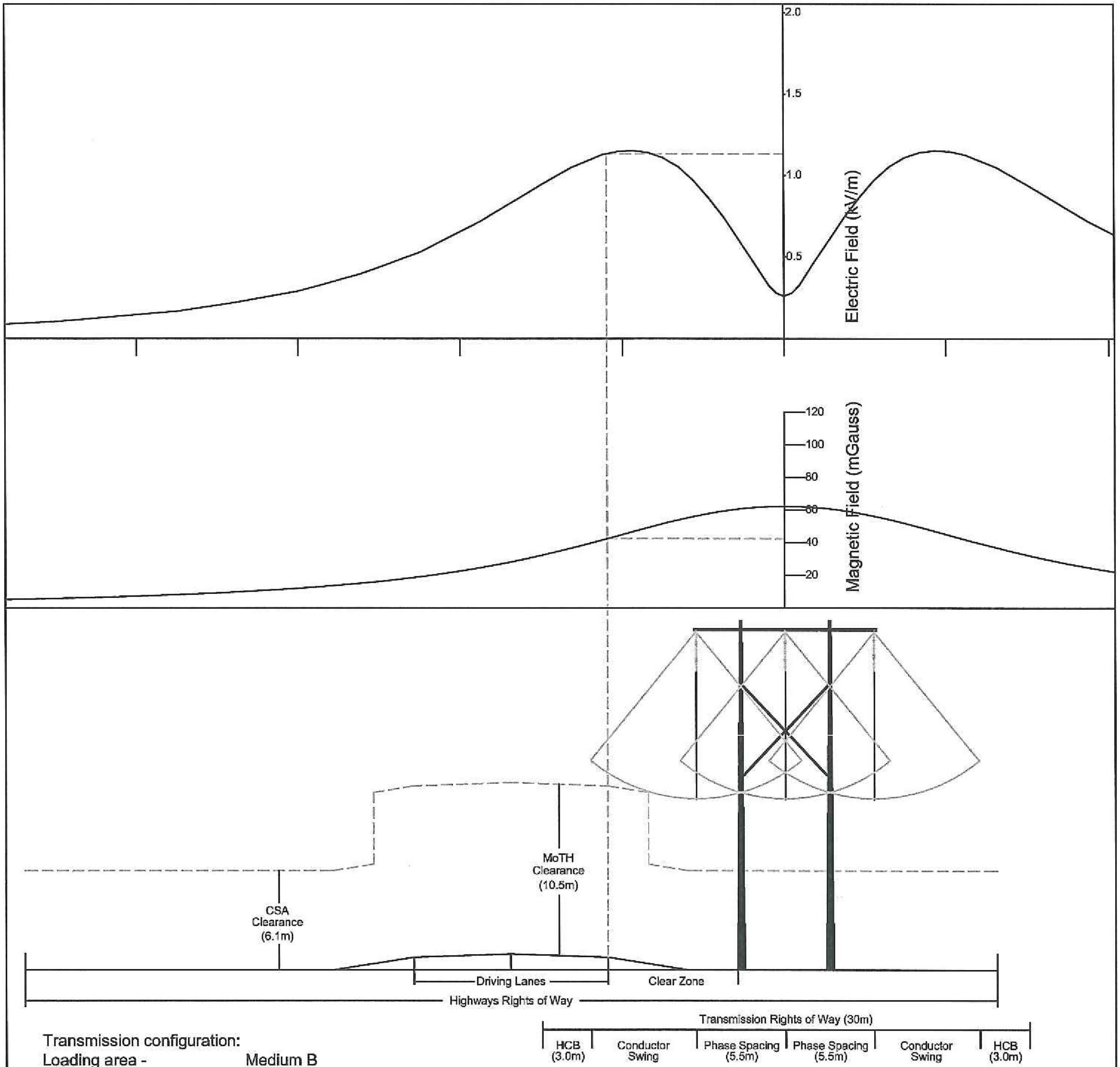
REVISIONS

No.	BY	DATE	DESRIPTION	APP.
1	JMD	05/08/11	ADDED CLEARANCE DIMENSIONS	
0	JMD	05/07/15	NEW DRAWING	

Proposed Sharing of Rights of Way
(287 kV beside Highway)

Detmold Consulting Ltd.

DRAWING No.	REV.
Sketch 1B	1



Transmission configuration:

Loading area -	Medium B
Ruling span -	203m
Ruling sag (max) -	7.8m
Horizontal clearance to buildings -	3.0m
Required transmission RW -	30m

Notes:

1) Powerlines crossing highways must meet highway vertical clearances over driving lanes under worst sag conditions.
2) Powerlines paralleling highways must meet highway vertical clearances over driving lanes under all conductor conditions.
3) Powerlines paralleling highways must provide CSA horizontal clearance to buildings (HCB) from swung conductors to edge of driving lanes.
4) Powerlines paralleling highways must meet CSA vertical clearances over highway rights of way.

REVISIONS

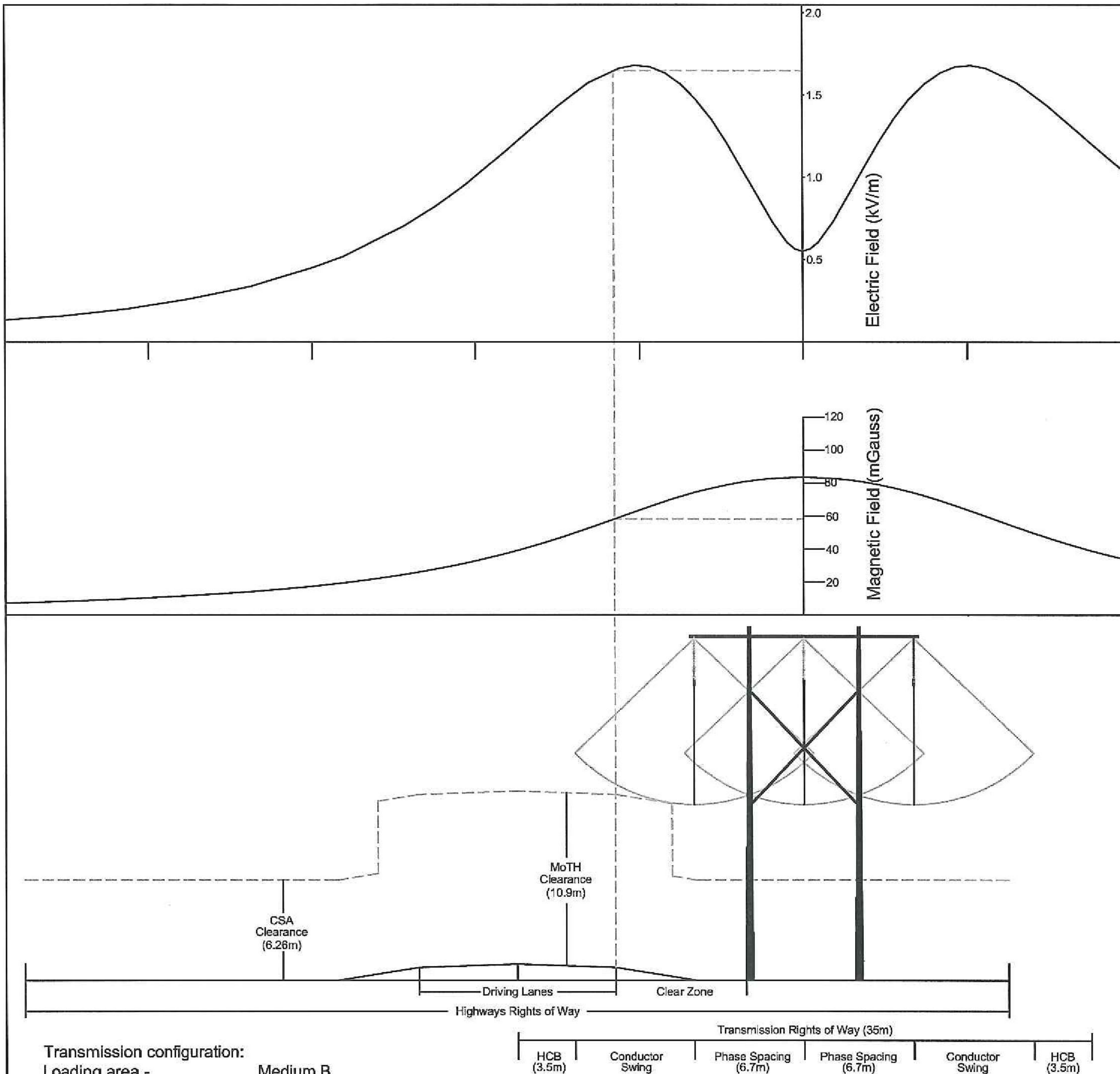
No.	BY	DATE	DESRIPTION	APP.
1	JMD	05/08/11	ADDED CLEARANCE DIMENSIONS	
0	JMD	05/07/15	NEW DRAWING	

Proposed Sharing of Rights of Way

(230 kV swung over Highway)

Detmold Consulting Ltd.

DRAWING No.	REV.
Sketch 2A	1



Transmission configuration:

Loading area -	Medium B
Ruling span -	195m
Ruling sag (max) -	7.24m
Horizontal clearance to buildings -	3.5m
Required transmission RW -	35m

Notes:

1) Powerlines crossing highways must meet highway vertical clearances over driving lanes under worst sag conditions.
2) Powerlines paralleling highways must meet highway vertical clearances over driving lanes under all conductor conditions.
3) Powerlines paralleling highways must provide CSA horizontal clearance to buildings (HCB) from swung conductors to edge of driving lanes.
4) Powerlines paralleling highways must meet CSA vertical clearances over highway rights of way.

REVISIONS

No.	BY	DATE	DESRIPTION	APP.
1	JMD	05/08/11	ADDED CLEARANCE DIMENSIONS	
0	JMD	05/07/15	NEW DRAWING	

Proposed Sharing of Rights of Way

(287 kV swung over Highway)

Detmold Consulting Ltd.

DRAWING No.	REV.
Sketch 2B	1