STANDARDS AND GUIDELINES

FOR COMMUNICATION SITES

Royal Canadian Mounted Police

COMMUNICATIONS SERVICES SECTION,
MOBILE COMMUNICATION SECTION
CIO SECTOR
June 2013
Version 1.1

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1.0 GENERAL REQUIREMENTS

1.1 General

1.1.1 This specification details the design, supply and installation of both self supporting and guyed communication towers, complete with antennas and transmission lines, for the use by the Royal Canadian Mounted Police (RCMP) at various locations throughout Canada. Depending on each site requirement, the contractor shall adhere to the appropriate aspect of each paragraph within this specification. (i.e.) self support or guyed tower.

1.1.2 The following list of acronyms and system definitions support this specification and shall be considered as supplemental information if not referred to in the text of this specification.

(a) CSLL	-	Communication Structure Load List
(b) CSS	-	Communication Structure Specification
(c) CLC	-	Canadian Labor Code
(d) RCMP	-	Royal Canadian Mounted Police
(e) Owner	-	RCMP Mobile Communication Services, Ottawa ON
(f) Technical Authority	-	As identified in contract
(g) Manager	-	RCMP Project Leader
(h) CSA S37-01	-	CSA Standard - Towers, Antennas and Antenna Supporting Structures
(i) Vendor or Contractor	-	Company submitting proposals or awarded contract
(j) CLC	-	Canadian Labor Code
(h) Communication Structure	-	includes tower, antenna's, piers, guy lines and anchors, hardware, transmission lines, and lighting kits

1.2 Instructions:

1.2.1 This specification must be read in conjunction with any subsequent amendments to form part of this contract.

1.2.2 The information contained in this specification and /or any related respondent or RCMP correspondence shall not be released to a third party, nor used in any form of advertising or promotion, without the express written permission of the RCMP.

1.2.3 Each Contractor shall examine and become familiar with the work, specifications and specification drawings of all other Contractors that may affect the Work of the Contractor.

1.2.4 The Contractor shall examine the work of all other contractors that may affect the Work of the Contract and shall immediately inform the Owner of any and all defects and

deficiencies in such other work. Failure to inform the Owner of such defects and deficiencies shall be deemed to be acceptance of the said work and constitute a waiver of all claims.

1.2.5 Project and site coordination meetings shall be held as required and if indicated in the SOW of the Project Specification or if specifically stated in the RFQ as an item of work. These meetings will be organized by the Owner who shall send out notices stating time and place to the Owner's Representative, Technical Authority, Contractors, Contractors and/or other persons whose presence is required. Attendance by the Contractor and his Sub-contractors is mandatory.

1.2.6 Minutes of meetings shall be taken by the Owner and will be submitted to all present at the meeting and to any other person, company, or organization as necessary.

1.2.7 Copies of the minutes shall be submitted on the understanding that if no objection to the contents of the said minutes are received by the Owner within two (2) working days of such submission then they will be deemed to be a true and accurate record of the meeting.

1.3 Safety Requirements

1.3.1 The successful contractor shall take adequate safety precautions throughout the period of his contract. He must include in his tender price the supply of all labor, materials, equipment and travelling expenses that would be necessary to fulfill this requirement and to be in conformance with all governing authorities as a minimum.

1.3.2 Observe and enforce the construction safety measures required of the various authorities having jurisdiction. Such authorities may include but are not limited to:

a) The Canada Labor Code,
b) The Provincial Workers Compensation Board,
c) Safety Code 6 - Health and Welfare Canada.
d) Occupational Health and Safety Act and Regulations for Construction Projects.
e) Manager's Safety Policy

1.3.3 In the event of conflict between any provisions of the above authorities, the Federal statutes will take precedent.

1.3.4 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials and regarding labeling and provision of material safety data sheets (MSDS) in accordance with jurisdictional authorities.

1.3.5 Deliver copies of Material Safety Data Sheets (MSDS) to the Owner on all products intended for use in the building and designated as a “controlled product.”

1.3.6 When any equipment or personnel are operating or working within 10 meters of an AM radiator tower or other high energy insulated structure a spotter is required to ensure safe operation of the equipment and individual.

1.3.7 Adhere to municipal, provincial and national codes when blasting is required. No blasting caps will be permitted on site while radio frequency levels exist.

1.3.8 In keeping with the policies of, the Owner and the Canada Labor Code, regular safety meetings will be held on site; minutes will be prepared and distributed to all concerned.

1.3.9 Each contractor shall be expected to become fully involved in the formation of the safety committee and be fully supportive of any workers under his control who may be appointed to the various safety committees.

1.4 Site Layout

1.4.1 The Contractor shall establish at the site, by means of iron bars or wooden stakes, the location of the structure center, anchors and waveguide bridges. The tower Contractor shall take care to ensure that new buried anchors are a minimum of 7 meters from existing RCMP property boundaries.

1.4.2 All layout of tower anchors, base, waveguide bridges, etc., shall be completed by a competent trained individual, such as a Professional Engineer or Licensed Land Surveyor, licensed in the Province or Territory where the tower is located.

1.4.3 Tower, anchor and waveguide bridge layout must be approved by RCMP or the authorized RCMP representative prior to construction. Contractors shall note and carefully abide by any and all grade references set by RCMP.

1.4.4 Contractor shall protect and preserve bench marks and reference points. Should any bench marks or reference points be disturbed or damaged while the Contractor is on site, the Contractor shall re-establish them at the Contractors cost, to the satisfaction of the Technical Authority.

1.4.5 Layout additional reference points, batter boards or offsets as required for the construction of anchors and foundations.

1.4.6 Establish guy anchor working points to suit the actual ground elevations.

1.4.7 New guys shall not interfere with any guys, antennas, or attachments on existing structures.

1.4.8 The new tower shall be located so as to optimize antenna placement as determined by the RCMP.

1.4.9 Tolerances

1.4.9.1 Elevations to underside of base plates +/- 12 mm as indicated on drawings on self supporting towers. All guyed tower base plates shall be level.

1.4.9.2 Location of guy working points +/- 2° off resultant line of action for the anchor shaft. Lateral location to be +/- 150 mm, out of theoretical guy-tower plane. Any deviation in

excess of these tolerances shall be clearly demonstrated by the Contractor not to diminish the structural capacity of the anchorage system. This shall be supported by structural calculations by the design engineer, which is subject to review by the Technical Authority.

1.4.9.3 Horizontal alignment of anchor bolts +/- 2mm.

1.4.9.4 Horizontal dimensions from center of tower to guy working points and anchors to be +/- 150 mm, except when fixed terminations require more accurate location of guy working points. In this case the tolerance shall suit the Contractors requirements for accurate measurement of guy cutting lengths.

1.4.9.5 Concrete dimensions to be not less than the dimensions specified on drawings.

1.5 Detail Drawings

1.5.1 Upon award of the Contract, the Contractor shall submit sealed drawings, which include:

a. Structural profile drawing showing the sizes of legs, web members and bolts. The elevations at which the member sizes changes shall be clearly shown. Also included in these drawings shall be elevations of antennas, ice shields, lights and other attachments. Antenna orientation, size, type and center of radiation shall be clearly indicated. The drawing shall include all pertinent design information including design standard, ice loading, wind loading, steel grades, bearing pressure, soil conditions, elevation difference from base and any special design factors.
b. A large scale plan of the tower clearly showing the position and size of all transmission lines, and lighting lines in relation to the leg and web members and antennas.
c. Detailed foundation designs. Pre tension values for all rock bolts must be clearly shown on the drawings.
d. Detailed drawings showing the following:
    a. Details of tower sections (face width and panel height);
    b. Details of each different leg and web member and their connections;
    c. Details of parts referenced in the design or Bill Of Materials (BOM);
    d. Details of lighting and ground fault interrupters;
    e. Details of all torque triangle members and their connections;
    f. Description of materials, i.e., grades of steel, bolts, etc.
    g. Approved anchorage points for fall protection.
e. Details of all antenna mounts and connections. These shall include plan view drawings showing the position of each antenna in relation to tower legs, pinwheel mounts and web members. These details shall be to scale and accurately reflect position of the antenna relative to the tower face and mounts.
f. Details of supports for all transmission lines and conduit, present and future, including material details.
g. Details of any special members.
h. Details of the climbing ladder, safety rail, anti-climb and trolley.
i. Tower profile showing antennas and mounts, etc.
j. Details of the tower base foundation, showing all dimensions and steel reinforcement or rock anchor details. Drawings shall show concrete strength. Where rock bolts are

used, installation and testing procedures shall be clearly indicated on the drawings. Generic copies of typical foundations are not adequate.

k. Detailed Bill of Materials showing quantities, part number, drawing reference number, weight, mark number, etc.
l. Plan view and details of waveguide bridges including ice protection canopy.
m. Details of ice guards for antennas and lights.
n. Design details related to wind and ice loading, design standard, etc.
o. Details with regard to any special design assumptions.
p. The Contractor shall submit design calculations to the Technical Authority in a format that can be verified with initial drawings for approval.
q. Drawings must specifically indicate that all tower members and/or attachments (i.e. mounts, diagonals, horizontals or lifelines) meet the 22.0 KN anchor point capacity required by the Canada Labour Code. Any exceptions to this must be clearly indicated on the design drawings.
r. Any other drawings or diagrams required in order to make clear the work intended or show its relation to adjacent work of others.

1.5.2.2 Submit for review three complete, sealed sets of design and detail drawings to the Technical Authority. After successful review, one print of each submitted drawing will be returned to the Contractor either "Reviewed" or "Reviewed as Noted". Thereafter no change shall be made on any drawing without the permission of the Engineer. All drawings submitted to the Technical Authority shall be sealed by the Professional Engineer accepting responsibility for the design. The name of the design engineer must be indicated on the drawings.

1.5.2.3 The Contractor, at no additional cost to the Owner, shall make any changes in the drawings, which may be required, consistent with the Specification and shall submit revised copies for review in the manner herein set out. The review does not relieve the Contractor from responsibility for ensuring that his complete work meets all the requirements of the drawings and Specifications contained herein. The Contractor shall ensure that the tower design, including guy location, does not interfere with the operation of the antenna systems.

1.5.2.4 Any work done prior to the return of the reviewed drawings shall be at the Contractor's own risk. The Owner or his representative may issue a stop work order if any site work is started prior to the Owners review of engineering drawings. All costs associated with this shall be the Contractor’s responsibility.

1.5.2.5 The Contractor shall verify all field measurements and proximity to existing structures and topographic features. Any discrepancies shall be reported to the Technical Authority immediately.

1.5.2.6 The Contractor shall provide a digital photo journal of the foundation construction when the Technical Authority is not onsite. The photos shall depict the foundation excavation, rebar placement in all pads and piers, and at various stages of concrete placement up to the completion of the footings.

1.5.3 <u>Drawings</u>

1.5.3.1 All drawings shall be 280 mm x 430 mm and include a graphic scale bar. Larger sizes will be permitted only if the Technical Authority gives prior written approval. The Contractor shall make every effort to provide consistent sized drawings, which optimize the amount of information shown. The Contractor shall provide a Table of Contents listing all drawing titles with a sequential numbering system. All drawings shall be bound in sets.

1.5.3.2 The contractor's individual drawing files will have a number format established by the Manager. The drawing package will have notepad or similar text file that is an index to the drawings. The file names may have the following form: • xxxx_yyyy_drw no. where xxxx is the location code, yyyy is the "Project No." and drw no is the contractors' drawing number. The total length of the file name may be limited to 15 characters.

1.5.3.3 All drawings shall have a title block that clearly shows the Project Name and Location, Owners Name (RCMP), design engineer (Name), Technical Authority, date, revision number, and a description of the drawing content. All drawings must be approved and stamped by a Professional Engineer licensed to practice in the province where the tower is located, prior to submission to the Technical Authority. Unsealed drawings will not be reviewed.

1.5.3.4 Where drawings have to be modified to reflect actual soils or rock conditions, the engineer of record shall submit sealed design drawings to the Technical Authority for review prior to the start of installation. The Technical Authority will review the design drawings and advise the Contractor to proceed within (7) working days of receiving the drawings and necessary design details.

1.5.3.5 Upon completion of all work, and prior to release of contract holdback, the Contractor shall issue three full sets of drawings for each site that reflect any and all changes from the original contract drawings. The Contractor will complete the AS BUILT DRAWINGS in (14) working days after completion of the Acceptance inspection by the Technical Authority. These drawings shall be stamped AS BUILT DRAWINGS and shall be sealed by the "Engineer of Record" in accordance with the requirements of this specification.

1.5.3.6 As built drawings shall show actual antenna azimuths, antenna heights, antenna type, antenna mounting arrangement, revised anchor radius and drop based on field installation, leg azimuth, waveguide bridge, position of tower relative to building, compound fence, building and fence grounding, ground resistance readings, foundation's (Tower base & anchors) with geotechnical design parameters and water table depths, pre tension values for rock bolts, etc.

1.5.3.7 An amount will be withheld from the Contract until all AS BUILT DRAWINGS have been received and reviewed.

1.5.4 Notice Of Completion

1.5.4.1 Upon completion of work, the Contractor shall submit to the Owner and Technical Authority written notification that the tower construction is complete and ready for an acceptance inspection. The Technical Authority shall complete the acceptance inspection while the Contractor is onsite. If there are any deficiencies the Technical Authority shall provide the Contractor with a preliminary list on site.

1.5.4.2 The Contractor shall within three (3) weeks of receiving the "Official Acceptance inspection Report" from the Technical Authority, correct all items to the satisfaction of the Owner. If this time has elapsed and no corrective measures taken, the Owner may hire a Sub-Contractor to complete the work on behalf of the Contractor and deduct any monies from the amount of the contract owed to the Contractor. If a major deficiency is identified in the Acceptance inspection Report, the Owner may suggest that a second visit to the site is necessary by the Technical Authority. This visit shall be at the expense of the Contractor.

1.6 Quality Control

1.6.1 Shop Inspection

1.6.1.1 Materials and workmanship will be subject to inspection at any time by a qualified inspection firm appointed by the Owner. Make drawings, specifications and mill test reports available to the inspector to facilitate this work.

1.6.1.2 Co-operate in permitting access to all places where work is being done or stocked prior to shipment.

1.6.1.3 Inspection shall not relieve the Contractor of his responsibility but is a precaution against oversight or error. Defective material and workmanship wherever found at any time prior to final acceptance of the work will be rejected regardless of previous inspection.

1.6.1.4 When appropriate, as part of a general shop inspection, be prepared to shop assemble the tapered base section of the mast and any platforms or outriggers with accompanying mast sections.

1.6.2 Foundation Inspection

1.6.2.1 The foundation placement is subject to inspection during the following stages:
- testing of rock bolts;
- placement of concrete for gravity anchors and the tower base.
- Digital photos of the form and per pour shall be forwarded to the Technical Authority.

1.6.2.2 The Contractor shall advise the Technical Authority of these activities a minimum of (5) business days in advance of their planned occurrence. Every effort shall be made to complete these activities within two full concurrent days on site. The Contractor shall

immediately notify the Technical Authority of any change in scheduling for rock bolt testing or placement of concrete.

1.6.2.3 The Contactor shall arrange for an independent testing firm to obtain and test concrete cylinders for compressive strength of concrete used on the site. Results will be forwarded to both the Owner and the Technical Authority. All costs associated with testing shall be the responsibility of the Contractor.

1.6.2.4 No concrete shall be poured prior to the Technical Authority's review of pre pour conditions. At the discretion of the Technical Authority, concrete poured prior to a pre pour inspection shall be removed and replaced at the Contractors expense.

1.6.2.5 All excavations shall be completed prior to the Technical Authority's arrival on site.

1.6.2.6 All concrete placement for guyed tower anchors must utilize an undisturbed earth face. If this is not possible, adequate soil placement and mechanical tamping must be utilized to produce a 98% Proctor reading. If after testing this reading is not reached, the Contractor shall replace all fill and compact to required values.

1.6.3 Grounding Inspection

1.6.3.1 All buried copper ground connections and runs shall be inspected before backfilling of the trenches. All costs to excavate grounding systems not inspected by the Owner or Technical Authority shall be the responsibility of the Contractor.

1.6.3.2 All connections shall be completed prior to the Technical Authority / Owners arrival on site using suitable manufacturer recommended techniques and tools.

1.6.3.3 All ground connections that do not meet acceptable standards shall be replaced at the Contractors cost.

1.6.3.4 The Contractor shall advise the Technical Authority of these activities a minimum of (5) business days in advance of their planned occurrence.

1.6.4 Acceptance Inspection

1.6.4.1 An Acceptance Inspection is to be carried out by the Technical Authority on behalf of the Owner. The Contractor must ensure that the installations are ready for inspection, prior to notifying the Technical Authority.

1.6.4.2 The Contractor shall provide adequate manpower, tools and equipment to complete any adjustments or remedial work requested by the Technical Authority during the Acceptance Inspection. Contractor costs for this shall be incorporated into the submitted Tender price.

1.6.4.3 The Contractor shall provide a written request to have the Technical Authority complete an Acceptance Inspection. This request shall be forwarded to the Technical Authority not less than five (5) business days in advance of the planned inspection.

1.6.4.4 All costs incurred by the Contractor during the Acceptance Inspection shall be at the Contractor's expense.

1.6.4.5 All work must be completed in accordance with contract specifications and instructions, prior to the Acceptance Inspection.

1.6.4.6 The Contractor will be responsible for the costs of all repeat Acceptance Inspections necessitated by work, which is considered by the Technical Authority to be incomplete or unsatisfactory. These costs shall include all associated Technical Authority and Owner costs, including fees, transportation, accommodations, meals, etc. These costs shall be deducted from the total amount of the Contract.

1.6.5 Post Erection Inspection

1.6.5.1 Not less than six (6) months and not more than one (1) year after acceptance of the tower by the Owner, the Technical Authority shall inspect the tower and the Contractor shall be onsite to carry out any adjustments necessary to restore it to the condition stipulated, and to remove any twist or bending of the mast which may have developed.

1.6.5.2 All costs incurred by the Contractor during the Post Erection inspection will be the responsibility of the Contractor and shall have been included in the Tender breakdown.

1.6.5.3 The Contractor shall give the Owner and Technical Authority notice in writing at least ten (10) business days in advance of the Post Erection inspection in order to facilitate scheduling of the inspector's visit.

1.6.5.4 After any straightening measures are carried out on the tower, the Contractor shall, under the direction of the Owner, re-orient antennas.

1.6.5.5 The Contractor shall provide a minimum or two qualified riggers with adequate tools and equipment to complete any adjustments or remedial work requested by the Technical Authority during the Post Erection Inspection.

1.7 Temporary Facilities

1.7.1 Access

1.7.1.1 The Contractor shall maintain access to the tower site during the construction period, regardless of the time of year. Snow removal shall be the responsibility of the Contractor.

1.7.1.2 The Contractor shall, at his sole expense, build and maintain temporary roads where required.

1.7.1.3 If authorized to use existing roads for access to the project site, maintain such roads for the duration of the Contract and make good on damage resulting from Contractor's use of roads. All damage, as a result of the Contractor’s activities, to the existing roadways or existing RCMP or adjacent property shall be returned to its original condition at the Contractors cost.

1.7.1.4 If indicated in the SOW of the Project Specification temporary power (110V single phase15AMP) will be supplied and paid for by the Owner to within 100 feet of the work place. Distribution in the form of extension cords, sub-panels, feeders, etc. will be the responsibility of the Contractor. All others connections for additional power requirements are the responsibilities of the contractor.

1.7.1.5 The Contractor shall provide and maintain power as required for the construction and temporary obstruction lighting (ref. CARs).

1.7.1.6 Connect to power supply in accordance with Canadian Electrical Code once the Owner provides the temporary power.

1.7.1.7 Temporary lighting to meet the Occupational Health and Safety Act requirements will be provided and paid for by the Owner. Task lighting will be the responsibility of the Contractor.

1.7.1.8 The Contractor shall provide and maintain temporary obstruction lighting on the communication structure as required by CARs.

1.7.1.9 Temporary water will be supplied and paid for by the Contractor. Distribution in the form of hoses, etc. will be the responsibility of the Contractor.

1.7.1.10 Temporary offices (including telephones, fax, etc.), sanitary facilities, fire protection, heating, cooling and ventilation will be the responsibility of the Contractor, in a location appointed by the Manager.

1.7.1.11 The Contractor shall provide and maintain in a safe condition and remove upon completion all necessary temporary works, supports, guy wiring, bracing and other means required, including making good all disturbed work to match existing and adjacent work. Submit drawings and details of such temporary works, supports, etc., duly prepared and stamped by a Professional Engineer Licensed to practice in the Province or Territory where the work is located and experienced in this type of work.

1.7.1.12 The Contractor shall provide and maintain in a safe condition all necessary temporary shoring and protection required to transfer loads and to protect new and existing structures where, either, supporting structures have been removed, or where, material and equipment is being moved. Submit drawings and details of such temporary and protection, duly prepared and stamped by a Professional Engineer licensed to practice in the Province or Territory where the work is located and experienced in this type of work. Such temporary shoring and supports are to remain in place until completion of this Contract or until directed by the Manager, whichever is sooner.

1.7.1.13 The Contractor shall provide all necessary and required temporary structures complete with platforms, safety devices and safety barriers, and provide all necessary and required temporary fall arrest systems, and weather tight and/or protective covers. All such safety devices, barriers, fall arrest systems, etc. must comply with the Canada Labor Code and /or Occupational Health and Safety Acts. These safety systems, safety devices, barriers, fall arrest systems, etc. must be maintained in safe condition at all times. Canada Labor

Code and /or Occupational Health and Safety Acts shall be adhered to with regard to construction safety at all times.

1.7.1.14 The Contractor shall be responsible for:

- receiving, off-loading and storing materials, equipment or other components where directed by the Manager;
- movement and hoisting of materials, equipment or other components around the site;
- provision of all hoisting equipment, flagmen and signal men properly trained to direct hoisting operations, complete with all necessary communication devices;
- provision of all slings, rigging, etc.
- implementation of all necessary and required dust control, noise abatement and safety policies and procedures
- provision of all necessary and required dust screens.

1.7.1.15 The Contractor shall protect the work of other Contractors from any damage resulting from work of this Contract. Any damage resulting from failure to comply with this requirement is the complete responsibility of this contractor.

1.7.2 Sanitary Facilities

1.7.2.1 Provide sanitary facilities for work force in accordance with regulations and ordinances.

1.7.2.2 Post notices and takes such precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.7.3 Power

1.7.3.1 Power supply may not be available during construction. The Contractor shall provide and maintain power as required for the construction and temporary lighting until the tower is officially accepted by the Owner. Official acceptance shall be defined as the point in time where all deficiencies have been completed, the Acceptance Inspection has been completed and the tower is ready for use by RCMP. The Contractor is obligated to inform the RCMP in writing 48 hours prior to leaving the premises. If permanent power is not available at this time, the Owner may lease temporary power from the Contractor until commercial power is available.

1.7.3.2 The Contractor shall provide and maintain all temporary power for the obstruction light system.

1.7.3.3 The Contractor shall connect tower lighting to power supply in accordance with Canadian Electrical Code.

1.7.4 Drainage

1.7.4.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.

1.7.4.2 The Contractor shall not pump water containing suspended materials into waterways, sewer or drainage systems.

1.7.4.3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.7.5 Project Signs

1.7.5.1 No Contractor signage will be permitted on the project without the written permission of the RCMP.

1.7.5.2 Required safety signage to warn of work overhead shall be clearly displayed at all times.

1.8 Clean Up And Disposal

1.8.1 Clean Up

1.8.1.1 Upon completion of the work, or sooner if ordered by the Owner, remove all temporary structures and clear away all rubbish, surplus and waste material remaining on or about the site, and attributable to this Contract, and place the site in a neat and tidy condition.

1.8.1.2 The clean up area shall include areas used for temporary site access or used on a temporary basis to facilitate the work.

1.8.1.3 The Contractor shall clean up all garbage on a daily basis and dispose of it in accordance with local and federal regulations.

1.8.1.4 Under no circumstances will burning of construction refuse be allowed on the Owner's site. Remove all waste material from the site to an approved dumping area as designated by the local authority.

1.8.1.5 If the Contractor fails to clean up the site and restore to an acceptable condition, the Owner shall initiate completion of the work and deduct all associated costs for the work from monies due to the Contractor.

End of Section

2.0 SITEWORK

2.1 Clearing and Grubing

2.1.1 General

2.1.1.1 This section covers the clearing of areas on the site of standing timber or brush or both as indicated on the drawings and/or designated in the Specification. This section also includes the removal or disposal of all resulting debris.

2.1.1.2 The Contractor shall investigate the need for and obtain, as required, all the necessary permits from the local authority prior to modification of any flora or fauna on the site.

2.1.1.3 If required by the Owner, the Contractor shall trim merchantable portions of trees of limbs and tops, and cut such portions into merchantable lengths. These merchantable lengths shall be piled neatly along the limit of the access road or along the limit of the clearing, separate from the debris. Merchantable Timber shall remain the property of the Owner and shall be disposed of only on written authorization from the Owner.

2.1.1.4 The Contractor shall obtain the necessary burning permits prior to burning of any cleared material or debris on the site.

2.1.2 Clearing

2.1.2.1 The Contractor shall cut off trees, brush, and scrub at a height of not more than 4 inches above the ground within the areas designated to be cleared.

2.1.2.2 Remove the trees, brush, scrub and any other debris within the areas to be cleared to a location designated on the site by the Owner in preparation for burning.

2.1.2.3 Burn under constant care of a competent watchman and in accordance with the authority having jurisdiction. While burning debris, do so in such a manner that surrounding vegetation, adjacent property or the site features will not be jeopardized.

2.1.2.4 Bury all material and debris that will not burn in accordance with the authority having jurisdiction. Buried material shall be consolidated and covered with at least 18 inches of granular. Landscape any excavations to create a neat appearance.

2.1.2.5 If the Contractor is prevented from disposing of debris resulting from clearing operations by reason of regulations or restrictions imposed by the Authority having jurisdiction, then disposal of such debris shall be to the approval of the Owner.

2.1.3 Grubbing

2.1.3.1 Grubbing shall be defined as the removal of all stumps, matted roots, rough filling or the resulting holes, and satisfactory disposal of all debris.

2.1.3.2 The area to be grubbed shall be shown on the drawings or as required by the Owner.

2.1.3.3 All stumps, roots, rotten wood, and debris within the areas to be grubbed shall be burned or otherwise disposed of in accordance with the above.

2.2 Excavating and Backfill

2.2.1 Definitions

2.2.1.1 The Owner shall only recognize two classes of excavation: - rock excavation and common excavation.

2.2.1.2 Rock Excavation is defined as excavation of materials from solid masses of igneous, sedimentary or metamorphic rock that, prior to its removal, was integral with its partner mass, and boulders or rock fragments having individual volume in excess of 1 cubic meter.

2.2.1.3 Common excavation is defined as excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense tills, hardpan, frozen materials and partially cemented materials that can be ripped and excavated with heavy equipment.

2.2.2 Requirements of Regulatory Agencies

2.2.2.1 The Contractor shall adhere to Municipal, Provincial and Federal codes where blasting is required.

2.2.2.2 The Contractor shall adhere to Municipal, Provincial and Federal requirements relating to the safety of excavations and protection of workmen.

2.2.3 Measurement

2.2.3.1 The Contractor shall be responsible for all computations regarding the amount and nature of all excavations required.

2.2.4 Materials

2.2.4.1 Backfill Material:

2.2.4.1.1 Granular Backfill: Pit run natural or blended sand or gravel consisting of clean hard durable particles free from clay lumps, cementation or organic material, having less than 10% by mass passing a No. 0.075 mm sieve, capable of being compacted to the degree specified herein and meeting the approval of the Technical Authority.

2.2.4.1.2 Common Backfill: Selected materials from excavations, suitable to the Technical Authority for the use intended, free from frozen materials, cinders, ashes, sods, organic materials, refuse and other deleterious substances.

2.2.5 Shoring and Bracing

2.2.5.1 Provide and set all shoring, bracing, etc. necessary to prevent the caving in of excavation sides. Shoring shall be placed so as to be independent of all foundations and shall remain in place until forms have been removed and approval given to proceed with backfilling.

2.2.6 Pumping and Drainage

2.2.6.1 Provide all pumping and drainage required to control ground and surface water during excavation and construction of sub grade work at no extra cost to the Client.

2.2.7 Excavation

2.2.7.1 Strip topsoil from within limits of excavation and stockpile as directed for spreading after backfilling.

2.2.7.2 Excavate to at least the depth shown on the drawings and to a width sufficient to perform the work properly and in Accordance with all regulations.

2.2.7.3 Bottoms of all excavations shall be level and cleaned of all loose material and debris before concrete is poured. All foundations shall rest on undisturbed earth or rock. The front face of all anchors not anchored to rock shall bear against undisturbed soil.

2.2.7.4 Should the bearing capacity at the levels indicated be found inadequate by a Technical Authority, the Technical Authority may order the excavation to be carried down to a proper bearing. Such work shall be classified as additional work and associated costs shall be reflected in the form of a change order initiated by the Technical Authority.

2.2.7.5 When excavations are carried down to a greater depth than shown on the drawings without the Technical Authority's written approval, the foundations shall be carried down to the excavated depth at the Contractor's expense. The method of deepening the foundation must be approved by the Technical Authority.

2.2.7.6 Do not excavate closer than 1.2 m to the nearest edge of any proposed or existing building face. Shore the excavation if necessary.

2.2.8 Rock Excavation

2.2.8.1 All rock excavations shall conform to alignments, profiles, and cross sections shown on the drawings. Carefully scale down all slopes and remove all rock, boulders and fragments, either on or outside the excavated area, liable to roll or slide down the side slopes of cut sections.

2.2.8.2 Excavated rock shall be disposed of on the site as directed by the Technical Authority.

2.2.9 Blasting

2.2.9.1 Blasting operations shall be undertaken only with the explicit written permission of the Owner.

2.2.9.2 The supply, transportation, storage and use of all explosives and accessory equipment used for blasting shall be in accordance with regulations of the authority having jurisdiction. The Contractor shall be responsible for all necessary precautions and cost to prevent damage to surroundings, including responsibility for arrangements, and all costs involved in temporary removal and replacement of utilities.

2.2.10 Backfilling

2.2.10.1 Do not proceed with backfilling operations until the Technical Authority has inspected and approved work in place. Give 48 hours notice to the Technical Authority so that he might schedule his site visit.

2.2.10.2 Backfill spaces excavated and not occupied by parts of substructure or other permanent works with specified material placed up to the surface or surrounding ground.

2.2.10.3 Place backfill material in uniform layers not exceeding 200 mm loose thickness and simultaneously on sides of structure so that loading is equalized.

2.2.10.4 Compact each layer to following percentages of corrected maximum dry density in accordance with ASTM D698-00.

(a) Common Backfill 95%
(b) Granular Backfill 98%

2.2.10.5 Place backfill so as to prevent the accumulation of water around foundations or anchors.

2.2.11 Restoration

2.2.11.1 Upon completion of work dispose of any remaining soils neatly on the site by berming the anchors and the tower base and "feathering-out" excess material.

2.2.11.2 Replace topsoil over excavated areas.

2.2.11.3 Restore areas affected by equipment outside the area of work to the condition that existed prior to commencement of work.

2.2.11.4 Remove surplus material and debris from the site to an area authorized for such disposition by those authorities having jurisdiction.

2.3 Access Roads and Parking Areas

2.3.1 General

2.3.1.1 This section gives the requirements for construction of graded and surfaced access roads to be provided at communication tower sites and includes the grading of tower sites and preparation of parking areas where such are required.

2.3.1.2 The Contractor shall furnish all labor, equipment, tools, materials and transportation necessary to complete the construction of the access road or roads in accordance with the pertinent alignment, profile and cross-section drawings, and the requirements of this Specification.

2.3.1.3 The work may include the clearing, grubbing and grading of tower sites and construction of parking areas where such work is required as indicated in the SOW or as required by the Owner.

2.3.1.4 The Contractor shall procure all permits and licenses, pay all fees and royalties, and make all necessary arrangements with Utility Companies and Authorities Having Jurisdiction for work covered by this Specification.

2.3.1.5 The Contractor shall do all clearing and grubbing in accordance with the requirements of this Specification.

2.3.1.6 The Contractor shall do all common and/or rock excavation, and all hauling, placing and compacting of fill required for embankment, when required, in accordance with this Specification.

2.3.1.7 The Contractor shall supply, haul, place, compact and grade all surface course materials as required by this Specification.

2.3.1.8 The Contractor will supply and install all culvert pipes and drainage structures as indicated on the drawings and as required by this Specification.

2.3.1.9 The Contractor shall supply and install all guard rails, where indicated on the drawings and as required by this Specification.

2.3.1.10 Foundation investigations, soils tests and preliminary surveys, sufficient and deemed required for the work will be the responsibility of the Owner.

2.3.2 Stripping and Disposal of Topsoil

2.3.2.1 Topsoil is defined as that part of the natural ground that contains organic matter.

2.3.2.2 The material so stripped shall be disposed of as fill in depressed areas outside the limits of construction, or in stock piles if required for use in other parts of the work.

2.3.3 Excavation

2.3.3.1 The Contractor shall do all the excavation, hauling, placing and compacting of the excavated material required in the construction of the roadway. This shall include excavation for all intersections, ditches, drainage relocations, and structures required under this Specification.

2.3.3.2 All material excavated shall be classified as "Common Excavation" or "Rock Excavation", as defined in this specification.

2.3.3.3 The Contractor shall not excavate outside the slopes or below the elevations required by the drawings or this Specification unless the Owner has first approved such excavation.

2.3.3.4 With the Owner's approval, cuts may be excavated to a greater width than specified here if such a method of obtaining fill is considered desirable.

2.3.3.5 Where unstable or material otherwise unsuitable for roadbed construction is encountered in cut sections, it shall be removed below design grade at the Owner's direction and replaced with satisfactory material. Wherever the Contractor excavates below the design grade he shall construct such fills in accordance with this specification.

2.3.4 Excavation in Borrow Pits

2.3.4.1 When sufficient quantities of material suitable for roadway embankment are not obtainable from various excavations required for the construction of the roadway, the Contractor shall provide suitable borrow pits.

2.3.4.2 The Contractor, before entering for operational purposes onto any borrow pit site, or access road shall file with the Owner satisfactory documentary proof of his right of occupation. In addition, the Contractor shall covenant to save the Owner harmless from all claims whatsoever arising or that may arise from his operation of the borrow pit and the access road, if any.

2.3.4.3 Where sources of excavation are on private property and permanently obscured from the roadway, debris from the clearing and grubbing, discarded waste, and all other debris shall be disposed of, and the excavated area left in a condition satisfactory to the property owner. Where excavation sources on private lands are visible from the roadway, disposal of debris and waste shall be the joint approval of the property owner and the Owner.

2.3.4.4 The Contractor shall thoroughly sample the borrow pit for suitability of materials either by pits or by boring. All or any portion of the borrow shall be rejected if tests show that the materials are not suited to their particular use.

2.3.4.5 Before any material is excavated from any borrow pit, the area shall be cleared and grubbed, and materials disposed of as required in the Specification.

2.3.4.6 All stone, broken rock, boulders and other materials that do not meet the requirements of this Specification for use in fill shall be disposed of by the Contractor in a manner satisfactory to the Owner.

2.3.5 Rock Excavation

2.3.5.1 Rock excavation shall be in accordance with this Specification and as noted herein.

2.3.5.2 All rock excavated from roadway cuts shall be placed in roadway embankments. All rock excavated for drains, ditches, culverts and channel changes shall, if required and feasible be placed in roadway embankments. Blasting to obtain fill will not be permitted.

2.3.5.3 Where rock is encountered in roadway cuts, it shall be shattered uniformly so as to eliminate water pockets. Rock excavation shall be carried out so as to drain the excavated

bed rock surface to the side ditches and not leave water pockets in the foundation of the roadbed.

2.3.6 Blasting.

2.3.6.1 Blasting shall be in accordance with this Specification and as noted herein.

2.3.6.2 Prior to any blasting a Pre Blast Survey shall be completed by the contractor detailing adjacent structures and assessing risk of damage. Copies of such reports shall be submitted to the Owner.

2.3.6.3 The Contractor shall be responsible for all damages to pole lines and public utilities either above or below ground or to adjoining property caused by blasting or from any cause whatsoever resulting from any of his operations in connection with this work. Before any blasting is done, the Contractor shall arrange to have moved to a safe location, or otherwise protected, any utility lines that could be damaged by such blasting. He shall maintain such relocated or protected lines and after completion of the operations he shall return the utility to the original location or such other location deemed satisfactory to the utility company. The Contractor shall bear the costs of any charges against The Owner for such protection or relocation.

2.3.7 Backfill - Granular or Common

2.3.7.1 Backfill materials are defined in this Specification.

2.3.7.2 Earth fill shall be constructed by depositing and spreading uniform layers of not more than 8 inches (loose measurement) in depth, for the full width of the embankment. Layers shall be kept level by use of road graders, bulldozers or other approved devices. In the case of side fill or sloping sections the low portion shall be constructed as above until the required cross-section is obtained. All boulders over 6 inches in diameter shall be removed.

2.3.7.3 Each layer shall be thoroughly compacted by the use of suitable equipment before the next layer is placed. Equipment used shall be such as will provide satisfactory compaction of the material being used in fills. If material being placed in fill is too dry for satisfactory compaction, water shall be uniformly added.

2.3.7.4 Compact earth fill in accordance with this Specification.

2.3.7.5 Any materials placed in earth fills which are soft or unstable due to excessive moisture content or for any other reason, shall be removed and replaced with suitable material. When unstable material such as muskeg is encountered within the limits of the roadway, the Contractor shall excavate and remove such material below the grade elevations shown on the drawings until stable foundation material is reached. Such areas shall then be backfilled with suitable material, and the excavated material disposed of, to the Owner's approval.

2.3.7.6 Any proposed method of constructing embankment in swamp or muskeg areas, other than excavation and backfill, as outlined in this specification must have the prior approval of the Owner.

2.3.8 Backfill - Rock Fill

2.3.8.1 Where embankments are constructed with boulders, rock or broken concrete fill, such materials shall be deposited by dumping over the end of the embankment. No dumping over the sides of fills will be permitted.

2.3.8.2 The fill material shall be well distributed as far as practicable, so as to fill the voids and form a solid embankment. The embankment shall be constructed to full width and to conform to profile grades and cross-sections as the work progresses. No rock placed in fills shall be greater in vertical dimension than one-third the depth of the section of the embankment in which such rock is being placed.

2.3.8.3 Top of rock fill shall be at least six inches below sub-grade elevation. The fill shall be completed with material that will enable final grading operations to bring the surface to proper cross-section.

2.3.9 Grading of Sub-grade Surface

2.3.9.1 Before the Contractor starts placing the surface course he shall make the sub-grade true to design Profile and Cross-section as shown on the drawings. The surface shall be free of ruts, and any compaction of the surface lost through use of the roadway by traffic, or compaction lost by other causes shall be corrected.

2.3.10 Surface Course

2.3.10.1 This work shall consist of supplying, hauling, placing, blending, grading and compacting surface course material to meet the requirements of this Specification.

2.3.10.2 The sub-grade, shoulders and ditches shall conform to the alignment and grades shown on the pertinent drawings or to the requirements of the Technical Authority, and compaction shall have been satisfactorily completed before placing of surface course material is started.

2.3.11 Material Requirements

2.3.11.1 Materials for surface course shall be selected or processed to conform to the requirements of this Specification. It is intended that coarse graded aggregate surface course material as herein specified shall be used for all access roads where sources of such material are reasonably available. In locations where such material cannot be obtained without excessive hauling or processing costs, consideration will be given to alternative methods of surface treatment. The Contractor shall submit a proposal for alternative methods of surface treatment at such locations for approval of the Technical Authority. The best accepted local practice shall be a guide for such proposals.

2.3.11.2 All surface course materials shall be approved for use by The Owner.

2.3.12 Coarse Graded Aggregate Surface Course

2.3.12.1 Coarse graded aggregate surface course material shall be processed or selected from

deposits of pit-run gravel, talus rock, mine waste, or other granular materials which may be approved by the Technical Authority. Materials such as shale will not be acceptable.

2.3.12.2 Sieve analysis of coarse graded aggregate surface course shall conform closely to the gradation shown in the following table:

Required Gradation for Granular Surface Course Material

Standard Sieve Size	Percent Passing by Weight
1 1/2" Sieve	100
No. 4 Sieve	25 - 40
No. 200 Sieve	0 -5

2.3.12.3 Acceptable pit-run material meeting this gradation requirement may be used, but crushing and screening will usually be required. Oversize material in deposits from which gravel is being produced shall be removed by screening or shall be crushed to the required size.

2.3.12.4 Materials from deposits of acceptable quality but deficient size may be supplemented from other sources to produce the required gradation.

2.3.12.5 The Contractor shall submit a representative sample of the surface course material to be used to the Technical Authority for approval. The sample shall contain not less than 22 kilograms. All costs of obtaining, packaging, and shipping samples shall be borne by the Contractor. Cost of laboratory examination required by the Technical Authority shall be borne by The Owner.

2.3.12.6 Only material approved by the Technical Authority may be used in the work. Any material of a quality or nature not suitable for its intended use shall be rejected.

2.3.12.7 Materials shall be considered unsuitable if particle shapes or other characteristics preclude satisfactory compaction or fail to provide a roadway suitable for traffic.

2.3.12.8 All surface course material shall be placed on the prepared subgrade and compacted in layers of the required widths, each to a thickness not greater than two inches, unless otherwise specified by the Technical Authority. After placing, the surface coarse shall be bladed smooth.

2.3.12.9 Immediately following grading of each layer, all material placed shall be compacted to full width by rolling with appropriate equipment. Rolling shall progress from sides to centre, parallel with the centre line of the road and shall continue until satisfactory compaction is obtained. Any irregularities or depressions that develop under rolling shall be corrected. Vibratory tamping devices shall be permitted when appropriate. Surface course material shall be sprinkled with water when required as an aid to compaction during rolling.

2.3.12.10 The number of layers shall be determined by the required thickness of the surface course as indicated on the drawings. Each layer shall be constructed as specified above.

2.3.12.11 After the required thickness has been obtained the surface shall be shaped and compacted by additional rolling and grading as required to produce the specified surface contour.

2.3.13 Culverts

2.3.13.1 All culvert pipe shall be corrugated galvanized sheet steel culvert pipe, and shall be the product of a reputable manufacturer, "ARMCO", or equal.

2.3.13.2 No culvert shall be less than 16 gauge sheet metal. Gauges of sheet metal for large diameters shall be in accordance with the manufacturer's recommendations.

2.3.13.3 The minimum diameter for any culvert pipe shall be eighteen inches.

2.3.13.4 Wherever possible culverts shall be installed after completion of embankment.

2.3.13.5 Excavation shall be done so as to permit thorough tamping of backfill under the haunches and around the pipe.

2.3.13.6 In excavation other than in solid rock, the width of the trench at the pipe bed shall be that of the outside diameter of the pipe to be laid, but in any case, not less than 24 inches. In rock excavations the width of the trench shall be 2 feet wider than the outside diameter of the pipe.

2.3.13.7 Where multiple pipes are laid, they shall be spaced not less than one diameter apart.

2.3.13.8 All culvert pipes shall be carefully laid in their prepared beds in the required lengths and diameters, and according to the required line and grade. Pipe shall be laid so that the rivets, if any, do not lie at the bottom of the trench.

2.3.13.9 Metal pipe sections shall be joined together with the couplings supplied by the manufacturer, and no fastenings will be omitted. The male end of sections shall always be laid downstream.

2.3.13.10 Where corrugated metal pipe is laid in diameters of 36 inches or over, under fills of 15 feet or more in height above the top surface of the pipe, the vertical diameter of the pipe shall be elongated about 5% by the use of timber struts. Struts shall be left in place until fills have been thoroughly consolidated.

2.3.13.11 All culvert pipe shall be installed with sufficient length to extend beyond the toe of the embankment. Culverts that do not permit the construction of embankments at the specified side slope will not be accepted.

2.3.13.12 Where necessary to protect the toe of the embankment against erosion culverts shall be provided with head walls. Grouted riprap, pressure treated timber, or concrete may be used.

2.3.13.13 Backfilling around and over the pipe, to a depth of one foot above the top of the pipe, shall be made with earth, free from sods, frozen lumps, stone or rock fragments. Backfill material shall be placed in layers not more than 6 inches deep, and shall be thoroughly compacted.

2.3.14 Ditches

2.3.14.1 Lateral access road ditches shall generally be constructed as shown in the Drawings of this Specification, where no special erosion problems exist.

2.3.14.2 Where possibilities of severe erosion exist, due to steep grades, heavy run-off, and interception of or interference with natural drainage, the Technical Authority will require additional erosion control measures. These shall include rip-rap paving of the invert of ditches, widening and deepening of ditches, construction of check dams, etc. Such construction shall be carried out as called for on the drawings, or as indicated on drawing details.

2.3.15 Guard Rails

2.3.15.1 Guard rails shall be supplied where indicated on the pertinent drawings. Material and construction shall be as shown in the drawings, when applicable.

2.3.16 Tower Site Parking Areas

2.3.16.1 Where shown on the drawings, or required by the Technical Authority, the Contractor shall carry out, as part of the work, all clearing, grubbing and grading of tower sites associated with the access roads.

2.3.16.2 Clearing and grubbing shall be performed in accordance with this Specification.

2.3.16.3 Installation of culvert pipes required for drainage at tower sites shall be as specified in this specification.

2.3.17 Access Road and Parking Area Configuration

2.3.17.1 Cleared width of right-of-way for access roads to communication structure sites shall not exceed 28 feet except where existing clearing has been performed by others. When greater widths are required for pole line or cable installations it shall be as shown on the drawings.

2.3.17.2 Width of traveling surface shall be 12 feet with shoulders 2 feet in width on each side. Total width between edges of embankment shall be 16 ft.

2.3.17.3 Generally grades shall be limited to a maximum of 12 per cent. Where conditions are such as to make this limiting gradient impractical, the proposed road profile shall require approval of the Technical Authority.

2.3.17.4 Maximum grade on horizontal curves shall not exceed 6 per cent where the degree of curvature exceeds 25 degrees.

2.4 Rock Anchors

2.4.1 Design

2.4.1.1 The minimum number of rock bolts to be installed at one anchor shall not be less than two.

2.4.1.2 The Williams Super High Tensile Rock Bolts (Solid) with expanding shield are not to be used in shear design unless the engineer of record can provide the Technical Authority with detailed computations and design data to collaborate the design.

2.4.2 Rock Bolts

2.4.2.1 Rock bolts shall be Williams High Tensile Rock Bolts with expanding shield or approved equivalent. The shield shall be designed to provide even bearing around the hole and to develop the full ultimate tensile strength of the bolt. Two nuts shall be supplied and installed to secure the anchor weldment. The second nut shall act as a locking nut and be of adequate quality for that purpose.

2.4.3 Grout

2.4.3.1 Grout shall be high early strength expanding type, with expansion of 3% to 4% prior to the gel stage. Grout shall have a minimum compressive strength of 27.5 MPa.

2.4.4 Holes

2.4.4.1 Drill holes to the diameter recommended by the rock bolt manufacturer for the bolt diameter to be used. Take care to ensure diameter is accurate and the hole is straight. Extend the hole 250 mm beyond the end of the rock bolt. Clean the hole before inserting the bolt.

2.4.4.2 The hole diameter must consider couplers or other bolt configurations such that there is adequate space to install grouting tubes.

2.4.4.3 Ensure that the holes are not reamed while drilling.

2.4.4.4 A log of rock types and any other relevant data that can be obtained by the drill rig should be completed by the Contractor while drilling holes and submitted to the Technical Authority for review.

2.4.5 Bolt Placement

2.4.5.1 Tap bolt into position taking care not to damage the threaded end.

2.4.5.2 Set expansion shield by torquing bolt to value recommended by the manufacturer with a manual or pneumatic torque wrench.

2.4.6 Testing

2.4.6.1 Pretension all bolts to 5% above the design load (Required Factored Uplift Load) for a period of not less than five (5) minutes, in accordance with the manufacturer's instructions.

2.4.6.2 Testing shall be carried out according to the manufacturer's instructions, and in the presence of the Technical Authority. The Contractor shall use a recently calibrated hydraulic jack, approved by Williams for tower anchorage and pretension usage. Proof of recent calibration by qualified personnel and a conversion chart shall be provided to the Technical Authority prior to the Technical Authority arriving onsite.

2.4.6.3 The Contractor shall accurately record torque and tension values for each bolt including the holding times. These values shall be submitted to the Technical Authority for review and shall be clearly indicated on AS BUILT drawings.

2.4.6.4 Any outward migration of the rock bolt during testing shall be noted and reported to the Technical Authority. The Contractor shall submit a remedial plan in consultation with the bolt manufacturer, approved by the Engineer of Record.

2.4.7 Grouting

2.4.7.1 Insert flexible grout tube to the bottom of the drill hole. Pump in grout (mixed in accordance with the manufacturer's instruction), slowly withdrawing the grout tube while maintaining pressure on the grout pump until grout is visible at the surface.

2.4.7.2 Grout must be pumped into the drill hole. Gravity placement is not permitted.

2.4.7.3 Grout shall not be installed until the rock bolt has been pretensioned in accordance with manufacturer's recommendations and the requirements of this specification.

2.4.8 Protection

2.4.8.1 Thoroughly protect the rock bolts above and below grade (300 mm) by hot dip galvanizing as per CSA S37. In addition, when the bolt is backfilled and below grade, apply a heavy bituminous compound such as Sternson Sehydratine or approved equivalent.

2.4.8.2 Follow manufacturer's written instructions with regard to curing and protection of grout prior to any backfilling of the anchor.

2.5 Compound Fencing

2.5.1 Products and Materials

2.5.1.1 Concrete mixes and materials: to this Specification - Cast-in-Place Concrete, All work shall be in accordance with CAN/CSA-A23.1.

2.5.1.2 Chain-link fence fabric shall be to CAN2-138.1-M80. Steel fabric shall be constructed of #9 gauge galvanized steel wire woven in a 50 mm (2") mesh. Tensile strength of individual pickets shall be 552 Mpa (80, 000 psi).

2.5.1.3 Tension wire shall be #6 gauge single strand wire electro galvanized with 600 grams (2.0 oz) of zinc per square meter.

2.5.1.4 Top salvage to have a twisted finish, bottom salvage to have a knuckled finish.

2.5.1.5 Barbed wire to consist of 3 strands, 4 point, 12.5 gauge, 150 mm spacing. Barbed wire to be supported on galvanized pressed steel or aluminum. Arm to accommodate 3 strands of barbed wire at a 45° outward overhang.

2.5.1.6 Posts, braces, top and mid rails to CAN2-138.2, standard continuous weld Schedule 80 galvanized steel pipe. End Posts, Corner Posts and Gate Posts are to be 89mm (3 1/2") OD.

2.5.1.7 Line Posts to be 60.3 mm (2 3/8") OD, Sch 40 galvanized steel pipe;

2.5.1.8 End, corner and gate posts to be 609mm (2') longer than height of fabric. No tubing conduit or open seam material will be permitted.

2.5.1.9 Top Rail and Mid rail (where required) to be 42.9mm (1 11/16") OD Sch40 galvanized steel pipe;

2.5.1.10 Tension bar: 5x20 mm min galvanized steel. Tension bar bands: 3x20 mm galvanized steel.

2.5.1.11 Tie wire fasteners: single strand, galvanized steel wire conforming to requirements of fence fabric No.9IWG.

2.5.1.12 Gate frames to ASTM A120-82, galvanized steel pipe, standard weight 3.4 kg/m2, 42.1 mm outside diameter pipe for interior bracing.

2.5.1.13 Fabricate gates as indicated with electrically welded joints, and hot-dip galvanized after welding. Fasten fence fabric to gate with twisted selvage at top. Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.

2.5.1.14 Furnish double 3.0m gates with drop bolt for closed position. All Fittings and hardware are to be hot dip galvanized steel. The Post caps are to provide a waterproof fit to fasten securely over posts and to carry top rail.

2.5.1.15 One 3.0m double gate shall incorporate a 1.0m man gate.

2.5.1.16 Zinc pigmented paint to CGSB 1-GP-178-Ma. . The average weight of the zinc coating shall be not less than 732 grams per square metre (2.4 oz per square foot) of uncoated surface area.

2.5.1.17 Grounding as per this specification.

2.5.1.18 The bottom tension wire shall be single strand, galvanized steel wire, 5mm diameter.

2.5.1.19 The wood used for guy anchor protection shall be pressure treated.

2.5.2 Fence Installation

2.5.1.20 See Appendix B.

2.5.1.21 Debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts. Provide clearance between bottom of fence and ground surface of 40 mm to 75 mm.

2.5.1.22 Erect fence along lines as indicated and in accordance with CAN/CGSB-138.3. .2

2.5.1.23 The depth of concrete footings shall be below frost line or a minimum 1370 mm (4'6") for line posts, and 1675 mm (5'6') for magnates. End and corner posts in normal soil and 1065 mm (3'6") for all posts in rock unless otherwise specified or approved by the Technical Authority in writing.

2.5.1.24 Fence posts shall utilize sonotubes of a minimum 203 mm (8 inches) diameter for line posts and a minimum of 304.8 mm (12 inches) diameter for corner, end and man gate posts for the full depth of the footings. Post spans shall not exceed 3 meters.

2.5.1.25 Install end posts at end of fence and at buildings.

2.5.1.26 Install gate posts on both sides of gate openings.

2.5.1.27 Install top rail between posts and fasten securely to terminal posts and secure waterproof caps.

2.5.1.28 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.

2.5.1.29 Install fence such that the height above grade is 2.5 meters and maximum post spacing is 3.048m.

2.5.1.30 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.

2.5.1.31 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals. Give tie wires minimum two twists.

2.5.1.32 The interior of all compounds shall be filled with a minimum 75mm layer crushed stone to help prevent vegetation from growing.

2.5.1.33 The guy anchor compound must be a minimum 3.048m x Height equal to the first guy level elevation.

2.5.1.34 The wooden posts for guy anchorage compounds shall be a minimum of 100mmx 100mm and spaced a maximum of 3.048m apart. The wooden posts must be buried a minimum of 1.0m below grade with at least 1.5m above grade.

2.5.1.35 A yellow guy marker must be installed on the lowest guy level of every anchor. The marker must be installed at least 6.1m above grade to protect for vehicles 6.1m in height.

2.5.1.36 A man access gate must be installed at guy anchorages fences to allow personnel access.

2.5.2 Gate Installation

2.5.2.1 Install gates in locations as indicated in attached drawings.

2.5.2.2 Level ground between gateposts and set gate bottom approximately 40 mm above ground surface.

2.5.2.3 Gate posts shall be centered in the concrete and shall be plumb and in line within 6 mm (1/4”). Gate posts shall be set at the same elevation regardless of ground contour.

2.5.2.4 Determine position of center gate rest for double gate. Cast gate rest in concrete as directed. Dome concrete above ground level to shed water.

2.5.2.5 Install gate stops as required.

2.5.3 Touch up

2.5.3.1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas. Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

2.5.3.2 Clean and trim areas disturbed by operations. Dispose of surplus material offsite.

End of Section

3.0 CAST IN PLACE CONCRETE

3.1 General

3.1.1 Design and install foundations and anchors to CSA A23.3-96 and CSA A23.1-94 respectively, except where specified otherwise.

3.1.2 Construct formwork and cast-in-place concrete work to CSA A23.1-94, except where specified otherwise.

3.1.3 Perform reinforcing work to CAN/CSA G30.18-M92 and welding of reinforcing to CSA W186-M1990, except where specified otherwise.

3.1.4 Cure and protect concrete work to CSA A23.1-94, except where specified otherwise.

3.2 Test Reports

3.2.1 A minimum of three cylinders will be taken from each truckload of concrete delivered to the site. The cylinders shall be forwarded to an independent testing firm and the results forwarded to the Technical Authority at the contractors expense.

3.2.2 Confirmation of strength, air content and slump shall be obtained for each load of cement delivered to the project. The results shall be forwarded to the Technical Authority.

3.2.3 If inspection or test results indicate that concrete materials do not meet the requirements of this specification, such materials shall be rejected and removed from the site at the Contractor's expense.

3.2.4 The Contractor shall be responsible for all costs associated with the replacement of concrete which does not meet the requirements set forth in this specification as determined by the Technical Authority. These costs include, but is not necessarily limited to, all concrete placement costs, all removal and disposal costs, all additional excavation costs, all additional testing costs, all additional Technical Authority costs, all additional design costs, and any other costs which may be directly or indirectly linked to the rejected concrete.

3.2.5 The Contractor shall notify the Technical Authority at least three (3) working days prior to placing concrete. Notification shall be in writing with a copy to the Owner.

3.3 Products and Materials

3.3.1 Lumber: plywood and wood form work materials to CSA A23.1-94.

3.3.2 Reinforcing steel: grade 400 deformed bars to CSA G30.18-M92 unless indicated otherwise.

3.3.3 Cement: to CSA A23.1-94, normal (type 10), sulphate resistant (type 50).

3.3.4 Water, fine aggregates, normal weight coarse aggregates: to CSA A23.1-94.

3.3.5 Chemical admixtures: to CAN3-A266.2-M78.

3.3.6 Non-shrink grout: premixed compound consisting of non-metallic aggregate, cement, and water reducing and plasticizing agents capable of developing minimum compressive strength of 50 MPa at 28 days.

3.4 Concrete Mixes

3.4.1 Except where indicated or specified otherwise use concrete mix designed to produce minimum compressive cylinder strength at 28 days of 30 MPa for tower foundation and 25 MPa for anchors. This shall be clearly indicated on design drawings.

3.4.2 Slump, unless noted otherwise, shall be 75 mm +/- 25 mm.

3.4.3 Air content shall be between 4 and 7% unless otherwise noted.

3.4.4 All concrete shall contain a water reducing agent such as "Possolith" by Master Builders, used in strict accordance with the manufacturer's instructions.

3.4.5 The maximum size of coarse aggregate shall be 19 mm.

3.4.6 If the air temperature is 5°C or less, the temperature of the concrete, at the time of placing, shall be between 15°C and 30°C.

3.4.7 All concrete exposed to exterior temperatures and weather in its final use shall contain an air-entraining agent. Total air content to be as specified in CSA Standard A23 for the particular size of aggregate being used. The air-entraining agent shall be compatible with the water reducing agent.

3.5 Execution and Workmanship

3.5.1 Place all anchors against an undisturbed front face.

3.5.2 Ensure that reinforcement and inserts are not disturbed during concrete placement.

3.5.3 Do not place concrete against any surface that is less than 5°C. Remove all snow and ice before placing.

3.6 Form work

3.6.1 Design all formwork in accordance with CSA Standard A23.

3.6.2 Only plastic or solid concrete block chairs will be accepted in order to maintain minimum cover requirements for rebar.

3.6.3 Withdraw all nails and thoroughly clean and repair all form materials before reusing.

3.6.4 Provide a 20 mm chamfer on all exposed corners.

3.6.5 Take necessary precautions to maintain the structure before and after forms are removed.

3.6.6 Take care that the concrete is not chipped or cracked while removing the forms. Pedestal forms to remain in place a minimum of 48 hours. Remove all forms above grade.

3.6.7 All formwork materials shall be removed from the excavations before backfilling. This includes both the tower base and gravity anchors.

3.7 Reinforcement

3.7.1 Clean all reinforcement of any loose scale, dirt, or other coatings that would destroy or reduce the bond. Reject bars with kinks or bends not shown on the drawings. Thoroughly clean all forms before installing reinforcement.

3.7.2 No field cutting, bending or displacement of any reinforcement shall be permitted for placement of weldments, anchor shafts or anchor bolts either before or after concrete is placed unless approval is given by the Technical Authority.

3.7.3 All reinforcement shall have a minimum of 75 mm concrete cover.

3.7.4 All reinforcement shall be placed so that it is a minimum of 75 mm above the bottom of the excavation. Reinforcement supports shall not transfer moisture to or cause the structural reinforcement to corrode. Rock or Clay brick are not to be used as reinforcement supports.

3.7.5 All footing foundations with an upper layer of reinforcing steel shall support the upper layers by use of bent spacers bars at 1.2m centers in each direction. The size and dimensions of the spacer bars are to sufficient to adequately support the top reinforcing layer.

3.8 Grouting of Base Plates

3.8.1 Use “In-Pact” preblended non-shrink dry pack grout as manufactured by C.C. Chemicals Ltd. or approved equal. All grout should be installed according to the manufacturer's written instructions.

3.8.2 Edges of grout should be tapered off at 45° to give a neat transition between base plates and concrete pedestals.

3.9 Curing and Protection of Concrete

3.9.1 Provide effective means of maintaining the temperature of concrete in place at a minimum of 10°C and a maximum of 30°C for three days after placing. When the mean daily temperature is less than 5°C provide protection for newly placed concrete by means of suitable enclosures or raised coverings, and insulation.

3.9.2 Insulation must be protected to prevent loss of effectiveness due to moisture.

3.9.3 The use of calcium chloride to accelerate curing is prohibited.

3.9.4 No loads shall be placed on newly poured concrete for a minimum of 7 days after the completion of the pour. Prior to erection of steel, the Technical Authority shall review the 7-day compressive strength test results.

3.10 Placement of Concrete

3.10.1 Consolidation of concrete should be performed by internal or immersion type vibration. Consolidation of the concrete by rods or shovels will not be permitted.

3.10.2 Place concrete in accordance with CSA A23.1-94. All concrete to be vibrated using high frequency internal or immersion type vibrators.

3.10.3 The Contractor shall ensure reinforcement and embedded items are not disturbed or displaced during concrete placement.

End of Section

4.0 TOWER AND RELATED STRUCTURES

4.1 General

4.1.1 Design, supply and erection of the towers shall be in accordance with the latest version of the following codes and standards, except where modified by the requirements of this Specification:

- CSA S37 01	Antenna Towers and Antenna Supporting Structures.
- CSA B33.4-1973	Galvanized Steel Tower Bolts and Nuts.
- ASTM A325M-00	High Strength Bolts for Structural Steel Joints
- CSA A23.1-94	Concrete Materials and Methods of Concrete Construction
- CSA A23.2	Test Methods and Standard Practices for Concrete
- CSA CAN3- A23.3-00	Design of Concrete Structures
- CSA S269.3-M92 (R2003)	Concrete Formwork
- CSA G30.18-M92 (R2002)	Welding of Reinforcing Bars in Reinforced Concrete Construction
- ACI Standard ACI-306	
- ASTM A325	High Strength Bolts for Structural Steel Joints
- CSA Standard W59-M1984	Welded Steel Construction
- CSA-G40.20-G40.21	General Requirements for rolled or Welded Structural Quality Steel
- CSA-G40.21-M92	Structural Quality Steels
- CSA-G164-M92	Hot Dip Galvanizing of Irregularly Shaped Articles
- CSA-S16.1-01	Limit States Design of Steel Structures
- CSA-B72-M1987	Installation of Lightening Rods
- CSA-C22.1-SB02	Canadian Electrical Code, Part 1
- CSA-G4-00 (R2006)	Steel Wire Rope for General Purpose and Mine Hoisting and Mine Haulage
- CSA-CAN3-G12-M92	Zinc Coated Steel Wire Strand
- W47.1-1992	Certification of Companies for Fusion Welding of Steel Structures
- W47.1S1-M1989	Supplement No.1-M1989 to W47.1-1983
- W59-1989	Welded Steel Construction (Metal-Arc Welding)
- Z259.2-M1990	Fall Arresting Devices, Personnel Lowering Devices and Life Lines
- Z259.1-1976	Fall Arresting Safety Belts and Lanyards for the Construction and Mining Industries

- Canada Labour Code
- Health and Welfare Canada
- Safety Code 6Limits of Exposure to Radio-Frequency Fields at Frequencies from 10 kHz-300kHz,
- Provincial Occupational Health & Safety Act and Regulations
- National Building Code of Canada 2005
- Canadian Aviation Standards Document CARs 621.19 Tower Obstruction Markings
- RCMP Safety Regulations

4.2 Tower Design

4.2.1 Design Ice Load: Unless specified in the Scope of Work document, the towers shall be designed for a minimum ice loading of 50 mm of radial ice on all exposed surfaces, including members, guys, all attachments, and antenna components. The density of the ice shall be taken as 900 kg/m^3.

4.2.2 Design Wind Load: The design shall be based on the Q_h site specific profile provided by Environment Canada.

4.2.3 The loading imposed on the tower by transmission lines and auxiliary lines - feeder lines, attached to it shall be based on the actual dimensions of the lines as determined from the manufacturer's specifications.

4.2.4 All towers shall be designed for a maximum twist / tilt not exceeding 1.5°. Maximum twist / tilt at each antenna level must be indicated on all preliminary and final tower designs.

4.2.5 The value of Cd shall be taken as 1.5 for flat feeders and 1.0 for round feeders.

4.2.6 Shielding of the transmission lines by the tower members, other feeders or attachments may be considered. When feeder lines are mounted on the inside of one face of the tower, shielding of the leeward lines may be considered, following the procedures outlined in "Commentary on Part 4 of NBCC 1990", Figure B-22. Shielding assumptions by the design engineer must be clearly stated, in writing, to the Technical Authority.

4.2.7 Loading from auxiliary facilities and attachments such as ladders, fall arrest rails, rest and transfer platforms, antenna mounts, ice guards, feeder line supports, lighting etc. must be considered in a similar fashion as to that of the transmission lines and feeders outlined above.

4.2.8 The Contractor shall submit detailed design calculations to support tower and foundation designs.

4.2.9 The contractor shall design all foundations and anchors based on the attached Geotechnical Report. In the absence of a Geotechnical report, the Contractor shall assume the following design parameters for soil and rock conditions:

- Soil:
  a. Earth pressure coefficients for undisturbed glacial till:
     $K_a = 0.31$; $K_p = 3.26$
  b. Earth pressure coefficients for compacted glacial till:
     $K_a = 0.33$; $K_p = 3.00$
  c. Unit weight of undisturbed dry till = 1800 kg/m^3
  d. Unit weight of compacted dry till = 1800 kg/m^3
  e. Allowable Bearing Pressure on undisturbed glacial till = 200 kPa

f. Allowable Bearing Pressure on structural fill = 150 kPa
g. Groundwater level = at surface
h. Frost Penetration = 1.2m
i. Drained angle of internal friction (undisturbed till) = 38˚
j. Drained angle of internal friction (compacted till) = 34˚

- Rock: a. Specific gravity = 2.5
b. Unconfined compressive strength of intact rock = 65 MPa
c. Shear Strength = 5.4 MPa
d. Estimated RQD = 70%
e. Design Water level = at surface
f. Allowable Bearing Pressure = 1000 kPa
g. Depth to sound rock = 0.5m

4.2.10 If the site is not known to be soil or rock, assume soil conditions

4.2.11 The Contractor shall design ice shields for all antennas, lights and photocells below the top mounted antenna. The design of the structure shall consider all loads imposed by all ice shields (both initial and future).

4.2.12 The tower design engineer of record shall have a minimum of 5 years of communication tower design experience and shall be prepared to fully support all assumptions made with regard to the tower design. These assumptions shall be clearly stated on correspondence, which accompanies the design drawing, complete with back up information, calculations, etc. The design engineer of record shall be clearly stated on all drawings.

4.2.13 Where requested by the Technical Authority, the design engineer must provide additional information to verify design adequacy or respond to Technical Authority queries. This information shall be provided at the Contractor's cost, in written form under the professional seal of the engineer of record.

4.2.14 Secondary members may be used to reduce the unbraced length of a leg or bracing member. They are not considered to directly resist the applied loads.

4.2.15 In determining unbraced length, a member that is considered to provide lateral support to a compression member shall be capable of resisting a force, either in tension or compression, acting perpendicular to the axis of the corresponding radius of gyration and equal to the percentage of the maximum capacity in the compression member given below. A different value may be used where indicated by suitable analysis. This force need not be applied simultaneously with primary design forces for conventional lattice towers.
Percentage of Axial Compressive Capacity for Lateral Support:

L/r of Compression Member	% of Axial Capacity
0 to 60	1.5
61 to 100	2.0
101 to 200	2.5

If the angle between the leg and the main diagonal of a K-brace panel is less than 25°, the

forces given by the table noted above may not be adequate. For these cases an analysis shall be completed taking into account eccentric and secondary stresses and member deformations.

4.2.16 These nodal forces are not additive to the primary design forces in the structure, but where the design forces in the primary members supporting the secondary bracing are less than the forces due to the nodal loads, the larger value shall be used.

4.2.17 The unbraced length, L, for any cross sectional axis of a member shall be taken as the distance along the axis of the member between the points at which it is intersected by the axes of the members providing support for that axis. The unbraced length may vary for different cross sectional axes of the member. Secondary members that do not directly resist the applied loads may be used to reduce the unbraced length of a member.

4.2.18 The slenderness ratio of a member is L/r, where r is the radius of gyration of the member on the axis perpendicular to the unbraced length under consideration.

4.2.19 The effective length factor, K, modifies the unbraced length, L, to take into account the structural configuration, including the rotational restraints and end connections.

4.2.20 The effective slenderness ratio, KL/r, is the ratio of the effective length, KL, to the corresponding radius of gyration, r.
The maximum effective slenderness ratio for compression members shall be:

a. 120 for leg members;
b. 200 for main members carrying design compression forces, other than leg members;
c. 240 for secondary members

4.2.21 The maximum effective slenderness ratio for tension only members, and components of built up members not in tension under initial loading conditions, shall be 300 unless other means are provide to control flexibility, sag, vibration, slack and other similar effects.

4.2.22 The w/t ratio of an angle member in compression shall not exceed 25, where w is the effective leg width and t is the nominal leg thickness.

4.2.23 The tower design engineer shall ensure that the tower twist and tilt design criteria is adequate to limit antenna movement based on manufacturer requirements and prevalent site conditions.

4.2.24 The tower design shall be clearly indicated on a tag permanently affixed to the tower base to include but not limited to the Manufacturer name, Contractor project number, year of installation, design code, tower height, and wind and ice design parameters.

4.2.25 Each guy assembly shall have a tag affixed to include but not limited to, the guy size, type (BS, GS, or EHS), and initial design tensions.

4.3 Antennas and Transmission Lines

4.3.1 Each antenna specification is located in the Scope of Work document. Prior to final design, the Contractor shall verify all antenna information including manufacturer, type, height, azimuth, lines, etc. Final design should proceed only with written confirmation from RCMP.

4.3.2 All antenna azimuths are referenced with regard to True North.

4.3.3 Towers shall be designed to accommodate any azimuth orientation of the antennas. Final azimuth to be determined by Owner.

4.3.4 Only initial mounts shall be supplied and installed under this contract.

4.3.5 All future antennas, lines, mounts and ice shields shall be incorporated in the tower design. Only lines and antennas marked as "initial" will be supplied and installed under this contract.

4.3.6 The Contractor shall be responsible for the installation of all systems as per the manufacturer's recommendations. All antenna / tower interface hardware not normally supplied by the antenna manufacturers shall be the responsibility of the tower Contractor. It shall be the Contractors responsibility to determine any additional material required to mount the antennas to the tower structure. This shall include all antenna struts, mounts, special attachments, bolts, etc. The Contractor shall liaise with the antenna manufacturers or suppliers to obtain adequate information required to design proper mounting interface components.

4.3.7 The Contractor shall be responsible for the procurement and installation of all lines and antenna systems, including line hangers, ground kits, connectors, hoisting grips, threaded rod, and other necessary hardware. Installation shall be in accordance with the manufacturer's recommendations.

4.3.8 All transmission line hangers shall be heavy duty stainless steel and placed to lesser of the manufacturer's recommendations or a maximum distance of 1200 mm center to center. Bolted hangers are preferred unless the tower is designed for snap in hangers.

4.3.9 Stacking hangers shall not be used.

4.3.10 The Contractor shall design, supply and install new mounts for all initial RCMP antennas. All antenna mounts, mount hardware and line hangers shall be heavy duty hot dip galvanized or stainless steel. Materials prone to rust or corrosion are not acceptable.

4.3.11 The Contractor shall provide design drawings for all initial and future mounts considered in the tower design.

4.3.12 The Contractor shall supply adequate manpower to complete antenna installation, testing and optimization. The Contractor will be required to coordinate all work with RCMP.

4.3.13 The Contractor shall replace all transmission lines, antennas, hangers, or any other item found to be defective or found to be not in compliance with this specification as a result

of the Contractors installation or lack of adequate protection. Any lines found to have moisture infiltration, shall be replaced by the Contractor at the Contractor's cost.

4.3.14 The Contractor shall be responsible for checking all material against the material list and protection of the material until it is installed and accepted by the Owner.

4.3.15 The antenna elevations are referenced from ground level to the center of the antenna. Deviations from these centers of radiation greater than ± 0.5 m must be reported to the Engineer.

4.3.16 All antennas are to be installed at the specified center of radiation, unless otherwise approved by the Owner.

4.3.17 The Contractor shall assemble the new antenna systems from a packaged state as supplied by the manufacturer. The Contractor shall provide all tools, work platforms or surfaces, blocking, and all other equipment necessary to properly assemble and install the antennas, transmission lines, hangers, cables, and conduit. Any on site storage will be the responsibility of the Contractor.

4.3.18 Antenna assembly and installation must be completed in accordance with the manufacturer's instructions and acceptable industry standards. Antennas or antenna components damaged accidentally prior to full acceptance by the Owner shall be replaced at the Contractors expense. Replacement will be completed so as not to delay project completion.

4.3.19 The Contractor shall install the antennas so that the bottom of the antenna is higher than any bottom boom arm in a double boom arm mount. Antennas are not to be mounted prior to lifting it into place.

4.3.20 A hoisting grip shall be installed and used to facilitate transmission line installation as recommended by the manufacturer. The hoist grip shall be connected to the tower after final placement of the line. The connection shall be made using a suitable galvanized connector. Connections may be made to secondary members such as transmission line support brackets, redundant horizontals, antenna mount members, or on primary members where special allowance has been made for such a connection.

4.3.21 Transmission line installation shall be in accordance with manufacturer recommendations and best industry standards.

4.3.22 Transmission lines shall not be installed on the upper side of horizontal boom arms where they may be damaged by workers accessing antennas.

4.3.23 Transmission line hangers shall be installed in accordance with manufacturers recommendations.

4.3.24 The minimum diversity requirement for antennas of the same sector is three meters, two meters for antennas in different sectors and a vertical separation of 1 meter.

4.3.25 The transmission lines shall be equipped with permanent tags located at the base of the tower. These tags shall clearly indicate type of line, antennas, antenna azimuth, etc.

4.3.26 The Contractor shall provide assistance to the RCMP technicians in completing the antenna sweeps.

4.4 Transmission Line Grounding

4.4.1 All transmission lines shall be grounded in accordance with C.S.A. and manufactures recommendations.

4.4.2 Ground kits shall be constructed of non braided solid copper and shall meet or exceed the requirements of the transmission line manufacturer.

4.4.3 The Contractor shall provide a copper ground bus bar at the level of the top and the base of the tower, approximately 500mm above the waveguide bridge. The ground riser shall be connected to this copper ground bar.

4.4.4 All ground kits where applicable shall be connected to the top, bottom and waveguide port buss bars. Alternatively the ground kits can be attached to the tower ground riser where a connection cannot be made to the buss bars provided.

4.4.5 The tower ground riser shall be connected to the buss bars located at the base and top of the tower.

4.4.6 The maximum spacing of ground kits shall be a maximum of 60.0m or as specified by the transmission line manufacturer.

4.4.7 The connection point on the ground riser or tower shall be lower than the connection point on the transmission line. The ground kit shall be placed a maximum of 3.0m above the first connection to the tower or 3.0m below the antenna to tower attachment unless the design of the tower prohibits. In this case the Technical Authority shall be notified and a remedial solution provided.

4.5 Materials

4.5.1 Preference shall be given to the use of structural steels with improved resistance to brittle fracture. A36 modified steel is not acceptable. All materials to be used in the tower shall be new and in accordance with the requirements of CSA S37 01.

4.5.2 Use of material sections less than 5 mm in thickness will not be permitted on primary or secondary structural members. Sections used for attachment or support of auxiliary facilities may be permitted, subject to review by the Technical Authority and submission of detailed calculations by the design engineer.

4.5.3 Hollow sections will not be permitted on primary or secondary structural members which include tower legs, horizontals and diagonals.

4.5.4 Two copies of mill test certificates for each lot of steel received from the mill by the Contractor shall be forwarded to the Technical Authority. These certificates shall record results of tests indicating Yield Strength, Ultimate Tensile Strength, Percent Elongation and Chemical Composition.

4.5.5 Mechanical tests shall be performed in accordance with the procedures outlines in ASTM Methods and Definitions for Mechanical Testing Steel Products, Serial Designation A370. The Contractor shall forward certificates of test results to the Owner, at least two (2) weeks prior to the commencement of fabrication of structures incorporating the related material.

4.5.6 All guys shall be one continuous length Bridge Strand, 1 x 7 Grade 180 Guy Strand or EHS unless noted otherwise in the drawings. All guy properties must be clearly indicated on design drawings and the wires must be manufactured in North America. Each cut guy end of wire shall be equipped with an ear clamp, stainless steel hose clamp or other approved mechanisms or processes to ensure that the strand does not "broom" open or otherwise become a hazard or maintenance problem.

4.6 Connections

4.6.2 Connections in the shop may be bolted or welded. All site connections shall be bolted.

4.6.3 Make all welded connections in conformance with CSA Standard W59.1. Use only low hydrogen electrodes or processes of equivalent rating. All weld designs shall be clearly indicated on the design drawings.

4.6.4 Make all bolted connections with high strength bolts conforming to ASTM Standard Specification A325. Place a hardened washer under the bolt element (nut or bolt head) turned in tightening the bolt.

4.6.5 Tighten all bolts from snug tight condition by the turn of the nut method as specified in CSA Standard S16.1-94. When all bolts in a connection are tight, bolt tension must not be less than the value shown in the following table:

Bolt Diameter		**Min. Bolt Tension***
Inches	**mm**	**kN [kip]**
2	--	53 [12]
5/8	--	85 [19]
--	16	91
3/4	--	125 [28]
--	20	142
7/8	--	174
--	22	176
--	24	205

**Equal to 70% of the minimum tensile strength given in the appropriate ASTM Standard, soft converted where appropriate and rounded to the nearest kilonewton.*

4.6.6 Power wrenches may be used to assist in installing bolts, provided they are of the adjustable type capable of cutting-out when bolts are snug tight.

4.6.7 After the tower has been completed, check all bolted connections, including those on miscellaneous metal work, and retighten all loose bolts. Exercise care that bolts adequately tightened are not subjected to additional rotation of the turned element. All damaged nuts or bolts shall be replaced.

4.6.8 The single bolt connection, either at the end of a member or at an intermediate support, shall not be considered to provide rotational restraint.

4.6.9 A multiple bolt connection shall be considered to provide rotational restraint where the connection is to a member capable of resisting rotation in the required plane.

4.6.10 Where a bracing member is connected to a leg member through a gusset plate by a multiple bolt connection, the bracing member may be considered restrained in the plane of the plate at the centroid of the connection. A gusset plate shall not be considered to provide restraint traverse to the plane of the plate.

4.6.11 Where analysis or tests show that a specific detail provides restraint differing from the requirements noted above, the effective slenderness ratio may be adjusted accordingly.

4.6.12 The factored resistance of the member and its connection in tension shall not be less than one third of the calculated factored compressive resistance unless erection and all other forces have been considered.

4.6.13 Where the threaded section of a bolt intercepts any shear plane the factored shear resistance of the bolt shall be reduced by a factor of 0.7.

4.6.14 The minimum resistance of a splice shall not be less than the maximum design force in the member, and where practical should equal the design resistance of the member. The splice shall provide sufficient stiffness to ensure the continuity of the member.

4.6.15 For splices that transfer compression by bearing, the mating surfaces shall be finished to bear. The splice shall have a minimum tensile resistance equal to the maximum tension force, but not less than 33% of the compressive resistance of the member, except where the design force in the splice is compression only, and a lower tension value can be justified by an engineering study taking into account the dynamic and erection forces in the member.

4.6.16 For gap splices the eccentricity between the centroid of the member and the centroid of the splice plates shall be taken into account in the design of the splice plates and bolt groups. Where compression forces govern, the splice shall be designed to develop the compressive resistance of the member.

4.6.17 For flange type splices in tension, the effects of prying action shall be considered in the design of the bolts and connecting parts.

4.7 Workmanship

4.7.1 Workmanship and finish throughout shall be equal to the best modern practice for this class of construction. All members shall be in accordance with the drawings and shall be straight and true. All like parts shall be interchangeable.

4.7.2 All punched holes must be accurately located so that the structure can be erected with a minimum of "drifting".

4.7.3 The ends of members shall be clipped as required to facilitate assembly.

4.7.4 In any bending or reworking of any material, methods employed shall ensure that the physical properties of the material are not impaired.

4.8 Marking

4.8.1 A number shall distinctly identify each separate member. Each member shall be clearly marked with its member number to facilitate erection.

4.8.2 All like parts shall have the same number.

4.9 Punching

4.9.1 Punching shall be done by methods designed to ensure accuracy. The center of any hole shall, in no case, be displaced more than 1.5 mm from its position shown on the drawings.

4.9.2 Plugging or welding mispunched holes will not be allowed.

4.9.3 Punches and dyes shall be sharp and true and all punch holes shall be round, true to size, and free from ragged edges and burrs.

4.9.4 Where applicable, punching performed on bent members shall be done after bending to avoid distortion of holes.

4.10 Welding

4.10.1 All welding shall be performed in accordance with CSA Standard W59 latest revision and shall be undertaken by a fabricator fully approved by the Canadian Welding Bureau to the requirements to CSA Standard W47, latest revision.

4.10.2 Field welding is not permitted.

4.11 Handling of Material

4.11.1 Materials shall be handled and stored in the plant and on the job site in such a manner that no damage shall be done to the materials of any existing building or structure.

4.11.2 Special care shall be taken to ensure that galvanizing, priming, or painting is not damaged during handling and erection of materials.

4.11.3 Storage of materials on the site will be the responsibility of the Contractor.

4.12 Galvanizing

4.12.1 All materials and fittings, including bolts, nuts and washers shall be hot dip galvanized to the requirement of CSA S37 01 and the standards specified therein. The galvanizing applied to structural members shall have a minimum Zinc mass of 610 g/m² (2.0 oz/ft²), equivalent to a thickness of 87 µm (3.40 mils). The galvanizing applied to bolts, nuts and threaded fasteners shall have a minimum Zinc mass of 460 g/m² (1.5 oz/ft²), equivalent to a thickness of 65 µm (2.54 mils).

4.12.2 All materials shall be completely fabricated before galvanizing. No galvanizing shall be permitted on assemblies after being bolted. No machine or shop work shall be allowed after galvanizing (except the tapping of nuts).

4.12.3 Before galvanizing, the steel shall be thoroughly cleaned of all paint, grease, rust, scale or other materials that will interfere with proper binding of the zinc with the steel.

4.12.4 Tests for uniformity and consistency of galvanized and painted coatings shall be made from time to time on as many samples as may be considered necessary by the Owner. Such tests shall be conducted in full accordance with the requirements of CSA S37 01 and the Contractor shall forward the standard recording results of the foregoing tests to the Owner. The Contractor shall be responsible for all costs associated with these tests.

4.12.5 The Contractor shall field paint all steel members of the tower where the galvanized finish has been scrapped or chipped during erection in the field. This shall be done using Loctite Extend or an approved equal. Steel members that have a slightly damaged finish shall be given three coats, applied according to the manufacturer's printed instructions.

4.13 Painting

4.13.1 If requested by the Owner the towers shall be painted. Unless otherwise stated, all towers shall be unpainted with daytime white lighting system and night time red obstruction lights to meet the requirements of the latest edition of the Canadian Aviation Standards Document CARs 621.19.

4.13.2 Properly formulated hot or cold phosphate solutions shall be used to remove oil, grease or other soiling on the galvanized surfaces prior to painting.

4.13.3 A suitable primer is galvanized-iron primer DEVGUARD 4120, or approved equal. The prime coat shall have a dry film thickness of 1.5 mils minimum.

4.13.4 The finish coat shall be single coat of Alkyd based enamel, capable of being applied to a dry film thickness of 2.25 mils minimum. The enamel colors shall be International Orange and White. Suitable alkyd paints are DEVGUARD 4308. All paints must meet ASTM performance requirements for abrasion resistance, pencil hardness, flexibility, and salt spray resistance.

4.13.5 All paint shall be applied under controlled shop conditions in accordance with manufacturer's recommendations. Paint shall be evenly spread and free from all brush marks, stains, defects and flaws.

4.13.6 No painting shall be done when the temperature is lower than 10°C and/or humidity is greater than 50%. No painting shall be done when the tower metal is hot enough to cause paint to blister and produce a porous coating. No coat of paint shall be applied until the previous coat is thoroughly dry as per manufacturer's recommendations. Any areas damaged during transit or erection shall be cleaned and touched up with new primers and/or paint as required, in accordance with manufacturer recommendations.

4.13.7 Contractor shall be responsible for damage done by paint spraying or dripping on Owner or other's property.

4.13.8 Contractor shall warrant all paintwork for a period of not less than 3 years. Any damage to the paint, from environmental conditions at the site, shall be repaired by Contractor at no cost to Owner, in a manner approved by Owner.

4.14 Erection

4.14.1 Only qualified and experienced personnel shall be utilized to complete the erection of RCMP towers. Contractor shall be prepared to provide resumes of all project personnel.

4.14.2 The tower shall be erected in a manner that will not bend, scrape, distort, or injure the component parts of the galvanizing.

4.14.3 Contractor shall not use iron sledges for hammering or driving any members. All hammering is to be done with wooden mauls or hammers of plastic, lead or other soft material.

4.14.4 Every failure of the material to join together properly shall be reported to the Owner.

4.14.5 Upon completion of erection, the tower shall be inspected by the Contractor for member damage. Any damaged or missing items, including nuts, bolts, etc., shall be replaced.

4.14.6 The Contractor shall be responsible to ensure that no members of the tower are over stressed during erection. Any members damaged during erection shall be replaced. The Contractor shall be responsible for any damages done to the work of others, or to adjoining structures and property during erection.

4.14.7 Upon completion of tower erection, the guys shall be adjusted to +15% and -5% of their specified initial tension, such that with a wind speed of 15 km/hr, the out of plumb between any two elevations on the structure shall not exceed 1 in 500.

4.14.8 The guy tensions shall be adjusted to within +15% and -5% of the stipulated design tensions noted in the design drawings. The tension calculations shall consider the ambient temperature at the time of adjustment. Full consideration of anchor location with respect to the tower base must be incorporated into the calculation of correct guy tensions. It shall be the Contractor's responsibility to obtain accurate measurements pertaining to elevation differences between the tower base and guy anchors.

4.14.9 The tower, after erection, shall be free of any visible twist or deflection. The Contractor shall use a three-transit set up to complete final adjustment of vertical alignment and twist.

4.15 Reinforcing Steel

4.15.1 Do not field cut, bend or displace any reinforcement to permit placing weldments or anchor bolts either before or after concrete is placed unless approval is given by the Engineer.

4.15.2 Clean all reinforcement of any loose scale, direct, or other coatings that would destroy or reduce the bond. Reject bars with kinks or bends not shown on the drawings. Thoroughly clean all forms before installing any reinforcement.

4.16 Grouting of Base Plates

4.16.1 For base plates, use In-Pact preblended non-shrink dry-pack grout as manufactured by C.C. Chemicals Ltd. or approved equal. All grout shall be installed according to the manufacturer's instructions. Edges of grout for both tower bases and waveguide bridge

piers shall be tapered off at 45° to give a neat transition between base plates and concrete pedestals.

4.17 Auxiliary Features

4.17.1 General

The following facilities shall be considered an integral part of the tower contract and shall be designed, supplied and erected as such. In mounting any of these auxiliary facilities, care shall be taken that the structural members of the tower are not weakened by the drilling of holes or any other means.

4.17.2 Ladder

The tower shall be equipped with a climbing ladder complete with a CSA approved safety rail. The ladders shall be bolted to the tower and shall conform to the latest version of CSA S37 01. Integral ladders are acceptable for all weld towers. The climbing ladder shall be positioned such that a safe climbing circle of a minimum 660mm is obtained. Climbing Pegs are not acceptable.

4.18 Working Area Platforms

4.18.1 It will not be necessary to provide working area platforms at obstruction light and antenna levels unless warranted by CSA S37 01.

4.19 Access to Obstruction Lights

4.19.1 The tower design shall accommodate safe access to service and maintain obstruction lighting. Where tower lights are located in excess of 100 cm from a climbing ladder, suitable access and climber support shall be provided for both guyed and self-support towers. Access to obstruction lights shall include provision of a suitable fall arrest system approved by the Owner.

4.20 Antenna Mountings

4.20.1 Suitable mountings shall be provided to mount the initial antennas on the tower. Care shall be taken to assure that these mountings have adequate strength and rigidity and that they meet the manufacturer's requirements. Mounts for future antennas shall not be included in the Work. All mounts shall be designed to facilitate the loading conditions prevalent to the site.

4.20.2 Pinwheel mounts and boom arms shall be designed to carry all intended antennas and lines under design load conditions.

4.20.3 Pinwheel mounts and boom arms shall also be designed to support the weight of maintenance personnel who may be at the outer limit of the pinwheel. For purposes of design it should be assumed that the pinwheel and its connection to the tower can support a minimal load of 500 lbs applied at the end of the pinwheel mount, in addition to the antenna and transmission lines under design load conditions.

4.21 Transmission Line Supports

4.21.1 Supports shall be provided to support the transmission lines at the elevation of all antennas.

4.21.2 Lines are to be supported and restrained at centers suitable to the manufacturer's requirements and mounts are to be installed on the outside face of the tower. The maximum spacing between supports shall be as per manufacturer's recommendations based on site-specific environmental loading, but installed so as not to interfere with climbing. Maximum hanger spacing shall be approved by Owner or Owner's representative.

4.21.3 All horizontal runs of transmission lines shall be protected from falling ice in a manner approved by the Engineer.

4.22 Ice Protection

4.22.1 Three U-Bolt clips are to be spaced 300 mm apart, directly above the grounding connection and guy markers on each guy.

4.22.2 Ice Shields shall protect all obstruction lights.

4.22.3 All antennas below the top antenna shall be protected by ice shields. The design of the ice guards for antennas shall incorporate the following:

i. Installation and removal of the antenna shall not be hindered or if this is not possible, the canopy must be capable of supporting the weight of the antenna and any material necessary to hoist it into place.
ii. Future re-orientation of the antenna shall not be hindered.
iii. The entire exposed top surface of the antenna must be protected.
iv. The ice guard shall be designed to carry a live load of 1.95 kPa and site-specific wind loads.
v. Ice guards shall be constructed with solid struts. Cable supports are not acceptable.
vi. Ice guards shall be constructed with a sloped top surface to deflect falling ice away from the tower.

4.23 Turnbuckles and Shackles

4.23.1 Turnbuckles and shackles shall be Crosby, manufactured from AISI 1035 steel, heat treated, and shall be hot dip galvanized in accordance with the requirements of the latest version of CSA Standard S37-01. The minimum turnbuckle length shall be 457 mm. The tower design shall provide full articulation at anchor and tower ends of each guy.

4.23.2 Install all turnbuckles so as to provide a minimum of 250 mm of take-up for future adjustment. Provide a locking device for each turnbuckle. The locking device shall consist of vinyl-coated cable or an approved equivalent.

4.24 Bridge Sockets

4.24.1 Bridge sockets shall be sized to provide a minimum of 1220 mm of adjustment. The sockets shall be installed so as to provide a minimum of 760 mm of take-up for future adjustment. The bridge sockets shall be made of heat-treated steel.

4.25 Waveguide Bridge

4.25.1 The waveguide bridge shall be supplied and installed as per approved design drawings. The waveguide bridge must protect transmission lines at all times.

4.25.2 The waveguide bridge must be independent of and not directly connected to the tower structure or the building. The bridge should be supported by a minimum of two waveguide bridge posts.

4.25.3 The waveguide bridge shall be designed to carry all initial and future waveguides, cables and conduits. The waveguide shall be supported on cable hangers connected to a trapeze style support system of stainless steel threaded rod or galvanized bar hangers and two levels of horizontal trapeze angles suitable and elevated to run directly into the waveguide window.

4.25.4 The Contractor shall provide a suitable adjustable plate extension to the bridge to protect the lines between the bridge and the building and the bridge and the tower. This plate must taper to the full width of the waveguide window or waveguide ladder on the tower.

4.25.5 Waveguide posts shall be fabricated with welded 100 cm x 100 cm ears at the base, to facilitate connection of the grounding system. Ears shall permit exothermic connection of the grounding system.

4.25.6 Unistrut or Cantruss sections are not acceptable for use on the waveguide bridge.

4.26 Anti-climb Devices

4.26.1 When required self-support and guyed towers are to be provided with an Anti-climb facility on the structure that will stop unauthorized access of the structure. Detailed drawings will be approved by the Technical Authority.

4.26.2 The Anti-climb panel type, shall incorporate a 11 or 12 gauge ($3.13mm<X<4.67mm$) continuous galvanized steel panels bolted flush to the structure using round headed hardware which cannot be used as a step or hand hold. The panel height should be a minimum 10 ft with the lower edge positioned as close to the tower base as possible,

leaving not more than 10 inches of space between the tower base and the bottom of the anti-climb panels. When required access should be prevented from both outside and inside the tower.

4.26.3 Exposed edges of the anti-climb shall be hemmed.

4.26.4 Barbed wire or expanded wire mesh shall not be permitted as part of the anti-climb.

4.26.5 For self support towers the anti climb, as a minimum, shall be such to prevent access to the climbing ladder. The design of the anti-climb for self-support and guyed tower should also incorporate the type of hanger support found on each side off the ladder or the tower face.

4.26.6 Platform type anti-climbs shall incorporate steel framing necessary to provide work platform capacity while supporting open plate grating. This facility will have a hatch or door type that can be easily opened for access to the structure while on the climbing facility.

4.27 Fall Arrest Safety Device

4.27.1 The Contractor shall design, supply and install a CSA approved Fall Arrest rail to meet the latest version of CSA Standard Z259.1-1990 and CSA Standard Z259.10-M1990. Cable fall arrest systems are not acceptable.

4.27.2 The tower structure shall be equipped with a continuous fall arrest rail from the base to the topmost projection of the structure.

4.27.3 The fall arrest rail shall be come complete with two CSA approved trolleys. Trolleys shall be supplied with lock safe clips for attachment to front D ring of a CSA Approved full body harness.

4.27.4 Fall arrest systems shall be designed to include rotatable pinwheels and access to antennas mounted to pinwheel booms.

4.27.5 Fall arrest rails shall not extend above the top of the tower and shall be supplied with a removable stop bolt at the top of the rail.

4.27.6 Any discontinuity of a fall arrest system shall be clearly marked by Owner approved signage prior to and after the location in question.

4.28 Warning Signs

4.28.1 The Contractor shall supply and install warning signage at the base of each tower structure to indicate that the tower shall be accessed only by trained individuals. In addition, caution signs shall be installed above and below each obstruction or change of climbing facility.

4.28.2 Tower base signs shall be 400mm by 400mm and shall incorporate black lettering on an orange background.

4.28.3 Tower caution signs shall be 75mm by 200mm and shall incorporate black lettering on an orange background.

4.28.4 Signs shall be weatherproof and not degrade as a result of prolonged exposure to the elements.

4.28.5 Signs shall be mounted at the base of the tower so as to be clearly visible to tower climbers. Placement of the sign shall not impede authorized climbers:

i. The English language sign shall read: "**Warning, Do Not Climb Tower Unless Equipped and Trained in Accordance with Labour Canada Regulations. PWGSC"**

ii. The French language sign shall read: **"Attention:ne montezpas dans les tours à moins de porter l'équipment et d'avoir reçu la formation prévus dans la réglementation canadiennedu travail"**

4.28.6 Sample signs are attached in Appendix A for illustration purposes only.

4.29 Tower Demolition and Removal

4.29.1 Demolition and removal shall include tower base, guy anchor foundations and waveguide bridge to a distance of 300mm below grade unless otherwise approved in writing by the Owner.

4.29.2 Removal includes all antenna mounts, TX lines, climb ladder, etc. These items shall be salvaged if requested by the Owner. If salvage is requested it shall be facilitated at no additional charge and neatly stored on site.

4.29.3 Towers must be demolished using a gin pole to remove a section at a time such that damage to the adjacent structures and existing building is avoided. Other methods shall only be utilized if approved by the Technical Authority.

4.29.4 The Contractor shall dismantle and dispose of the existing tower and associated components. These components shall include, but not necessarily be limited to tower

steel, guys, antenna mounts, anchor assemblies above grade, waveguide bridge, conduit, lights, ladders, etc.

4.29.5 The tower shall be dismantled in such a manner so as to pose no threat to the new tower and antennas or transmitter building. Responsibility for any and all damage to property as a result of the dismantling and disposal of the existing tower shall be the sole responsibility of the Contractor. Protection of the general public is of paramount importance.

4.29.6 The Contractor shall provide sufficient detail to the Owner and Technical Authority with regard to the proposed method of dismantling the towers. Details should include measures to safeguard existing structures on adjacent property and protection of the general public. This method must be reviewed by the Technical Authority hired by the Owner prior to the start of work and include sketches and calculations if required. This review shall not relieve the Contractor of any responsibility or liability with regard to the dismantling process.

4.29.7 The Contractor shall provide the Owner with a minimum notice of 5 working days of the tower dismantling start.

4.29.8 The Contractor shall dispose of material in a manner approved in writing by the Owner and shall provide written documentation with regard to where and how the material will be disposed. On site disposal is not permitted. Materials that can be recycled shall be disposed of in this manner.

4.29.9 Foundations must be demolished to 300mm below grade minimum, were applicable, and site left in a neat and tidy condition. Foundations on rock shall be removed to grade level. Some backfill may be required to reinstate the site where foundations are removed below grade. This shall be included in the tender bid price as part of the demolition.

4.29.10 No removal can begin until antenna systems are installed on the new tower. After the antennas are installed and operating to the Owner's satisfaction, removal may proceed.

4.29.11 Verify with the Owners rep to confirm salvaged items.

End of Section

5.0 ELECTRICAL

5.1 Grounding

5.1.1 Please See Appendix C.

5.1.2 The Contractor shall be responsible for the supply, installation and testing of a complete permanent continuous grounding system for the site, including tower (continuous in tower ground), tower base, tower guys, waveguide bridge, waveguide bridge posts, fence, and equipment shelter.

5.1.3 The contractor shall install proper warning tape 500mm all buried ground wires.

5.1.4 The grounding design shall be as noted in the attached Appendix unless the existing site topography and soil / rock conditions warrant a special design as recommended and developed by the Owner.

5.1.5 When a new tower is located on a previously existing site, all new grounding systems must be bonded to the existing grounding system as directed by RCMP.

5.1.6 All bonding and grounding provisions shall conform to CSA Standard C22.1.

5.1.7 Provide sacrificial anodes at each gravity anchor to suit soil conditions.

5.1.8 Ground rods and conductors to be located 1.5 m (min.) from the tower base and anchor foundations and will tie in to existing systems where available and where directed by the Owner.

5.1.9 Ground rods that cannot be driven vertically shall be placed in a 76mm diameter drilled hole, filled with a Bentonite and water mixture. The procedure for placing the ground rod in Bentonite is as follows:

1. Drill 76mm diameter hole in rock, 3m deep.
2. Pour water 1/3 height of the hole.
3. Insert ground rod.
4. Add Bentonite powder in hole, alternating with water.

5.1.10 All ground wire is to be #2/0 stranded copper wire. Exposed above grade copper wire shall be vinyl coated copper. Below grade ground conductor shall be bare and be buried a minimum of the frost depth into undisturbed earth.

5.1.11 The ground riser shall be vinyl coated (non-tinned) and attached to the tower with approved connectors.

5.1.12 All self-support towers shall have a copper lead from each leg connected to a ground rod. A total of six ground rods will be required to be connected to the tower base ground ring. Tower design shall incorporate 100mm X 100mm grounding lugs on all tower legs and

waveguide posts. These lugs shall be suitable for connection of ground conductors by exothermal welding.

5.1.13 All guyed towers shall be grounded via connections at the leg and #2/0 stranded copper extending from each leg to a ground rod at the base of the tower. The ground rods shall be connected to the tower base ground ring and a #2/0 copper ground lead shall extend from the base ground ring to each anchor ground rings. Tower design shall incorporate 100mm X 100mm grounding lugs on all tower legs and waveguide posts. These lugs shall be suitable for connection of ground conductors by exothermal welding.

5.1.14 The tower Contractor will connect tower, guys and waveguide bridge piers to the grounding system as follows:

.1) to the tower-using exothermic welding on fabricated ground plates or lugs.
.2) to the guy wires - using Burndy KVSU connectors, such that adverse reactions of different materials will not occur.
.3) wire to wire connections underground - using exothermic welding.
.4) conductor to ground rod using exothermic welding
.5) conductor to lightning rod using Burndy KSU connectors
.6) wire to waveguide post terminal using exothermic welding.
.7) All connections shall be made according to manufacturer's directions.
.8) All above ground exposed conductor shall be vinyl coated.

5.1.14.1 Before making a ground system connection, remove all paint, foreign matter or dirt.

5.1.15 Transmission Line and Antenna Grounding

5.1.15.1 Supply and install a continuous run of #2/0 stranded copper conductor for the entire length of the tower. The ground riser shall be neoprene coated and not come in contact with any material that may create a dissimilar materials reaction.

5.1.15.2 Attach ground riser to the tower using predrilled holes and approved connectors.

5.1.15.3 The ground riser shall be connected to the lightning rod at the top of the tower, using approved Burndy or equivalent connectors.

5.1.15.4 All transmission lines shall be grounded using grounding kits in accordance with manufacturer’s instructions. All groundings leads will have a minimum of two holes.

5.1.15.5 Lines shall be connected in 4 locations (top, middle, base of tower and near the building entrance). All connections must be made in accordance with manufacturer’s instructions.

5.1.15.6 The Contractor shall provide approved copper bus bars at the top and at the base of the tower and intermediate locations so no span is more than 61.0m .This bus bar must be securely attached to the ground riser.

5.1.15.7 The contractor where requires shall supply and install a bus bar directly below the waveguide port with proper attachment to the ground ring.

5.1.16 Building and Compound Fence Grounding

5.1.16.1 As a minimum, every second fence post and both gate posts shall be connected to the grounding ring with exothermic welding.

5.1.16.2 A flexible ground lead must connect the 2.0 meter compound gate to the internal 1.0 meter man gate.

5.1.16.3 The Contractor shall ensure that no portion of the grounding ring is damaged with the installation of the compound fence posts.

5.1.17 Lightning Rod

5.1.17.1 Supply and install a lightning rod system to the top of the tower to provide adequate lightning protection to the top antenna (must extend above all antennas). The ground riser shall be connected to the lightning rod using approved connectors. The lightning rod system must meet the approval of the Owner.

5.1.18 Measurement of Ground Resistance

5.1.18.1 The Contractor shall submit to the Owner and Technical Authority the soil resistivity measurements for each site. A four stake method of measuring the soil resistivity should be carried out with the four stakes being placed at 3.0 meter centers into undisturbed soil.

5.1.18.2 The Contractor shall measure the resistance to ground for all the above ground leads. As a minimum, readings shall be submitted to the Technical Authority and Owner for the tower anchors, tower base leads, building and fence ground leads as well as the waveguide bridge, AC Ground and all bus bar leads.

5.1.18.3 Ground reading measurements MUST be taken using the “Fall of Potential” method with appropriate Meggor equipment. Results from the use of handheld devices will not be accepted.

5.1.18.4 Resistance measurements must be taken **BEFORE** AC Power is connected to the grounding system to negate the grounding potential of the Hydro lines. For existing RCMP sites, the ground resistance measurements for new installations are to be verified before they are connected to the existing grounding system.

5.1.18.5 Do not proceed with backfilling operations until the Owner/Technical Authority has inspected and approved all grounding work in place. Give 48 hours notice to the Owner/Technical Authority to facilitate the site visit.

5.2 Lighting and Power Supply

5.2.1 It will be the responsibility of the Contractor to install the tower lighting control box on existing RCMP sites. For new RCMP sites the control box shall be shipped to the RCMP Project Manager to be installed in the new RCMP shelter. It will be the Contractors responsibility to install the control box if the control box is not installed by others.

5.2.2 The complete wiring system and lighting fixtures shall be of a waterproof type using COREFLEX CABLE (or approved equal), rigid fittings with cast-iron or aluminum type junction boxes.

5.2.3 All wiring shall be in accordance with CSA requirements, and type RA-90-40C wire shall be used throughout the installation. Wiring shall be supplied and installed as per the following schedule:

Height Range (m)	Conductor Size	
	Main Cable	Branch Cable
0 to 91	#12	#14
91 to 137	#10	#14
137 to 183	#8	#14

5.2.4 Wires shall be routed into a junction box or fixture such that when proceeding up the tower the wires shall exit the box from the bottom and enter the next higher box from the top of the box or fixture.

5.2.5 Tower obstruction lighting shall be wired so that lamps in each double obstruction fixture will be on opposite side of a three-wire circuit.

5.2.6 The obstruction lamps shall be LED based.

5.2.7 AC outlets will not be required on the towers.

5.2.8 Permits and Temporary Lighting

5.2.8.1 The Contractor shall obtain an electrical installation permit from the appropriate agency and submit to the Owner evidence that the lighting installation has been inspected and approved by the said agency.

5.2.8.2 The Contractor shall make arrangements to provide temporary tower lighting until official acceptance of the tower by the Owner.

5.2.9 Ice Protection

5.2.9.1 The Contractor shall install ice protection for all exposed waveguides, lights and lighting system components.

5.2.10 Cable Attachment

5.2.10.1 The Contractor shall adequately secure the cables at intervals that do not exceed manufacturer's recommendations and to a maximum of 1200mm. Cables shall be

fastened to the tower by suitable clamps manufactured specifically for this purpose. Use of metallic ties, wire, wraplock, or plastic ties to secure cables is unacceptable.

5.2.10.2 The cable shall not be bound in a parallel run with any RF transmission lines and must be physically separated from such lines.

5.2.11 Shop Drawings

5.2.11.1 The Contractor shall submit shop drawings clearly indicating all elements of the lighting system.

5.2.12 Termination of Wire and Hook Up

5.2.12.1 The Contractor shall terminate all wiring inside the building, in a panel provided by the Contractor. The location of this panel shall be as indicated for new buildings or as approved by the Technical Authority in existing buildings.

5.2.12.2 The Contractor shall attach conduit to ceilings and walls so as to avoid conflict with existing equipment. All conduits shall be installed in a neat manner.

5.2.13 Photoelectric Cell and Controls

5.2.13.1 The Contractor shall supply the lighting system complete with photoelectric cell and associated controls. (For dual or Red Lighting system only).

5.2.13.2 Photoelectric cell and control details shall be submitted to the Owner and Technical Authority for approval, prior to installation. All units shall meet CSA Standards.

5.2.13.3 All connections to the power supply source shall be the responsibility of the Contractor and shall be completed by qualified electrical personnel.

5.2.14 Lighting System

5.2.14.1 All tower lighting systems shall utilize LED based lamps and shall meet all requirements of CARs 621.19.

5.2.14.2 Where there is a requirement for beacons (as directed by CARs 621.19 or otherwise directed by Transport Canada or Nav Canada), beacons shall be dual red/white medium intensity and utilize LED lamps. Systems shall be complete and be in compliance with CARs 621.19.

5.2.14.3 The white lighting system shall flash white under daytime operation and switch to red for night operations.

5.2.14.4 The light system must be accompanied by the appropriate control box from the manufacturer to allow for future modification to include a red light system for night operation. This is available from the manufacturer upon special request.

5.2.14.5 The white lighting system shall incorporate a back-up system so that it operates with D.O.L.s and red for day and night.

5.2.14.6 Tower lighting systems shall not create noise that may be picked up by the operation of radio equipment installed at the site.

5.2.14.7 All fixtures shall be residential friendly.

5.2.14.8 All Tender submissions shall contain adequate information to evaluate the lighting system. Such information shall include all technical data, control system, local maintenance company, charge out rate for maintenance personnel, response time.

5.2.14.9 The control cabinet shall be located inside the Owners building. All components (electronic card, capacitors, transformers, etc.) are also to be part of the cabinet for control. DO NOT install the lighting control cabinet on the same wall as the waveguide port.

5.2.14.10 The white lighting system at the top of the tower is to contain only the flashing tube. Transformers or capacitors are not to be located at the top of the tower.

5.2.14.11 The light controls shall allow for constant monitoring in both day and night modes, indicate a light failure and define the location of the outage.

5.2.14.12 The alarms shall be easily integrated into the RCMP telemetry system for remote monitoring.

5.2.14.13 The alarm system shall incorporate a fail-safe mode in the case of day or nighttime failure.

End of Section

ATTACHMENT 1

Warning Signage