Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

RETURN BIDS TO:
RETOURNER LES SOUMISSIONS À:

Travaux publics et Services gouvernementaux Canada
Place Bonaventure, portail Sud-Est
800, rue de La Gauchetière Ouest
7 ième étage
Montréal
Québec
H5A 1L6
FAX pour soumissions: (514) 496-3822

SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Comments - Commentaires

Vendor/Firm Name and Address
Raison sociale et adresse du fournisseur/de l'entrepreneur

Issuing Office - Bureau de distribution

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Place Bonaventure, portail Sud-Est
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H5A 1L6

Title - Sujet St-Hubert - Exp.conseil Cent.Contr.	
Solicitation No. - N° de l'invitation 9F030-131009/A	**Amendment No. - N° modif.** 001
Client Reference No. - N° de référence du client 9F030-13-1009	**Date** 2014-05-21
GETS Reference No. - N° de référence de SEAG PW-$MTC-775-12750	
File No. - N° de dossier MTC-4-37015 (775)	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à 02:00 PM** **on - le 2014-06-17**	**Time Zone** **Fuseau horaire** Heure Avancée de l'Est HAE
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☑ **Other-Autre:** ☐	
Address Enquiries to: - Adresser toutes questions à: Aguilera, Maria Pia	**Buyer Id - Id de l'acheteur** mtc775
Telephone No. - N° de téléphone (514) 496-3573 ( )	**FAX No. - N° de FAX** (514) 496-3822
Destination - of Goods, Services, and Construction: **Destination - des biens, services et construction:**	

Instructions: See Herein

Instructions: Voir aux présentes

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Vendor/Firm Name and Address
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Telephone No. - N° de téléphone
Facsimile No. - N° de télécopieur

Name and title of person authorized to sign on behalf of Vendor/Firm (type or print)
Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)

Signature **Date**

Canada

AMMENDMENT 001:

Insertion of missing documents:

1. **Appendix D:** Doing Business, Quebec Region, Architectural and Engineering Services (AES), May 1, 2013

2. **Appendix F:** Functional and Technical Programme (FTP) - RCM Terrestrial Facilities *(Partial version without appendices for information)*

- ALL OTHER TERMS AND CONDITIONS REMAIN UNCHANGED -

Public Works and Government Services Canada

Travaux publics et Services gouvernementaux Canada

Canada

Respect • Integrity • Excellence • Leadership

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Doing Business
Quebec Region

Architectural and Engineering Services

May 1st, 2013 – GDDE # 721745

www.pwgsc-tpsgc.gc.ca

TABLE OF CONTENTS

Appendices

SECTION 1 INTRODUCTION

This document must be used in conjunction with the Terms of Reference TOR (Project brief, Request for proposals or others), as the two documents are complimentary. The TOR describes project-specific requirements while this document deals with information common to all projects. In case of a conflict between the two documents, the requirements of the TOR override this document.

The Consultant shall check with the Project Manager if this document is current. The updated version of the latest is the one applicable to the project.

SECTION 2 PWGSC NATIONAL CADD STANDARD

Drawings shall be in accordance with Public Works and Government Services Canada (PWGSC) National CADD Standards, **Quebec regional version**, and CSA B78.3 of Canadian Standards Association.

Refer to:
http://www.tpsgc-pwgsc.gc.ca/biens-property/cdao-cadd/index-eng.html

For the Quebec region:
http://www.tpsgc-pwgsc.gc.ca/cdao-cadd/index-eng.html

The above link is subject to change. The Consultant shall check with the Project Manager to ensure that the link and related information are current and relevant with regards to PWGSC National CADD Standards **for the Quebec region.**

SECTION 3 - GUIDE TO PREPARATION OF CONSTRUCTION DOCUMENTS FOR PWGSC

1 Purpose

This document provides direction in the preparation of construction contract documents (namely specifications, drawings and addenda) for Public Works and Government Services Canada (PWGSC).

Drawings, specifications and addenda must be complete and clear, so that a contractor can prepare a bid without guesswork. Standard practice for the preparation of construction contract documents requires that:

- Drawings are the graphic means of showing work to be done, as they depict shape, dimension, location, quantity of materials and relationship between building components.
- Specifications are written descriptions of materials and construction processes in relation to quality, colour, pattern, performance and characteristics of materials, installation and quality of work requirements.
- Addenda are changes to the construction contract documents or tendering procedures, issued during the tendering process.

2 Principles of PWGSC Contract Documents

PWGSC's contract documents are based on common public procurement principles. PWGSC does not use Canadian Construction Document Committee (CCDC) documents.

The terms and conditions are prepared and issued by PWGSC as well as other related bidding and contractual documents. For information, the clauses are available on the following web site: http://ccua-sacc.tpsgc-pwgsc.gc.ca/pub/tmtc-eng.jsp
Any questions should be directed to the Project Manager.

3 Quality Assurance

Consultants are required to undertake their own quality control process and must review, correct and coordinate (between disciplines) their documents before sending them to PWGSC.

SPECIFICATIONS

1 National Master Specification

The National Master Specification (NMS) is a master construction specification available in both official languages, which is divided into 48 Divisions and used for a wide range of construction and/or renovation projects. In preparing project specifications, the Consultant must use the current edition of the NMS in accordance with the “NMS User’s Guide”.

The Consultant retains overriding responsibility for content and shall edit, amend and supplement the NMS as deemed necessary to produce an appropriate project specification free from conflict and ambiguity.

2 Specification Organization

Narrowscope sections describing single units of work are preferred for more complex work, however, broadscope sections may be more suitable for less complex work. Use either the NMS 1/3 - 2/3 page format or the Construction Specifications Canada full-page format.

Start each Section on a new page and show PWGSC Project Number, Section Title, Section Number and Page Number on each page. Specification date, project title, and consultant’s name are not to be indicated.

3 Terminology

Use the term "Departmental Representative" instead of Engineer, PWGSC, Owner, Consultant or Architect. "Departmental Representative" means the person designated in the Contract, or by written notice to the Contractor, to act as the Departmental Representative for the purposes of the Contract, and includes a person, designated and authorized in writing by the Departmental Representative to the Contractor.

Notations such as: "verify on site", "as instructed", “to match existing”, “example”, “equal to” or “equivalent to”, "to be determined on site by “Departmental Representative", should not be indicated in the specifications as this promotes inaccurate and inflated bids. Specifications must permit bidders to calculate all quantities and bid accurately. In exceptional cases, if quantities are impossible to identify (i.e. cracks to be repaired) give an estimated quantity for bid purposes (unit prices). Ensure that the terminology used throughout the specifications is consistent and does not contradict the applicable standard construction contract documents.

4 Dimensions

Dimensions are to be in metric only (no dual dimensioning).

5 Standards

As references in the NMS may not be up to date, it is the responsibility of the consultant to ensure that the project specification uses the latest applicable edition of all references quoted. The following is a list of some of the Internet websites which provide the most current publications of standards for reference in the construction specification document.

- CSA standards: http://www.csa.ca
- CGSB standards: http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html
- ANSI standards: http://www.ansi.org
- ASTM Standards: http://www.astm.org
- ULC standards: http://www.ulc.ca
- General reference of standards: http://www.techstreet.com/

The NMS website (http://www.tpsgc-pwgsc.gc.ca/biens-property/ddn-nms/index-eng.html) also links to other documents references in the NMS under its "Links" feature.

6 Specifying Materials

The practice of specifying actual brand names, model numbers, etc., is against departmental policy except for special circumstances. The method of specifying materials shall be by using recognized standards such as those produced by Canadian Gas Association (CGA), Canadian General Standards Board (CGSB), Canadian Standards Association (CSA), and Underwriters' Laboratories of Canada (ULC), or by trade associations such as Canadian Roofing Contractors' Association (CRCA) and Terrazzo, Tile, Marble Association of Canada (TTMAC). Canadian standards should be used wherever possible.

If the above method cannot be used and where no standards exist, specify by a non-restrictive, non-trade name “prescription" or "performance" specifications.

In exceptional or justifiable circumstances or, if no standards exist and when a suitable non-restrictive, non-trade name “prescription” or “performance” specification cannot be developed, specify by trade name. Include all known materials acceptable for the purpose intended, and in the case of equipment, identify by type and model number.

Acceptable Materials: set up the paragraph format as follows:

Acceptable Materials:

1. ABC Co. Model [_____].
2. DEF Co. Model [_____].
3. GHI Co. Model [_____].
4. Alternative Materials: Approved by addendum in accordance with Instructions to Tenderers.

Alternatively, include the following article in Part 1 of each Section in which trade names appear:

Acceptable Materials*: Where materials are specified by trade name refer to the “Instructions to Tenderers” for a procedure to be followed in applying for approval of alternatives.*

Alternative materials to those specified may be considered during the solicitation period, however, the onus will be on the Consultant to review and evaluate all requests for approval of alternative materials.

The term “Acceptable Manufacturers” should not be used, as this restricts competition and does not ensure the actual material or product will be acceptable. A list of words and phrases that should be avoided is included in the NMS User's Guide.

Sole Sourcing: Sole sourcing for materials and work can be used for proprietary systems (ie. fire alarm systems, EMCS – Energy Monitoring and Control Systems). A justification will be required in this context.

Wording for the sole source of work should be in Part 1 as:

“Designated Contractor

.1 Hire the services of [_____] to do the work of this section.”

Wording for the sole source of Energy Monitoring and Control Systems (EMCS) should be in Part 1 as:

“Designated Contractor

.1 Hire the services of [_____] or its authorized representative to complete the work of all EMCS sections.”

and in Part 2 as “Materials

.1 There is an existing [_____] system presently installed in the building. All materials must be selected to ensure compatibility with the existing [_____] system.

Wording for the sole source of materials (ie. fire alarm systems) should be in Part 2 as:

“Acceptable materials

.1 The only acceptable materials are [_____] .”

Prior to including sole source materials and/or work, the Consultant should contact the Project Manager to obtain the approval for the sole sourcing.

7 Unit Prices

Unit prices are used where the quantity cannot be precisely estimated (eg. earth work). The approval of the Project Manager must be sought in advance of their use.

Use the following wording:

[The work for this section] or [define the specific work if required, e.g. rock excavation] will be paid based on the actual quantities measured on site and the unit prices stated in the Bid and Acceptance Form.

In each applicable NMS section, replace paragraph title "Measurement for Payment" with "Unit Prices”.

Refer to Appendix 1 of the Bid and Acceptance Form to view a sample of Unit Price Table.

8 Cash Allowances

Construction contract documents should be complete and contain all of the requirements for the contractual work. Cash allowances are to be used only under exceptional circumstances (ie. utility companies, municipalities), where no other method of specifying is appropriate. Obtain approval from the Project Manager in advance to include cash allowances and then use “Section 01 21 00 - Allowances” of the NMS to specify the criteria.

9 Warranties

It is the practice of PWGSC to have a 12 month warranty and to avoid extending warranties for more than 24 months. When necessary to extend beyond the 12 month warranty period provided for in the General Conditions of the contract, use the following wording in Part 1 of the applicable technical sections, under the heading "Extended Warranty":

- "For the work of this Section [_____], the 12 month warranty period is extended to 24 months.

- Where the extended warranty is intended to apply to a particular part of a specification section modify the above as follows: "For [_____] the 12 month ... [_____] months."

Delete all references to manufacturers' guarantees.

10 Scope of Work

No paragraphs noted as "Scope of Work" are to be included.

11 Summary and Section Includes in Part -1 General of Section

Do not use the terms "Summary" and "Section Includes."

12 Related Sections

In every section of the specification at 1.1 "Related Sections": coordinate the list of related sections and appendices. Ensure co-ordination among the sections of the specification and ensure not to reference any section or appendices which do not exist.

13 Index

List all the plans and specification sections with correct number of pages, section names and correct drawing titles in the format shown in Appendix C.

14 Regional requirements

The Consultant should contact the Project Manager to obtain the regional requirements concerning Division 01 or other short form specifications as might be appropriate. For example, in the Quebec Region, the use of the *Section 01 11 01 – Work related general information* is necessary.

15 Health and Safety

It is required that all project specifications include "Section 01 35 29.06 - Health and Safety Requirements." Confirm with the Project Manager to determine if there are any instructions to meet regional requirements.

16 Designated Substances Report

Include "Section 01 14 25 - Designated Substances Report"

17 Subsurface Investigation Reports

Subsurface Investigation Report(s) are to be included after Section 31 and the following paragraph should be added to Section 31:

Subsurface investigation report(s)

.1 Subsurface investigation report(s) are included in the specification following this section.

When the Project Manager determines that it is not practical to include the subsurface investigation report(s), alternate instructions will be provided.

Where tender documents are to be issued in both official languages, the subsurface investigation report(s) shall be issued in both languages.

In addition to the provision of the Subsurface Investigation Report, the foundation information required by the National Building Code of Canada 2005 (Division C, Part 2, 2.2.4.6) shall be included on foundation drawings.

18 Experience and Qualifications

Remove experience and qualification requirements from specification sections.

19 Prequalification and Pre-award submissions

Do not include in the specification any mandatory contractor and/or subcontractor prequalification or pre-award submission requirements that could become a contract award condition. If a prequalification process or a pre-award submission is required, contact the Project Manager.

There should be no references to certificates, transcripts or license numbers of a trade or subcontractor being included with the bid.

20 Contracting Issues

Specifications describe the workmanship and quality of the work. Contracting issues should not appear in the specifications. Division 00 of the NMS is not used for PWGSC projects.

Remove all references within the specifications, to the following:

- General Instructions to Bidders
- General Conditions
- CCDC documents
- Priority of documents
- Security clauses
- Terms of payment or holdback
- Tendering process
- Bonding requirements
- Insurance requirements
- Alternative and separate pricing
- Site visit (Mandatory or Optional)
- Release of Lien and deficiency holdbacks

DRAWINGS

1 Title Blocks
Use PWGSC title block for drawings and sketches (including addenda).

2 Dimensions
Dimensions are to be in metric only (no dual dimensioning).

3 Trade Names
Trade names on drawings are not acceptable. Refer to SECTION 3, SPECIFICATIONS, 6.0 Specifying Materials for specifying materials by trade name.

4 Specification Notes
No specification type notes are to appear on any drawing.

5 Terminology
Use the term "Departmental Representative" instead of Engineer, PWGSC, Owner, Consultant or Architect. "Departmental Representative" means the person designated in the Contract, or by written notice to the Contractor, to act as the Departmental Representative for the purposes of the Contract, and includes a person, designated and authorized in writing by the Departmental Representative to the Contractor.

Notes such as: "verify on site", "as instructed", “to match existing”, “example”, “equal to” or “equivalent to”, "to be determined on site by “Departmental Representative", should not appear on drawings as this promotes inaccurate and inflated bids. Drawings must allow bidders to calculate all quantities and bid accurately. In exceptional cases, where quantities are impossible to quantify (i.e. cracks to be repaired), refer to indications contained in section 3, Specifications, 3 Terminology.

6 Information to be included
Drawings should show the quantity and configuration of the project, the dimensions and details of how it is constructed. There should be no references to future work or any information planned to be changed by future addenda. The scope of work should be clearly detailed and elements not in contract should be eliminated or kept to an absolute minimum.

7 Drawing Numbers: Sets of drawings shall be numbered according to the type of drawing and the discipline involved, as indicated in the PWGSC NATIONAL CADD STANDARD.

During the Design Phase of the project each issue and review of documents must be noted on the Notes block of the drawing title, but at the time of construction document preparation, all revision notes should be removed.

8 Presentation Requirements: Present drawings in sets comprising the applicable civil, architectural, structural, mechanical and electrical drawings in that order. All drawings should be of uniform standard size.

9 Prints: Print with black lines on white paper. Confirm with Project Manager the size of prints to be provided for review purposes.

10 **Binding:** Staple or otherwise bind prints into sets. Where presentations exceed 20 sheets, the drawings for each discipline may be bound separately for convenience and ease of handling.

11 **Legends:** Provide a legend of symbols, abbreviations, references, etc., on the front sheet of each set of drawings or, in large sets of drawings, immediately after the title sheet and index sheets.

12 **Schedules:** Where schedules occupy entire sheets, locate them on top of each set of drawings for convenient reference. *See CGSB 33-GP-7 Architectural Drawing Practices for schedule arrangements.*

13 **North Points:** On all plans include a north point. Orient all plans in the same direction for easy cross-referencing. Wherever possible, lay out plans so that the north point is at the top of the sheet.

14 **Drawing Symbols:** Follow generally accepted drawing conventions, understandable by the construction trades, and in accordance with PWGSC publications.

ADDENDA

1 Format

Prepare addenda using the format shown in Appendix B. No signature type information is to appear.

Every page of the addendum (including attachments) must be numbered consecutively. All pages must have the PWGSC project number and the appropriate addendum number. Sketches shall appear in the PWGSC format, signed and sealed.

No Consultant information (name, address, phone #, consultant project # etc.) should appear in the addendum or its attachments (except on sketches).

2 Content

Each item should refer to an existing paragraph of the specification or note/detail on the drawings. The clarification style is not acceptable.

DOCUMENTS FOR TENDER CALLS

1 Translation

When required, all documentation included in the construction contract documents shall be in both official languages.

Ensure that English and French documents are equal in all respects. There can be no statement that one version takes precedence over the other.

2 Consultant shall provide:

- Per construction document submission, a completed and signed Checklist for the Submission of Construction Documents. See Appendix 'A'.
- Specification: originals printed one side on 216 mm x 280 mm white bond paper.
- Index: as per Appendix 'C'
- Addenda (if required): as per Appendix 'B' (to be issued by PWGSC).
- Drawings: reproducible originals, sealed and signed by the design authority.
- Tender information:
  - Including a description of all units and estimated quantities to be included in unit price table.
  - Including a list of significant trades including costs. PWGSC will then determine which trades, if any, will be tendered through the Bid Depository.

    Government Electronic Tendering System (MERX): Consultants to provide an electronic true copy of the final documents (specifications and drawings) on one or multiple CD-ROM in Portable Document Format (PDF) without password protection and printing restrictions. The electronic copy of drawings and specifications for bidding and construction purposes are required to be signed and sealed by professionals in each discipline. See Appendix 'D' and Appendix 'E'.

3 PWGSC shall provide:

- General and Special Instructions to Bidders
- Bid and Acceptance Form
- Standard Construction Contract Documents

SECTION 4 CLASSES OF CONSTRUCTION COST ESTIMATES USED BY PWGSC

DESCRIPTION OF THE CLASSES OF ESTIMATES USED BY PWGSC FOR CONSTRUCTION COSTING OF BUILDINGS PROJECTS

Class 'D' (Indicative) Estimate:

Based upon a comprehensive statement of requirements, and an outline of potential solutions, this estimate is to provide an indication of the final project cost, and allow for ranking all the options being considered.

Submit Class D cost estimates in elemental cost analysis format latest edition issued by the Canadian Institute of Quantity Surveyors with cost per m² for current industry statistical data for the appropriate building type and location. Include a summary in the cost estimate, plus full back up, showing items of work, quantities, unit prices, allowances and assumptions.

The level of accuracy of a class D cost estimate shall be such that no more than a 20% design contingency allowance is required.

Class 'C' Estimate:

Based on a comprehensive list of requirements and assumptions including a full description of the preferred schematic design option, construction/design experience, and market conditions. This estimate must be sufficient for making the correct investment decision.

Submit Class C cost estimates in elemental cost analysis format latest edition issued by the Canadian Institute of Quantity Surveyors with cost per m² for current industry statistical data for the appropriate building type and location. Include a summary in the cost estimate, plus full back up, showing items of work, quantities, unit prices, allowances and assumptions.

The level of accuracy of a class C cost estimate shall be such that no more than a 15% design contingency allowance is required.

Class 'B' (Substantive) Estimate:

Based on design development drawings and outline specifications which include the design of all major systems and subsystems, as well as the results of all site/installation investigations. This estimate must provide for the establishment of realistic cost objectives and be sufficient to obtain effective project approval.

Submit Class B cost estimates in elemental cost analysis format latest edition issued by the Canadian Institute of Quantity Surveyors. Include a summary in the cost estimate, plus full back up, showing items of work, quantities, unit prices, allowances and assumptions.

The level of accuracy of a class B cost estimate shall be such that no more than a 10% design contingency allowance is required.

Class 'A' (Pre-Tender) Estimate:

Based on completed construction drawings and specifications, prepared prior to calling competitive tenders. This estimate must be sufficient to allow a detailed reconciliation/negotiation with any contractor’s tender.

Submit Class A cost estimates in both elemental cost analysis format and trade divisional format latest edition issued by the Canadian Institute of Quantity Surveyors. Include a summary in the cost estimate, plus full back up, showing items of work, quantities, unit prices, allowances and assumptions.

The level of accuracy of a class A cost estimate shall be such that no more than a 5% design contingency allowance is required.

SECTION 5 TIME MANAGEMENT

5 Time Management, Planning, and Control

The Time Management, Planning, and Control Specialist (scheduler) shall provide a Project Planning and Control System (Control System) for Planning, Scheduling, Progress Monitoring and Reporting and a Time Management, Planning, and Control Report (Progress Report). It is required that a fully qualified and experienced Scheduler play a major role in providing services in the development and monitoring of the project schedule.

The scheduler will follow good industry practices for schedule development and maintenance as recognized by the Project Management Institute (PMI).

PWGSC presently utilizes the Primavera Suite software and MicroSoft Project for it's current Control Systems and any software used by the consultant should be fully integrated with these, using one of the many commercially available software packages.

5.1 Schedule Design

Project Schedules are used as a guide for execution of the project as well as to communicate to the project team when activities are to happen, based on network techniques using Critical Path Method (CPM).

When building a Control System you must consider:

1. The level of detail required for control and reporting;
2. The reporting cycle- monthly and what is identified in the Terms of Reference, but also includes Exception Reports;
3. That the duration must be in days;
4. What is required for reporting in the Project Teams Communications Plan and
5. The nomenclature and coding structure for naming and reporting requirements of activities, schedules and reports.

5.2 Schedule Development

For purposes of monitoring and reporting of project progress and ease of schedule review it is important to maintain a standard for all schedules and reports starting with the Work Breakdown Structure (WBS), identification of Milestones, naming of activities as well as schedule outputs and paper sizing and orientation.

Work Breakdown Structure

When developing the schedule the consultant needs to use PWGSC standards and practices. Two basic requirements are the National Project Management System (NPMS) and a Work Breakdown Structure (WBS), structured supporting the NPMS (Levels 1-4).

The WBS is as follows:

- Level 1 Project Title (NPMS)
- Level 2 Project Stage (NPMS)
- Level 3 Project Phase (NPMS)
- Level 4 Processes to meet Deliverables/Control Points Milestones (NPMS)
- Level 5 Sub-Processes and Deliverables in support of Level 4
- Level 6 Discrete activities. (Work Package)

Not all the Stages, Phases and Processes in the NPMS will be required on all the projects, however the structure remains the same.

Major and Minor Milestones

The Major Milestones are standard Deliverables and Control Points within NPMS and are required in all schedule development. These Milestones will be used in Management Reporting within PWGSC as well as used for monitoring project progress using Variance Analysis. The Minor milestones are process deliverables (Level 4) or sub-process deliverables (level 5) also used in Variance Analysis.

Each Milestone will also be assigned appropriate coding for Status Reporting and Management Reporting.

Milestones must have zero duration and are used for measuring project progress.

Milestones may also be external constraints such as the completion of an activity, exterior to the project, affecting the project.

Activities

All activities will need to be developed based on Project Objectives, Project Scope , Major and Minor Milestones, meetings with the project team and the scheduler's full understanding of the project and it's processes.

Subdivide the elements down into smaller more manageable pieces that organize and define the total scope of work in Levels 5-6 that can be scheduled, costed, monitored and controlled. This process will develop the Activity List for the project.

Each activity is a discrete element of work and is the responsibility of one person to perform.

Each activity will describe the work to be performed using a verb and noun combination (i.e. Review Design Development Report).

Activities should not have durations longer that 2 update cycles, with exception of activities not yet defined in a “Rolling Wave”.

Each activity will be assigned at WBS level 6 and appropriately coded for Status Reporting and Management Reporting.

These elements will become activities, interdependently linked in Project Schedules.

Project Logic

Once the WBS, Milestones and Activity List have been developed the activities and milestones can be linked in a logical manner starting with a Project Start Milestone. Every activity and milestone must be linked in a logical manner using either a Finish to Start (FS), Finish to Finish (FF), Start to Start (SS) or Start to Finish (SF) relationship. There can be no open-ended activities or milestones.

A Finish to Start (FS) is the preferred relationship.

When developing relationships; avoid the use of lags and constraints in place of activities and logic.

Activity Duration

The activity duration (in days) is the estimated length of time it will take to accomplish a task.

Consideration needs to be taken in how many resources are needed and are available, to accomplish any activity. (Example: availability of Framers during a “Housing Boom”.) Other factors are the type or skill level of the available resources, available hours of work, weather etc.

There will be several types of lists and schedules produced from this process, which will form part of the Progress Report.

Activity List

An Activity List identifies all activities including milestones required to complete the whole project.

Milestone List

A Milestone List identifies all project Major and Minor milestones.

Master Schedule

A Master Schedule is a schedule used for reporting to management at WBS level 4 and 5 that identifies the major activities and milestones derived from the detailed schedule. Cash Flow projections can be assigned at WBS level 5 for monitoring the Spending Plan.

Detailed Project Schedule

A Detailed Project Schedule is a schedule in reasonable detail (down to WBS Level 6 and 7) for progress monitoring and control, this will ensure that the schedule shall be in sufficient detail to ensure adequate planning and control.

5.3 Schedule Review and Approval

Once the scheduler has identified and properly coded all the activities; put them into a logical order and then determined the appropriate durations. The scheduler can then analyze the schedule to see if the milestone dates meet the contractual requirements and then adjust the schedule accordingly by changing durations, resource leveling or changing logic.

When the schedule has been satisfactorily prepared the scheduler can present the detailed schedule to the Project Team for approval and be Baselined. There may be several iterations before the schedule meets with the Project Teams agreement and the contractual requirements.

The final agreed version must be copied and saved as the Baseline to monitor variances for reporting purposes.

5.4 Schedule Monitoring and Control

Once Baselined the schedule can be better monitored, controlled and reports can be produced.

Monitoring is performed by, comparing the baseline activities % complete and milestone dates to the actual and forecast dates to identify the variance and record any potential delays, outstanding issues and concerns and provide options for dealing with any serious planning and scheduling issues in report form.

Analyze and report from early start sequence on all activities due to start, underway, or finished for the complete project.

Thee will be several reports generated from the analysis of the baseline schedule and will form part of the Time Management Report in the Required Services Sections (RS)

Progress Reports

A Progress Report reflects the progress of each activity to the date of the report, any logic changes, both historic and planned, projections of progress and completion the actual start and finish dates of all activities being monitored.

The Progress Report includes:

A Narrative Report, detailing the work performed to date, comparing work progress to planned, and presenting current forecasts. This report should summarize the progress to date, explaining current and possible deviations and delays and the required actions to resolve delays and problems with respect to the Detail Schedule, and Critical Paths.

Narrative reporting begins with a statement on the general status of the project followed by a summarization of delays, potential problems and project status criticality, any potential delays, outstanding issues and concerns and options for dealing with any serious planning and scheduling issues.

A Variance Report, with supporting schedule documentation, detailing the work performed to date, comparing work progress to planned. This report should summarize the progress to date, explaining all causes of deviations and delays and the required actions to resolve delays and problems with respect to the Detail Schedule, and Critical Paths.

A Criticality Report identifying all activities and milestones with negative, zero and up to five days Total Float used as a first sort for ready identification of the critical, or near critical paths through the entire project.

Included in the Progress Report as attachments are: WBS chart, Activity Lists, Milestone Lists, Master Schedules, Detailed Project Schedule

Exception Report

The Scheduler is to provide continuous monitoring and control, timely identification and early warning of all unforeseen or critical issues that affect or potentially affect the project.

If unforeseen or critical issues arise, the Scheduler will advise the Project Manager and submit proposed alternative solutions in the form of an Exception Report.

An Exception Report will include sufficient description and detail to clearly identify:

1. Scope Change: Identifying the nature, reason and total impact of all identified and potential project scope changes affecting the project.
2. Delays and accelerations: Identifying the nature, the reason and the total impact of all identified and potential duration variations.
3. Options Enabling a Return to the project baseline: Identifying the nature and potential effects of all identified options proposed to return the project within baselined duration.

5.5 Standard issue of documents

At each issue of documents or deliverable stage provide a complete and updated Progress Report, the contents of each report will vary with requirements and at each project phase. Typically a Progress Report has:

1. Executive Summary;
2. Narrative Report;
3. Variances Report;
4. Criticality Report;
5. Exception Report (as required)
6. Work Breakdown Structure Chart;
7. Activity List;
8. Milestone List;
9. Master Schedule with Cash Flow Projections;
10. Detail Project Schedule (Network Diagram or Bar Charts);

5.6 Schedule Outputs and Reporting Formats

The sheet sizing and orientation is more a suggestion that a role, changes to the paper format may vary to accommodate the information and column information required.

Progress Reports

Paper Size: Letter
Paper Format: Portrait
Title Format: Project Title; Report Type; Print Date; Data Date; Revision Block
Body Text: Narratives for each report to match other reports generated in the D.S.S.
Variance Report Columns: Activity ID, Activity Name, Planned Finish, Revised Finish, Variance, Activity % Complete,
Criticality Report Columns: Activity ID, Activity Name, Duration, Start, Finish, Activity % Complete, Total Float.

Exception Reports

Paper Size: Letter
Paper Format: Portrait
Title Format: Project Title; Report Type; Print Date; Data Date; Revision
Body Text: Narrative to match other reports generated in the D.S.S.
Paper Size: Letter
Paper Format: Landscape
Title Format: Project Title; Report Type; Print Date; Data Date; Revision
Columns: Activity ID, Activity Name, Duration, Remaining Duration, Start, Finish, Total Float.

Work Breakdown Structure (indent tree):

Paper Size: Letter
Paper Format: Portrait
Columns: WBS Code, WBS Name, Duration, Cost estimate, start and finish dates.
Footer Format: Project Title; Report Type; Print Date; Data Date; Revision Block

Activity Lists

Paper Size: Letter
Paper Format: Portrait
Columns: Activity ID, Activity Name, Start, Finish, Predecessor, Successor.
Footer Format: Project Title; Report Type; Print Date; Data Date; Revision Block

Sort with Early Start, then Early Finish, then Activity ID and with the WBS.

Milestone Lists

Paper Size: Letter
Paper Format: Portrait
Footer Format: Project Title; Report Type; Print Date; Data Date; Revision Block
Columns: Activity ID, Activity Name, Start, Finish.

Sort with Early Start, then Early Finish, then Activity ID and without the WBS.

Master Schedule (Bar Chart)

Paper Size: 11X17
Paper Format: Landscape
Footer Format: Project Title; Report Type; Print Date; Data Date; Revision Block
Columns: Activity ID, Activity Name, Duration, Activity % Complete, Start, Finish, Total Float.

Sort with Early Start, then Early Finish, then Activity ID and with the WBS.

Detailed Project Schedules (Bar Chart)

Paper Size: 11X17
Paper Format: Landscape
Footer Format: Project Title; Report Type; Print Date; Data Date; Revision Block
Columns: Activity ID, Activity Name, Duration, Activity % Complete, Start, Finish, Total Float.

Sort with Early Start, then Early Finish, then Activity ID and with the WBS.

SECTION 6 RISK MANAGEMENT

6.1 DEFINITIONS

Procurement Plan: Formal submission for approval to enter into a contract and composed of a (1) cost estimate of the requirement (including cash allowances, and design, estimating and inflation allowances), (2) a contingency and, (3) an anticipated amendment amount.

Allowances: Additional resources included in an estimate to vcover the cost of known but undefined requirements for an individual activity, work item, account or sub account: design allowance, ecstimating allowance, inflation allowance and other allowances specifically identified are part of a cost estimate

Cash Allowances : a specific amount to be used for specific work item or service.
(a) Cash Allowance Construction: additional resources included in an estimate to cover the cost of known but undefined requirements whose probability of occurrence is high. this allowance is specifically identified in a cost estimate.
(b) Cash Allowance Consultant: additional services included in an estimate to cover the cost of known but undefined requirements whose probability of occurrence is high. this allowance is specifically identified in a cost estimate.

Risk Allowance: Anticipated monetary value of risk events, due to the complexity of the project, market conditions, competitiveness, and timing of project, contingencies are likely to happen and do not form part of cost estimates.

Anticipated Amendments: This is basically the pre-authorization of amending authority to a certain level. Individual contract amendments within this authority must still be approved by the correct level of authority.

The total amount of the Anticipated Amendment to a project cost estimate is determined as the summation of the Expected Monetary Value of risk events reasonably expected to occur during the life cycle of a project.

Risk Management: The art and science of identifying, analyzing, and responding to risk factors throughout the life of a project and in the best interests of its objectives. (PMBOK)

Risk Event: A discrete occurrence that may effect the project for better or worse (i.e. late delivery of a piece of equipment is a “risk event” that may cause a schedule delay).

Probability: The likelihood that an event will occur (i.e. Low, Medium, High).

Impact: The result of the occurrence of an event on the project either positive or negative. (i.e. a schedule delay as a result of late delivery of a piece of equipment may have a high negative impact on a project; increased access to a construction site due to early departure of occupants in an office space may have a positive impact on a project).

The Impact of individual Risk Events can be qualified as low, medium, high or quantified in terms of time, cost (immediate cost or in-service cost (O&M)) or performance.

High risk*: A project (or element of a project) may be assessed as high risk if one or more hazards exist in a significant way and, unless mitigated, would result in probable failure to achieve project objectives.

Medium risk*: A project (or element of a project) may be assessed as medium risk if some hazards exist but have been mitigated to the point that allocated resources and focused risk management planning should prevent significant negative effect on the attainment of project objectives.

Low risk*: A project (or element of a project) should be assessed as low risk if hazards do not exist or have been reduced to the point where routine project management control should be capable of preventing any negative effect on the attainment of project objectives.

**per Treasury Board Secretariat Manuals Chapter 2-2 Project Management*

EMV: Expected monetary value of risk event (i.e. cost or saving to the project if risk event occurs)

6.2 RISK MANAGEMENT CHECKLIST

Probability, impact, over all risk, risk response and risk allowance are to be determined for each item listed below;

Resources External to Project Management Team

- Planning Resources and Performance
  - errors and omissions
  - low accuracy of estimates (allowances)
  - data inadequacies
  - level of liability insurance
  - potential for misinterpretation / misunderstanding of documents
  - planning inexperience
- Construction Resources Required & Performance
  - level of liability insurance
  - design versus execution methods
  - suitability of execution methods to design
  - commissioning issues (start up / turnover difficulties)
  - contractor construction strategy
  - reputation of contractor
  - contractor financial stability
  - contractor inexperience
  - resources obtained less qualified than desired
  - availability / suitability / performance of resource

Project Scope Delivery

- Delivery of Specified Requirement
  - accuracy of client requirements in terms of cost/ schedule / performance / quality and ability to interface with existing environment
  - conflicting client priorities
  - low level of client knowledge

- Unstated Client Requirements
  - completeness of client requirements in terms of cost/ schedule / performance / quality and ability to interface with existing environment
  - restricted working conditions
  - opportunities for changes / positive impact

- Stakeholder Requirements, Stated and Unstated
  - low involvement of user groups in scope of definition
  - interface with existing systems
  - restricted working conditions
  - operational needs

Site / Asset / Building Actual Conditions

- Actual Physical Environment
  - availability / accuracy of as built documentation and existing condition reports
  - high variability / low stability of soils
  - potential for soil contamination
  - presence of hazardous materials
  - availability / access to site
  - presence of other contractors on site
  - climate (winter conditions, rain, wind, water levels)

Government / PWGSC / Client / Context

- Impact on Adjacent Areas Actual
  - impact on adjacent areas (land / tenants/ traffic / operations)

- Impact from External Sources
  - legal lawsuits, patent rights, licensing, etc.
  - political impacts including visibility of project
  - social sensibilities
  - potential strikes
  - market risks
  - bad press (media coverage)

- Impact from Unanticipated Regulatory Change
  - environmental legislation and environmental screening
  - potential changes to Acts, Codes and Regulations
  - municipal building / occupancy permit issues

- Procedures Known
  - suitability of tender documents
  - suitability of contracting method
  - delays in tendering process
  - client internal coordination
  - change order process

- Plan Approval / Design Reviews
  - approvals may be required from Client, PWGSC, Treasury Board, FHBRO, Fire Commissioner, Police, Emergency Services, Municipalities, Cities, etc.
  - absence of Investment Analysis
  - unstable / changing client organization
  - heritage building issues
  - health and safety issues
  - potential for “hold orders”
  - design review delays (client / PWGSC / TBS / other)
  - approval delays (client / PWGSC / TBS / other)

APPENDIX 'A' - Checklist for the issue of Construction Documents to PWGSC

Last updated 2011-07-28

Date:	
Project Title:	**Project Location:**
Project Number:	**Contract Number:**
Consultant's Name:	**PWGSC Project Manager:**
Review Stage: **66%** □ **99%** □ **100%** □	

Item	Verified by:	Comments:	Action by:
Specifications:			
1 National Master Specifications			
1a The current edition of the NMS has been used.			
2 Specification Organization			
2a Either the NMS 1/3 - 2/3 page format or the Construction Specifications Canada full page format is used.			
2b Each Section starts on a new page and the Project Number, Section Title, Section Number and Page Number show on each page.			
2c Specification date and consultant's name are not indicated.			
3 Terminology			
3a The term Departmental Representative is used instead of Engineer, PWGSC, Owner, Consultant or Architect.			
3b Notations such as: "verify on site", "as instructed", "to match existing", "example", "equal to", "equivalent to" and "to be determined on site by" are not used.			
4 Dimensions			
4a Dimensions are provided in metric only.			
5 Standards			
5a The latest edition of all references quoted is used.			

Item	Verified by:	Comments:	Action by:
Specifications:			
6 Specifications Materials			
6a The method of specifying materials uses recognized standards. Actual brand names and model numbers are not specified.			
6b Identify if non-restrictive, non-trade name "prescription" or "performance" specifications are used.			
6c Indicate if a list of acceptable materials have been used.			
6d The term "Acceptable Manufacturers" is not used.			
6e Indicate if sole sourcing has been used.			
7 Unit Prices			
7a Unit prices are used only for work that is difficult to estimate.			
8 Cash Allowances			
8a Indicate if cash allowances have been used.			
9 Warranties			
9a Indicate if warranties extend more than a 12 or 24 months period.			
9b Manufacturers guarantees are not indicated.			
10 Scope of Work			
10 No paragraphs noted as "Scope of Work" are included.			
11 Summary and Section Includes			
11a In part 1 of section, paragraphs "Summary" and "Section Includes" are not used.			
12 Related Sections			
12a The list of related sections and appendices are coordinated.			
13 Index			
13a The index shows a complete list of drawings and specification sections with the correct number of pages and correct drawing titles and section names.			

Item	Verified by:	Comments:	Action by:
Specifications:			
14 **Regional requirements**			
14a General Instructions are included (Section 01 11 01 for Quebec region).			
15 Health and Safety			
15a Section 01 35 29.06 - Health and Safety Requirements is included.			
16 Designated Substances Report			
16 a Section 01 14 25 - Designated Substances Report is included.			
17 **Subsurface Investigation Reports**			
17a Subsurface Investigation Reports are included in Division 31.			
18 Experience and qualifications			
18a Experience and qualification requirements do not appear in the specification sections			
19 Pre-qualifications			
19a There are no mandatory contractor and/or subcontractor pre-qualification requirements or references to certificates, transcripts or license numbers of a trade or subcontractor being included in the bid.			
20 Contracting Issues			
20a Contracting issues do not appear in the specifications.			
20b Division 00 of the NMS is not used.			
21 Quality Issues			
21a There are no specification clauses with square brackets "[ ]" or lines "__" indicating that the document is incomplete or missing information.			

Item	Verified by:	Comments:	Action By:
Drawings:			
1 Title Blocks			
1a The PWGSC title block is used.			
1b The project information in the title block is coordinated between disciplines.			
2 Dimensions			
2a Dimensions are provided in metric only.			
3 Trade Names			
3a Trade names are not used.			
4 Specification Notes			
4a There is no specification type notes.			
5 Terminology			
5a The term Departmental Representative is used instead of Engineer, PWGSC, Owner, Consultant or Architect.			
5b Notations such as: “verify on site”, “as instructed”, “to match existing”, “example”, “equal to”, “equivalent to” and “to be determined on site by” are not used.			
6 Information to be included			
6a The project quantity and configuration, dimensions and construction details are included.			
6b References to future work and elements not in contract do not appear or are kept to an absolute minimum and clearly marked.			

Item	Verified by:	Comments:	Action By:
Drawings:			
7 *Respect of PWGSC standards for electronic format*			
7a The electronic format of drawings respects the current CADD standards of PWGSC.			
7b The electronic format of drawings and specifications, in English and French, respects the PWGSC directory structure for electronic tender documents.			

I confirm that the plans and specifications of all disciplines have been thoroughly reviewed and that the items listed above have been addressed or incorporated. I acknowledge and accept that by signing certifying that all items noted above have been addressed, should it be found during the tendering of these documents or implementation of the project, that the items above were not properly addressed, my firm will be responsible to resolve all related issues at my firm's expense and may receive an unsatisfactory consultant performance evaluation which could have an impact on my firm's ability to obtain work from PWGSC in the future.

Consultant's Representative: _____

Firm name: _____

Signature: _____ Date: _____

APPENDIX 'B' - Sample of Addendum
Last updated April 22, 2008

ADDENDUM No. _____

Project Number: _____

The following changes in the bid documents are effective immediately. This addendum will form part of the contract documents

DRAWINGS

SPEC NOTE: indicate drawing number and title, then list changes or indicate revision number and date, and re-issue drawing with addendum.

1 A1 Architectural

.1

SPECIFICATIONS

SPEC NOTE: indicate section number and title.

1 Section 01 11 01 – Work related general information

SPEC NOTE: list all changes (i.e. delete, add or change) by article or paragraph

.1 Delete article (xx) entirely.
.2 Refer to paragraph (xx.x) and change ...

2 Section 23 05 00 - Common Work Results - Mechanical

.1 Add new article (x) as follows:

APPENDIX 'C' - Sample of Index for Drawings and Specifications
Last updated April 22, 2008

Project No: _____ **Index**
Page 1 of ___

DRAWINGS AND SPECIFICATIONS

SPECIFICATIONS:

SPEC NOTE: List all Divisions, Sections (by number and title) and number of pages.

DIVISION	SECTION	NO. OF PAGES
DIVISION 01	01 11 01 – Work related general information.....	xx
	01 14 25 - Designated Substances Report.....	xx
	01 35 29.06 - Health and Safety.....	xx
DIVISION 23	23 xx xx	
DIVISION 26	26 xx xx	

DRAWINGS:

SPEC NOTE: List all Drawings by number and title.

C-1	Civil and landscaping
A-1	Architectural
S-1	Structural
M-1	Mechanical
E-1	Electrical

APPENDIX 'D'

USER MANUAL ON DIRECTORY STRUCTURE AND NAMING CONVENTION STANDARDS FOR CONSTRUCTION TENDER DOCUMENTS ON CD ROM

Issued by:

Real Property Contracting Directorate

PWGSC

May 2005

Last Updated: June 3, 2008

Version 1.0

PREFACE

The Government of Canada (GoC) has committed to move towards an electronic environment for the majority of the services it offers. This covers the advertisement and distribution of contract opportunities, including construction solicitations. As a result, it is now necessary to obtain a copy of construction drawings and specifications (in PDF format ***without*** password protection) on one or multiple CD-ROM to facilitate for the GoC the transfer of the construction drawings and specifications electronically to the Government Electronic Tendering System (GETS).

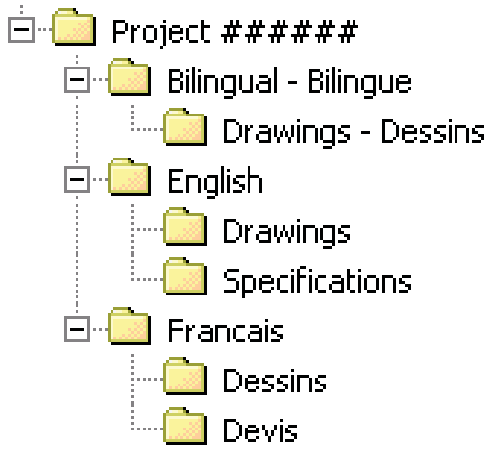
There is therefore a need to adopt a common directory structure and file-naming convention to ensure that the information made available to contractors electronically and in hard (printed) copy is in accordance with the sequence adopted in the real property industries, both for design and construction. This manual defines the standard to be followed by both consultants and print shops at time of formatting and organizing the information, whether drawings and specifications are created by scanning print documents or saved as PDF files from the native software (AutoCAD, NMS Edit, MS-Word, etc…) in which these were created.

It is important to note that the procedure described in this manual is not an indication that consultants are relieved from following the established standards for the production of drawings and specifications. The sole purpose of this manual is to provide a standard for the organization and naming of the electronic files that will be recorded on CD-ROM.

1. DIRECTORY STRUCTURE

1.1 1st, 2nd and 3rd Tier Sub-Folders

Each CD-ROM, whether it is for the original solicitation (tender call) or for an amendment (addendum), must have the applicable elements of the following high-level Directory Structure created:



The following important points are to be noted about the Directory Structure:

- The "*Project ######*" folder is considered the 1st Tier of the Directory Structure where ###### represents each digit of the Project Number. The Project Number must always be used to name the 1st Tier folder and it is always required. Free text can be added following the Project Number, to include such things as a brief description or the project title;

- The "*Bilingual - Bilingue*", "*English*" and "*Français*" folders are considered the 2nd Tier of the Directory Structure. The folders of the 2nd Tier **cannot** be given any other names since GETS uses these names for validation purposes. At least one of the "*Bilingual - Bilingue*", "*English*" and "*Français*" folders is always required, and these must always have one of the applicable sub-folders of the 3rd Tier;

- The "*Drawings - Dessins*", "*Drawings*", "*Specifications*", "*Dessins*" and "*Devis*" folders are considered the 3rd Tier of the Directory Structure. The folders of the 3rd Tier **cannot** be given any other names since GETS also uses these names for validation purposes. There must be always at least one of the applicable 3rd Tier folder in each document.

IMPORTANT:	The applicable elements of the Directory Structure (1st, 2nd and 3rd Tier folders) are always required and cannot be modified.

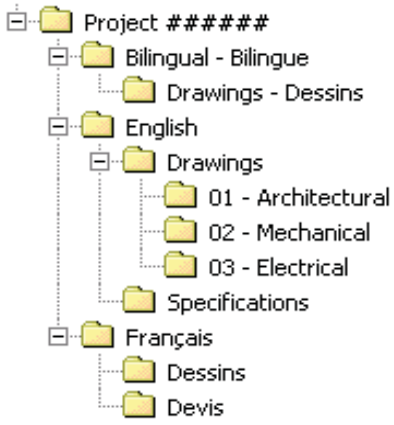
1.2 4th Tier Sub-Folders for Drawings

The "*Drawings – Dessins*", "*Drawings*" and "*Dessins*" folders must have 4th Tier sub-folders created to reflect the various disciplines of the set of drawings.

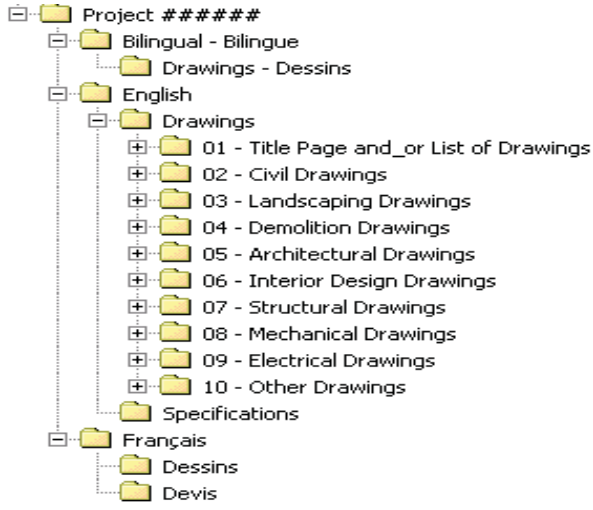
Because the order of appearance of the sub-folders on the screen will also determine the order of printing, it is necessary to start with a number the identification name of the sub-folders in the "*Drawings – Dessins*", "*Drawings*" and "*Dessins*" folders.

Note: The first sub-folder must be always reserved for the Title Page and/or the List of Drawings unless the first drawing of the set is an actual numbered discipline drawing.

Examples of 4th Tier sub-folders for drawings:



or



1.2.1 Naming Convention

The 4th Tier sub-folders for drawings must adhere to the following standard naming convention.

For the "*Drawings*" and "*Dessins*" folders:

- Y

Where:

= A two digit number ranging from 01 to 99 (leading zeros must be included)

Y = The title of the folder

Example: 03 – Mechanical

For the "*Drawings - Dessins*" folder:

- Y - Z

Where:

= A two digit number ranging from 01 to 99 (leading zeros must be included)

Y = The English title of the folder

Z = The French title of the folder

Example: 04 - Electrical - Électricité

It should be noted that the numbering of the 4th Tier sub-folders is for sorting purposes only and is not tied to a specific discipline. For example, "*Architectural*" could be numbered 05 for a project where there is four other disciplines before "*Architectural*" in the set of drawings or 01 in another project where it's the first discipline appearing in the set.

It is essential to ensure that the order of the drawings on the CD-ROM be exactly the same as in the hard copy set. GETS will sort each drawing for both screen display and printing as per the following rules:

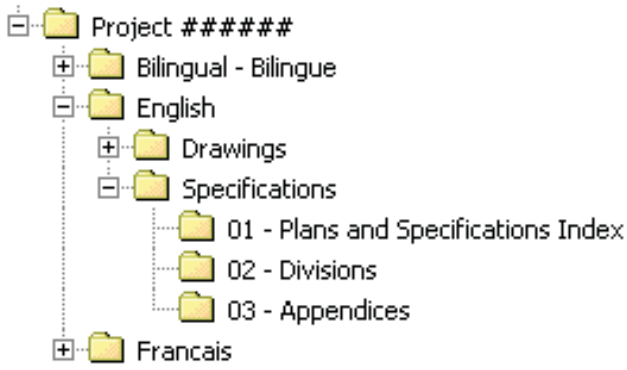
- The alphanumerical sorting is done on an ascending order;
- The alphanumerical order of the sub-folders determines the order of appearance on the screen as well as the order of printing (as an example: all the drawing PDF files in the 01 sub-folder will be printed in alphanumerical order before the drawings in the 02 sub-folder etc…);
- Each drawing PDF file within each sub-folder will also be sorted alphanumerically. This will determine the order of appearance on the screen as well as the order of printing (i.e. Drawing A001 will be printed before Drawing A002, Drawing M02 before Drawing M03, etc…).

1.3 4th Tier Sub-Folders for Specifications

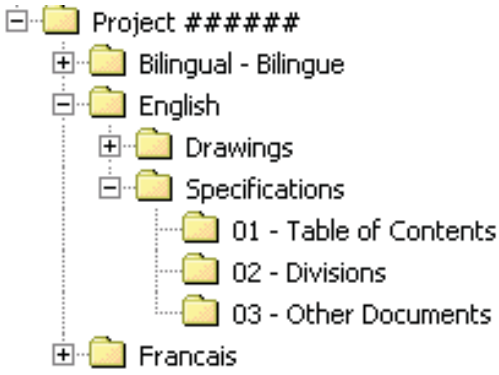
The "*Specifications*" and "*Devis*" folders must have 4th Tier sub-folders created to reflect the various elements of the specifications.

Because the order of appearance of the sub-folders on the screen will also determine the order of printing, it is necessary to start with a number the identification name of the sub-folders in the "*Specifications*" and "*Devis*" folders.

Examples of 4th Tier sub-folders for specifications:



or



1.3.1 Naming Convention

The 4th Tier sub-folders for specifications must adhere to the following standard naming convention.

For the "*Specifications*" and "*Devis*" folders:

- Y

Where:

## =	A two digit number ranging from 01 to 99 (leading zeros must be included)
Y =	The title of the folder

Example: **02 – Divisions**

It should be noted that the numbering of the 4th Tier sub-folders is for sorting purposes only and is not tied to an element of the specifications.

It is essential to ensure that the order of the elements of the specifications on the CD-ROM be exactly the same as in the hard copy. GETS will sort each element of the specifications for both screen display and printing as per the following rules:

- The alphanumerical sorting is done on an ascending order;
- The alphanumerical order of the sub-folders determines the order of appearance on the screen as well as the order of printing (as an example: all the specifications PDF files in the 01 sub-folder will be printed, in alphanumerical order before the PDF files in the 02 sub-folder, etc…);
- Each specifications PDF file within each sub-folder will also be sorted alphanumerically. This will determine the order of appearance on the screen as well as the order of printing (i.e. Division 01 will be printed before Division 02, 01 - Appendix A before 02 - Appendix B, etc…).

2. NAMING CONVENTION FOR PDF FILES

Each drawing, specifications division or other document that are part of the tender documents must be converted in PDF format (without password protection) in accordance with the following standard naming convention and each PDF file must be located in the appropriate sub-folder of the Directory Structure.

2.1 Drawings

Each drawing must be a **separate single page** PDF file. The naming convention of each drawing must be:

X### - Y

Where:

X = The letter or letters from the drawing title block ("*A*" for Architectural or "*ID*" for Interior Design for example) associated with the discipline

= The drawing number from the drawing title block (one to three digits)

Y = The drawing name from the drawing title block (for bilingual drawings, the name in both English and French is to appear)

Example: A001 - First Floor Details

Each drawing that will be located in the appropriate discipline 4th Tier sub-folders must be named with the same letter ("*A*" for Architectural Drawings for example) and be numbered. The drawing number used to name the PDF file must match as much as possible the drawing number of the actual drawing (the exception being when leading zeros are required).

The following important points about drawings are to be noted:

- The drawing PDF files within each sub-folder are sorted alphanumerically for both displaying and printing. If there are more than 9 drawings in a particular discipline the numbering must use at least two numerical digits (i.e. A01 instead of A1) in order to avoid displaying drawing A10 between A1 and A2. The same rule applies when there are more than 99 drawings per discipline i.e. three digits instead of two must be used for the numbering (for example M003 instead of M03);

- If drawing PDF files are included in the "*Bilingual - Bilingue*" folder, these cannot be included as well in the "*English*" and/or "*Français*" folders;

- If drawings not associated with a particular discipline are not numbered (Title Page or List of Drawings for example), these will be sorted alphabetically. While this does not represent a problem if there is only one drawing in the sub-folder, it could disrupt the order when there are two or more drawings. If the alphabetical order of the drawings name does not represent the order on the hard copy set, the drawings are to be named as per the following standard convention when converted in PDF format to ensure proper display and printing order.

  ## - Y

  Where:

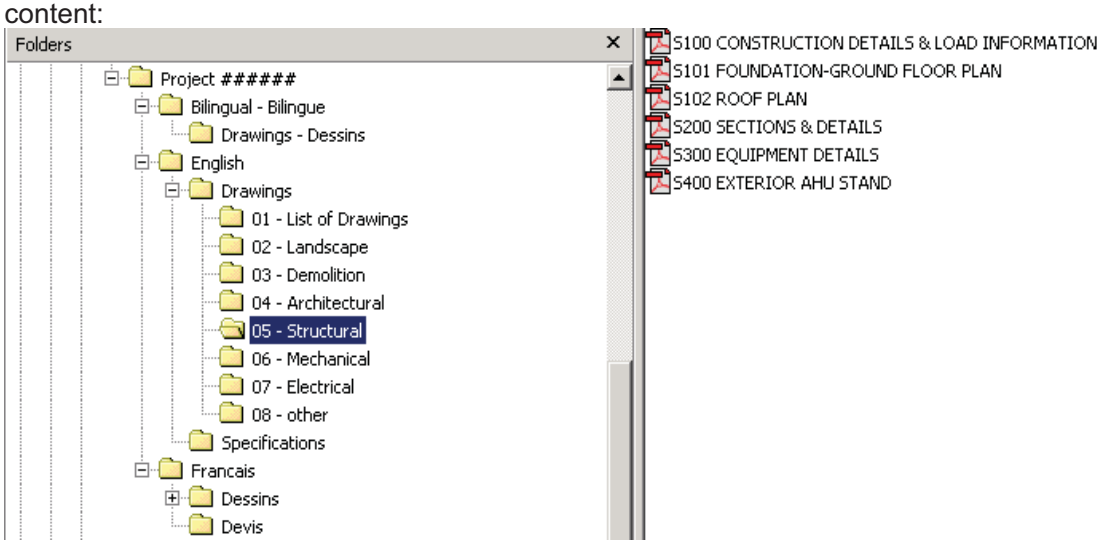
  ## = A two digit number ranging from 01 to 99 (leading zeros must be included)

  Y = The name of the drawing

  Example: 01 - Title Page
  02 - List of Drawings

  If numbers are not used in the PDF files name, "*List of Drawings*" will be displayed before "*Title Page*" because "L" comes before "T" in the alphabet.

Example of a 4th Tier Drawings sub-folder's content:



2.2. Specifications

Each Specifications Division must be a separate PDF file and all pages contained in each PDF file must have the same physical size (height, width). The Plans and Specifications Index must also be a separate PDF file. If there are other documents that are part of the Specifications (e.g. Appendix or other) these are to be separate PDF files as well.

2.2.1 Documents other than Specifications Divisions

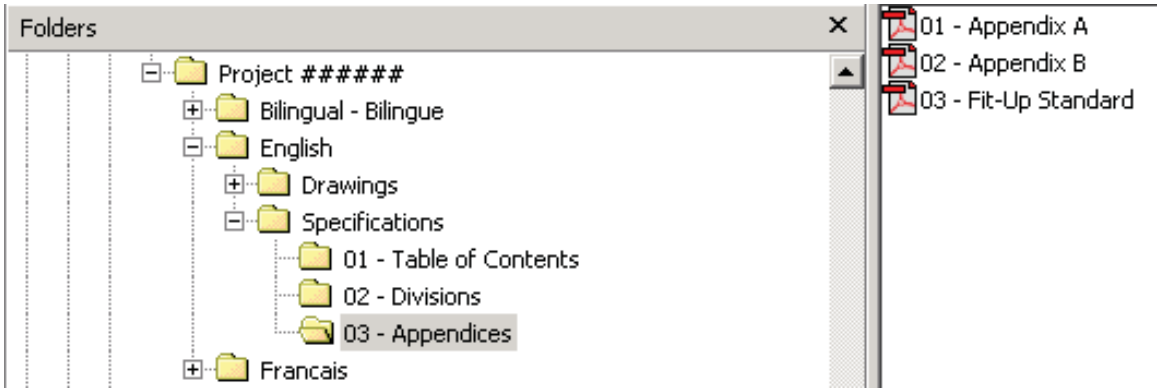
Because PDF files within the Specifications sub-folders are sorted alphanumerically (in ascending order) for both on screen display and printing order, all files that appear in folders other than the "*Divisions*" sub-folder must be named using a number:

- Y

Where:

## =	Two digit number ranging from 01 to 99 with leading zeros required
Y =	Name of the document
Example:	01 - Plans and Specifications Index

Example of a sub-folder content (sub-folder other than "*Divisions*"):



2.2.2 Specifications Divisions

The Specifications Divisions must be named as follows:

Division ## - Y

Where:

Division ## = The actual word "*Division*" followed by a space and a two digit number ranging from 01 to 99 (with leading zeros required)

Y = Name of the Specifications Division as per **CSC/CSI MasterFormat™**

Example: Division 05 – Metals

The following important point about specifications is to be noted:

- The Numbering of the Divisions **cannot** be altered from **CSC/CSI MasterFormat™** even if some Divisions are not used in a given project. For example, Division 05 will always remain Division 05 even if Division 04 is not used for a given project.

Example of a "*Divisions*" sub-folder content:

3. CD-ROM LABEL

Each CD-ROM is to be labeled with the following information:

Project *Number* / *Numéro* de projet
Project Title / *Titre du projet*
Documents for Tender / Documents pour appel d'offres
CD *X* of/de *X*

Example:

Project 123456 / Projet 123456
Repair Alexandra Bridge / Réparation du pont Alexandra
Documents for Tender / Documents pour appel d'offres
CD 1 of/de 1

APPENDIX 'E'

BASIC REFRENCE GUIDE ON CONVERTING CONSTRUCTION DRAWINGS INTO PORTABLE DOCUMENT FORMAT (PDF)

Issued by:

Real Property Contracting Directorate

PWGSC

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PREFACE

Portable Document Format (PDF) is the standard format for documents that are posted on the Government Electronic Tendering System (GETS). There is therefore a need to obtain from architectural and engineering consultants an electronic copy of drawings and specifications in PDF for tendering Government of Canada (GoC) construction projects.

In order to have the highest quality in term of resolution and printing, consultants should to the greatest extent possible have the PDF drawing and specification files derived from the native software in which they were created. Scanning is permissible but only in special circumstances, for example when there is no electronic version of a drawing being included in a construction tender package.

The purpose of this document is to provide basic information on the conversion of Computer Aided Design and Drafting (CADD) drawings in PDF. Creating a PDF file from a CADD drawing is a relatively simple process once all the necessary configurations and settings are in place. It actually should not take any longer than it would take to create a plot file or to send a drawing to a printer. The information in this guide is not intended to cover all technical aspects of the conversion, which can be done using various methods, but rather to highlight important points about the process and file settings. The conversion of specifications is not covered in this basic reference guide since it does not require any special configuration or setting.

The information provided in this basic reference guide is not an indication that consultants are relieved from following the established standards for the production of drawings and specifications. The sole purpose of this guide is to provide basic information on the PDF conversion process bearing in mind that additional detailed technical information is available from the various software manufacturers.

1.0 PRINTER DRIVERS

Adobe Acrobat provides two different printer drivers that are able to convert CADD drawing into PDF format, Acrobat PDF Writer and Acrobat Distiller. Before creating a PDF file from a CADD drawing, a choice must be made as to which one will be used.

Acrobat PDF Writer is a non-PostScript printer driver that works best with documents that don't contain complex graphics

Acrobat Distiller is a PostScript printer driver that works best with documents that contain PostScript fills, Encapsulated PostScript (EPS) graphics, or other complex elements.

It is recommended that Acrobat Distiller be used to create PDF file of architectural and engineering drawings due to their size and complex graphical nature.

2.0 PRINTER CONFIGURATION

Before converting a CADD drawing to PDF, an Acrobat printer configuration file for the PDF paper size needs to be created. This function can be done in the CADD software rather than using a custom paper size defined for the Acrobat distiller feature. The recommended method is to add a PostScript Adobe plotter in the CADD software and making the necessary setting in terms of media source and size, scale and orientation. The configuration can then be re-used to simplify the conversion process for future files that use the same page size.

As an alternative, although not recommended, a custom-defined size can be created in Acrobat Distiller in the *properties* menu.

3.0 CREATING PDF FILES

Once the printer configuration has been done in the CADD software, open up Acrobat Distiller and make the necessary settings in the *preferences* and *job options* sub-menu. Ensure that the page size match the sheet size selected in the CADD software to create the file. Particular settings can be saved under different names for future use.

With the Acrobat Distiller application open, ensure the required sheet size is displayed in the *job options* window. Then it is simply a matter of bringing the CADD file into the Acrobat Distiller creation box.

A progress bar will show during the conversion and the newly converted PDF file should open up and be displayed for verification.

4.0 PDF FILES SETTINGS

4.1 Security

Adobe Acrobat contains security features that can de used to secure the files by restricting any changes to the files. However, since the files will be posted on GETS and will be used for printing copies, the files **must not** be password protected and **must** allow printing.

4.2 Drawing Orientation

The final PDF drawing files must be displayed on the screen in the same direction that the users are intended to view them. This can be achieved by adjusting the setup of the plotter. If the drawing is not oriented properly after the conversion, it can be rotated manually within Adobe Acrobat.

4.3 Font Type

In order to avoid any problems during the conversion and to minimize the potential for font display errors, the fonts used for the production of construction drawings must be *PostScript or True Type fonts.*

4.4 Resolution

Since the PDF files will be used for printing, it is important that a proper resolution be selected. It is recommended to select 600 dots per inch (dpi).

4.5 Scale

When choosing the Plot scale in Adobe, it is important to choose the 1:1 scale to ensure the integrity of the scale from which the drawings were created in the CADD software.

5.0 SCANNING

Scanning is not recommended and should be done only when the drawing is not available electronically. When scanning a drawing, it is important that it be done in real size (scale 1:1) to ensure that the scale remains intact in subsequent printing. It is recommended that each scanned drawing be opened and verified to ensure that the resolution, scale and border are of an acceptable quality.

6.0 FINAL CHECKLIST

When the drawing file has gone trough the PDF conversion, it is recommended to open it and verify the following:

- That the sheet size displayed is what was intended to be created (the size is viewable in the lower left corner of the drawing).
- That the orientation of the sheet is correct.
- That the line types, line weights and fonts match the CADD drawing.
- That the PDF file is in black and white.
- That each drawing is a single PDF file.
- That the PDF file is not password protected and printable.

If all the items are verified, the PDF file is useable

7.0 ADDITIONAL INFORMATION

For more information about the creation of PostScript and EPS files please refer to the User's Guide of the CADD software being used to produce the drawings. For more information about creating PDF file please refer to the Acrobat Distiller User's Guide and/or visit the Adobe Web site at www.adobe.com.

Canadian Space Agency
John H. Chapman Space Centre

6767, route de l'Aéroport
Saint-Hubert (Québec)

N/Ref : 09350-74

February 24th, 2014

Functional and Technical Programme (FTP)
RCM Terrestrial Facilities

Original document by

CIMAISE
Rochon
Experts-Conseils

Partial version without appendices for information

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In the past few years, the number of satellite missions has increased at the Canadian Space Agency. All of the missions are currently controlled from the John H. Chapman Space Centre in St-Hubert. The upcoming integration of the Radarsat Constellation Mission creates an immediate need to rethink the Mission control center and its purpose for the next 20 years.

This new RadarSat Constellation Mission has particular needs that require remodeling of the actual department; additional space is required in this area of the Space Centre in order to run properly. Considering this situation and given the agency's intention to increase the number of missions, it is proposed to reorganize the department in order to accommodate future missions. This reorganization of the department will have an impact on current facilities and missions; considering the critical nature of running missions, significant coordination will be required for Radarsat Constellation integration.

The integration of the Radarsat Constellation Mission to the current facilities requires an additional 1018 square meters in Pavilion 2 level 2 of the Space Centre. This is in addition to the 1051 square meters required to run missions, which will bring the total area of the Satellite Operations department to 2069 square meters. Thanks to the free space available in this area, it is possible to fit the new mission's rooms in the satellite department.

Considering the intention to accommodate additional satellite missions, the Mission control center department must be designed so that room reorganization is easily possible with as few changes as possible. Services, both mechanical and electrical, equipment, layout, security and rooms must allow for flexibility in order to include missions for the next 20 years. Furthermore, integration of multimission teams must seriously be considered in the planning of the new Mission control center.

SECTION 1

INTRODUCTION

This Functional and Technical Program's main goal is to confirm real estate requirements for the Radarsat Constellation Mission's (RCM) program and to establish the possibility of its integration into the Primary Control Facility's (PCF) actual facilities.

Integration of the RCM program's required spaces aligns with an update of the Mission control center (MCC) and its contiguous rooms in P2N2 of the Head Office in St-Hubert. This project, being the first major in this area since the building construction 15 years ago, it must be planned to account for the next 20 years. Therefore, this area must reflect the flexibility required to ensure operation workflow for the coming years.

The RCM program is developed by ASC in partnership with MacDonald, Dettwiler & Associates Inc (MDA), which is the main contractor for Radarsat construction. MDA, a long-time partner, is currently using space within the MCC for mission control such as Radarsat 2.

1.1 AGENCY PRESENTATION

1.1.1 MISSION

Established in March 1989, the Canadian Space Agency (CSA) was created through an Act of Parliament, proclaimed in December 1990. The CSA is committed to leading the development and application of space knowledge for the benefit of Canadians and humanity.

To achieve this, the Agency promotes an environment where all levels of the organization:

1 Pursue excellence collectively
2 Advocate a client-oriented attitude
3 Support employee-oriented practices and open communications
4 Commit itself to both empowerment and accountability and
5 Pledge to cooperate and work with partners to our mutual benefit

Its mandate is to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians.

1.1.2 SPACE CENTRE

The agency building is now 21 years old; in late June 1993, the CSA headquarters was completed in Saint-Hubert (Longueuil), Quebec. The building houses the astronaut training facilities, the RADARSAT Mission Control Room, the MOC (MSS Operation Centre) and labs devoted to life sciences, robotics, space systems, optics, and computer technology.

1.1.3 CURRENT AND FUTURE SATELLITE PROGRAMS

All of the following satellite missions are, or will be, controlled directly from the SatOps of the John H. Chapman Space Centre. Missions will be run simultaneously by the CSA and private industry partners such as MDA.

Radarsat 1

Launched in November 1995, RADARSAT-1 provided Canada and the world with an operational radar satellite system capable of timely delivery of large amounts of data. Equipped with a powerful synthetic aperture radar (SAR) instrument, it acquired images of the Earth day or night, in all weather and through cloud cover, smoke and haze. RADARSAT-1 was Canada's first Earth-observation satellite. RADARSAT-1 was a Canadian-led project involving the Canadian federal government, the Canadian provinces, the United States, and the private sector. It provided useful information to both commercial and scientific users in such fields as disaster management, interferometry, agriculture, cartography, hydrology, forestry, oceanography, ice studies and coastal monitoring. The satellite reached its end of service life in 2013, thus bringing an end to the Radarsat 1 mission.

SCISAT

Launched on August 12, 2003, SCISAT helps a team of Canadian and international scientists improve their understanding of the depletion of the ozone layer, with a special emphasis on the changes occurring over Canada and in the Arctic. The Canadian SCISAT mission is a partnership of universities, government, and industry. A scientific team of researchers from around the world is conducting in the Atmospheric Chemistry Experiment (ACE) which aims to measure and understand the chemical processes that control the distribution of ozone in the Earth's atmosphere, particularly in the northern latitudes.

Radarsat 2

Launched in December 2007, Radarsat 2, Canada's next-generation commercial radar satellite offers powerful technical advancements that will enhance marine surveillance, ice monitoring, disaster management, environmental monitoring, resource management and mapping in Canada and around the world. RADARSAT-2 demonstrates the Canadian space community's leadership in developing remote sensing technology and applications. With state-of-the-art technology, it is one of the world's most advanced commercially available Earth observation radar image providers and offers users around the world an expanded range of high-quality data products for hundreds of applications.

NEOSSat

The Near-Earth Object Surveillance Satellite (NEOSSat), launched February 25, 2013, is the latest in a proud family of world-leading Canadian satellites. The world's first space telescope dedicated to detecting and tracking asteroids and satellites. It circles the globe every 100 minutes, scanning space near the Sun to pinpoint asteroids that may someday pass close to Earth. NEOSSat is also sweeping the skies in search of satellites and space debris as part of Canada's commitment to keeping orbital space safe for everyone.

M3MSat

Canada is currently building the M3MSat (Maritime Monitoring and Messaging Micro-Satellite), a technology demonstration satellite that will be used to assess the utility of having in space an Automatic Identification System (AIS) for reading signals from vessels to better manage marine transport in Canadian waters. Scheduled to be launched in 2014, M3MSat will be able to process data from the marine self-configuring network implemented by the International Maritime Organization through the United Nations.

RCM

The RADARSAT Constellation is the evolution of the RADARSAT Program with the objective of ensuring data continuity, improved operational use of Synthetic Aperture Radar (SAR) and improved system reliability. The three-satellite configuration will provide complete coverage of Canada's land and oceans offering an average daily revisit, as well as daily access to 95% of the world to Canadian and International users. The mission development has begun in 2005, with satellite launches planned for 2018.

1.2 RELEVANT STUDIES AND PROJECTS

1.2.1 ARCHITECTURE

Studies

Two studies have been previously conducted, concerning the RCM facilities location, both handed to the CSA in March 2011. The first study aimed to determine the possibility of developing the new control inside the high bays. It was suggested to add two floors inside the high bays' existing volume. It was thus possible to create 1095 square meters of new floor area. In addition, about 500 square meters of existing surface was reassigned to the RCM program. Access and circulation, both vertical and horizontal, needed to be modified according to staff, to increase this area of the building.

The purpose of the second study was to evaluate the possibility of adding a new Pavilion on the east end of the dorsal area. The new Pavilion would be comprised of one floor measuring 1960 square meters. This new building was intended to house the new RCM control center and the existing Mission control

center. By doing so, existing rooms were freed up in Block 2 level 2 for Block 8 and 9 relocation.

Due to the major financial requirement as well as the lack of available functional spaces, these options were put aside. Both options require structural work, which significantly increase costs for Control Center implementation. In the first study, spaces were spread out throughout the Agency, which is not adequate for proper mission operation.

1.2.2 MECHANICAL

Server room capacity increase

A former study of the capacity increase opportunity of the server rooms of CSA, located at P2N2 and P2N3 (levels 2 and 3 of pavilion 2) was presented in December 2009, complete with proposed solutions. One of these solutions has been applied and converted into a project that was completed in May 2011. That project included new A/C fan-coil units of increased capacity, all without involving any shut down of the CSA computer rooms, including the existing RADARSATs server room at P2N2.

In 2011, a short study that took into account the final results of the upgraded A/C systems was presented to the CSA. Among various conclusions, it was estimated that in the RADARSAT server room, the maximum heat dissipation could be raised from 23 kW, actual cooling charge, to 43 kW, without disturbing the whole chilled water infrastructure currently in place at P2N3, including chiller capacity back-ups at P6N1.

Building condition report

A Building Condition Report (BCR) was produced for the CSA for the whole facility of the John H. Chapman Centre in 2011 and among other recommendations, the replacement of the existing stand-alone URA units was highlighted to be done in the future, since these units were installed and have been in operation since 1993 and are at their standard life cycle end after twenty (20) years.

Smoke detection system

A study to improve the performance of the smoke detection system (VESDA) of the server rooms has been conducted in December 2013. The conclusion of that study was to make modifications to the existing system.

1.2.3 ELECTRICITY

For the architectural studies that analyzed the feasibility of implementing the RCM mission facilities in the high bays area and in a separate building at St-Hubert, electrical studies were also conducted simultaneously. The considerations of the electrical disciplines in each of the studies allowed the agency to define the technical approach and to assign figures for carrying out the project. Unfortunately, due to architectural considerations, mostly financial, there was no choice but to set these studies aside.

Server room capacity increase

In a study presented in December 2009 and along with other mechanical solutions proposed in order to increase the server rooms' capacity and reliability, one of the proposed solutions has been applied. This solution was converted into a project and completed in May 2011. This project included the installation of a new emergency generator set of 600kW at 347/600V, 3P, 4W for redundancy, the increase of UPS A and B systems from 150kVA to 225kVA and all the modifications required to the electrical distribution in order to supply accordingly the required mechanical equipment. This equipment, which is part of the

critical ventilation and cooling systems, is now backed up by the redundant generator set systems in which the new 600kW generator sets play a crucial role. It is worth mentioning that all of the work was carried on without any shut down to the CSA server rooms, including the Radarsat's computer room #2B-205.A1.

Building condition report

A BCR (building cost report) has been produced to review the actual conditions of the entire John H. Chapman Space Centre equipment in order to put in place a facility modernization plan. Following the recommendations indicated in the BCR, the fire alarm system (detection and auxiliary function and display) shall be replaced by 2015 in a separate project. The report also concluded that the two existing generator sets of 310kW and 1250kW, along with the UPS systems of 225kVA each, are considered to be in good condition and reliable to supply the critical loads for the next 20 years. But in order to increase the reliability and at the same time to leverage the monitoring capability, the main control panels of both generator sets will be replaced in a separate project expected to end in 2014.

1.3 FTP OBJECTIVES

Since its creation, all CSA satellite missions have been planned, controlled and monitored from the John H. Chapman Space Centre in St-Hubert. Over time, the number of simultaneous missions has increased, therefore requiring more resources within the building. However, new technologies allowed to reduce the size of the satellites' required equipment inside the agency, permitting the Mission control center to remain in the rooms provided for this purpose at the building construction.

The CSA would like to increase the number of satellite missions managed from the Space Centre. With this in mind, the Radarsat Constellation Mission (RCM) has been established. However, the mission multiplication involves increased resource needs within the Mission control center. With this in mind, this FTP aims to:

- Confirm real estate requirements for the RCM program;
- Determine if available resources (space, equipment, electrical and mechanical services) are sufficient;
- Determine the Mission control center space requirements;
- Determine the Mission control center services requirements (mechanical, electrical);
- Determine the Mission control center equipment requirements;
- Determine security levels for the Mission control center;
- Propose technical solutions in order to meet Mission control center requirements.

1.4 ASSUMPTIONS

Given that this FTP is partly based on existing facilities used for current satellite operations, some assumptions have been established. Therefore, the following statements have been considered valid for data compilation and FTP development:

- The different functions, listed in room area schedule, are all required;
- The functions' dedicated surfaces are adequate;
- The number of employees in each room is adequate;
- The operational requirements of the existing rooms are adequate
- The integration of the multimission team will avoid future requirements for additional resources.
- Required rooms can be placed anywhere in the Mission control center in order to ensure optimal department layout.

1.5 SATOPS FACILITIES

1.5.1 ARCHITECTURE

Since the construction of the John H. Chapman Space Centre, all of the satellite operations are performed from Pavilion 2 level 2 (P2N2). Currently, the area of the Mission control center is 1051 square meters (see appendix 1) and includes all the rooms required for running missions. There are currently 3 satellite missions running and managed from the centre.

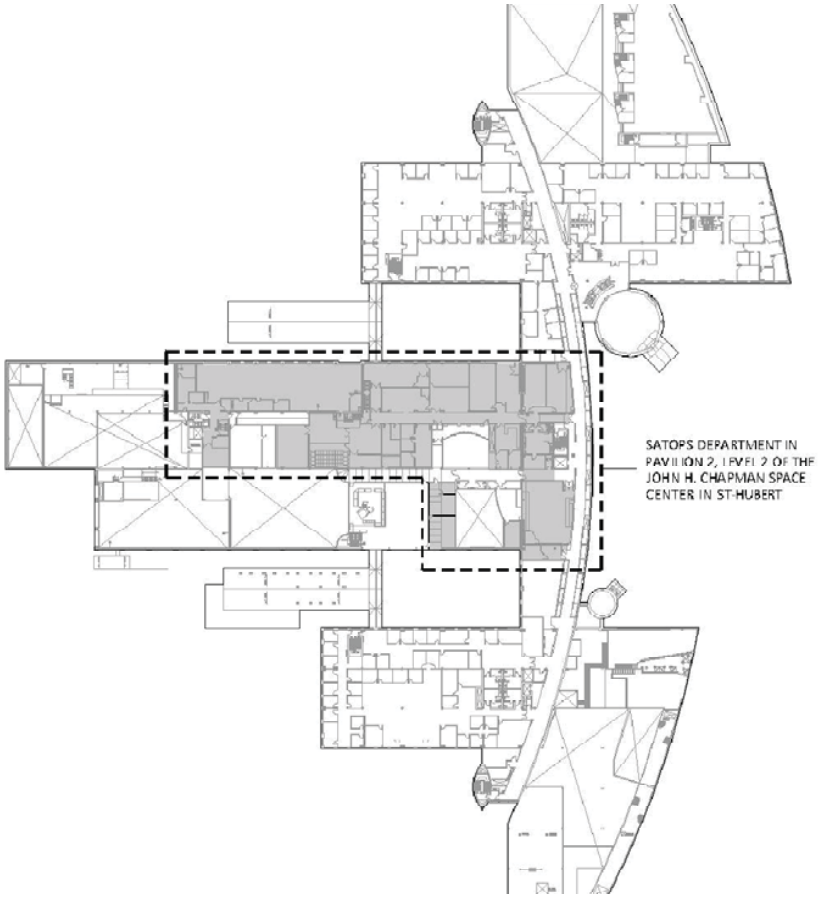

Figure 1 – Mission control center location within P2N2

Currently, the department includes dedicated rooms for planning, launching, controlling and compiling data. These rooms are assisted by support rooms, such as server rooms and telecom rooms, but they also have various rooms for technicians and engineers. Moreover, since this department is active 24 hours per day, it is independent from the main building and has its own kitchenette and sanitary rooms.

Additional area

It is important to mention that some rooms, adjacent to the MCC, such as 2C200 and 2D200, are currently unoccupied. Of these rooms, some have been freed up following program shutdowns; missions are generally stopped when equipment reaches its end of service life or when programs are over. These rooms can be reorganized to accommodate MCC requirements. In addition, the last missions required smaller equipment, which helped to maintain free space in this area. Thereby, taking into account that the actual IT department, currently occupying rooms in P2N2, can be relocated

elsewhere in the Space Centre, thereby creating free space, an additional area of 901 square meters is available in the SatOps area.

Available area

When combining currently used space for satellite programs with vacant space in this zone, a total area of 1952 square meters is available in P2N2 of the John H. Chapman Space Centre. In the Room Area Schedule, Appendix 1 of this document, there is a list of existing space, showing how the existing rooms are allocated.

As indicated in the Room Area Schedules, the upcoming integration of the RCM program to existing facilities requires an additional area of 943 square meters, spread throughout the MCC. Based on the 901 square meters of additional space available in P2N2, see Zone 950 on Room Area Schedule, there is a shortfall of 42 square meters. It should be noted that combining the existing and RCM satellite missions exceeds the total available area in Pavilion 2. Even though there are 42 square meters lacking, this only represents 2% of the total required area for SatOps operations. Considering this low percentage, combined with the circulation coefficient, which can be lowered to thereby reduce the MCC area required, it can be stated that the P2N2 area is large enough to integrate all required rooms for satellite operations, both for current missions and the RCM mission.

Circulation coefficient

The circulation coefficient, with a value of 1.36 (rounded to 1.4), is a factor applied to net surfaces to allow for circulation space. It is thus possible to determine ideal surfaces needed, allowing spaces to be functional. This factor takes into account room nature and use, and space obstruction by furniture, as well as number of users and their ability to move. Therefore, in this situation, given obstructing equipment in spaces and number of employees, the factor has been set at 1.36.

1.5.2 MECHANICAL

General

The John H. Chapman Space Centre is heated, ventilated and air-conditioned by several HVAC systems for different types of space needs.

As a standard of the building, exposed spaces are heated by hot-water baseboard heaters. A heating loop of variable water temperature controlled from the boiler room provides the necessary heat to match the total losses.

Offices and meeting room service

Offices and meeting rooms are generally treated by double duct or single duct H type systems, equipped with hot water heating coils, chilled water cooling coils, steam humidifiers, fresh and return air mixing boxes controlled by CO2 (carbon dioxide) controllers or by free cooling economizers. In the Primary Control Facility (PCF) area, most of the offices and meeting rooms are treated by dedicated zone "Liebert" units.

Server rooms A/C units

Server rooms are air-conditioned year-long by chilled water supplied fan-coils in P2N2 and P2N3. A smoke removal ventilation exhaust system protects these rooms in case of fire, in addition to the clean agent and sprinklers system.

Stand-alone A/C units (URA)

Currently, eight (8) stand-alone C/A "Liebert" units (#URA-001 to URA-008) condition an estimated portion of 708 m² of the main SatOps area. Two (2) out of those (8) units supply conditioned air through ceiling diffusers. Six (6) of these units supply air through a raised floor and return it through the ceiling. These height (8) units have a total capacity of 42.5 tons of refrigeration, equivalent to 137 kW of electric sensible heat gains.

Telco area fan-coil units

The electrical switch room and telecommunications equipment room (called the TELCO area) are air-conditioned by (3) three dedicated chilled water fan-coils (AC systems # 058, 059 and 060) for a total cooling capacity of 6 total tons of refrigeration, equivalent to 19 kW of electric sensible heat dissipation.

Central heating and cooling of the John H. Chapman Centre

Main heating equipment:	2 natural gas boilers of 200 BHP/each, used in winter;
	1 electrical 800 kW boiler, used during low peak periods;
	2 hot water heating loops supply baseboard type convectors and unit heaters on the perimeter;
Main cooling equipment:	3 centrifugal type chillers of 300 tons/each, used in summer with open type cooling towers;
	2 turbine type chillers of 70 and 80 tons, operated year-long with closed type cooling towers;
	1 screwtype 80 ton chiller, used mainly for the server rooms cooling redundancy with a glycol fluid cooler.
Steam production for humidification:	1 natural gas steam boiler of 100 BHP, used in winter.

Humidification

All ventilation systems requiring humidification are connected to the building's steam piping network, except the URA "Liebert" units in the PCF area, which have their own independent internal steam humidifiers.

Chilled water

The chilled water produced by the above redundant system provides the cooling capacity to the FAN-COILS of the server rooms and also to the (8) stand-alone air-conditioning units URA-001 to 008 of the current offices and technical room facilities at P2N2.

Central HVAC systems available for the RCM project

Among the numerous HVAC systems of the John H. Chapman Space Centre, specifically four (4) systems supply conditioned air to the existing area in P2N2, which is proposed to integrate additional space requested by the RCM integration project. A brief description of these units is as follows:

System #007	Double duct, c/w free cooling capability, covering an approximate area of 266 m².
System #011	Double duct, c/w free cooling capability, covering an approximate area of 89 m².
System #013	Single duct, c/w free cooling capability, covering an approximate area of 503 m². Note: this system originally designed for an extension of the current ***IT Engineering Help department*** has extra cooling and ventilation capacity not used currently.
System #016	Double duct, c/w free cooling capability, covering an approximate area of 110 m².

Note that systems #007, #011, #013 and #016 also provide air conditioning to other rooms of CSA's facilities not listed above but can easily have their air distribution modified to match the new loads of the new rooms, taking in account an average of 0,08 kW/m² of sensible heat load.

However, these systems do not have any redundancy as needed by level 2 or 3 critical rooms as indicated in the Technical Data Sheets, Appendix 5.

Controls

Building controls are centralized through a DDC communication network controlled by computers located in P6N1 and building service management.

Most of the perimeter areas have pneumatic control devices, the hot water baseboard heating system and the ventilation systems heating coils are controlled with pneumatic valves assisted by electronic controllers.

Plumbing

- Standard cold, hot water and recirculation pipes are provided in all the pavilions of the JHC Space Centre, including sanitary and storm drainage.

- Domestic hot water is provided by a 200 kW electric hot water heater and a 1500-gallon tank located in P6N1.

- Infrared electronic faucets and flush valves are used as building standards on wash basins, urinals and toilet bowls.

Fire protection

The entire building is protected by water base type sprinklers.

Special extinguishing systems are provided for in more sensitive areas, such as:

- FM-200 gas in server rooms;
- Pre-action type sprinkler systems in server rooms;
- Pre-action type sprinkler systems in control rooms and MCC areas.

Portable extinguishers are located according to applicable building codes for people's security in all areas.

The fire alarm signal is sent to the fire protection systems and the alarm panel of the building by an early-response smoke aspiration detection system type VESDA VLP.

1.5.3 ELECTRICITY

Electrical distribution

1. Normal electrical distribution

    - Considering the vocation of P2N2 that housed the RADARSAT 1 mission and now houses only the RADARSAT 2, it requires that most loads be protected by UPS or by generator. Presently, the normal distribution supplies only a small percentage of loads in this part of the facility. The nature of each load will be clarified hereafter.

2. St-Hubert's emergency electrical distribution

    - All three available stand-by generator sets that are available at the Space Centre contribute together to back up the installations in P2N2. The first of the three is 1250kW, 347V/600V, 3PH, 4W and is located in room 6B-101. The second one located in an outside enclosure adjacent to room 2C-103 is 600kW, 347V/600V, 3PH, 4W. The third one is 310kW, 347V/600V, 3PH, 4W and is located near the Radarsat's antenna.

    - Two non-modular double conversion UPS systems of 225kVA/202.5kW with an output at 120/208V, 3PH, 4W with designed battery run-time of 7 minutes are located in room 2B-302 (UPS B) and 2B-303 (UPS A), each in its own room. They are respectively backed up by the 600kW (UPS B) and 1250kW (UPS A) generator sets.

    - A third UPS system of 10kVA at 120/208V, 3PH, 4W supplies the loads of room 2C-200. This non-redundant UPS system is backed up by the 1250kW generator sets and is located in room 2C-201A.

    - A static transfer switch of 100A at 120/208V, 3PH, 4W supplies load outlets of P2N2, mostly office outlets. Indeed, this static transfer switch enables a feed to a single corded load by one of the 225kVA/202.5kW UPS (A or B) at any time.

3. David Florida Laboratories' emergency electrical distribution

    - A UPS system of 30kVA at 120/208V, 3P, 4W supplies the loads of the server in room #307.

Services

1. PCF Server room

    - The majority of servers used for Radarsat 1 & 2 Missions are located in 2B-205A1.

    - Based only on our evaluation, the critical electrical infrastructure supplying the servers in the Mission control center's server room is concurrently maintainable without impacting all of the continuity of the missions. This means that one component of the critical distribution can fail or be shut down intentionally without impacting the operations. Although, this is not the case for the single-corded equipment in the server room and in the office space connected to a UPS outlet (i.e. the control rooms, operations, etc.) which are supplied by a single point of failure, the static transfer switch. This is the same situation for the office space mechanical equipment that is backed up by only one generator set.

    - Dual-corded servers and telecommunications equipment are supplied by two different distribution paths originating from electrical distributions located in two different electrical rooms, 2B-302 and 2B-303

    - Single corded loads are supplied by the static transfer switch located in room 2B-301.

    - In order to maintain a fully redundant (2N) configuration up to the load, distribution panels and static transfer switches are supplied by both 225kVA/202.5kW UPS, each connected to one of the two generator sets at 600kW and 1250kW

    - Power and network cabling in the server rooms are installed in open cable trays above the ITE racks.

    - Each rack has two power bars (rack PDUs) each supplied by a different UPS (A+B source availability down to the rack level).

    - 4-post racks with no door or blanking panel are installed.

2. David Florida Laboratories Server room

    - There are no details available.

Office space

- In P2N2, most of the electrical distribution wiring for services is through the raised floor; except in room 2S-107 where services are distributed through an electrified furniture wiring system.

- Except in room 2S-107 and room 2C-204, most of the services in P2N2 are connected to power receptacles integrated into the raised floor that are supplied via the static transfer switch.

- In room 2C-200, the power receptacles integrated to the raised floor are supplied by the non-redundant 10kVA UPS system (no redundancy) and the wall outlets are backed up only by the 1250kW generator set (no redundancy).

- Some receptacles and outlets in P2N2 are backed up only by the 310kW generator set.

Mechanical equipment electrical connections

- Duct heaters that are located above the suspended ceiling in room 2S-207 are connected to the normal distribution.

- Ventilation equipment for the server rooms are connected via either the 600kW or the 1250kW generator sets.

- The mechanical equipment that are powered by 600V,3PH, like the stand-alone air handlers (URA units) installed in some areas of P2N2, are backed up only by the 1250kW generator set (no redundancy).

- The mechanical equipment that is powered by 120/208V, 3PH is backed up only by the 310kW Radarsat's antenna generator set (no redundancy).

Lighting

- The general lighting is mostly composed of ceiling-recessed 750mm x 750m fluorescent lighting fixtures complete with a parabolic lens.

- Most of the general lighting fixtures in P2N2 are supplied at 347V by the emergency electrical distribution of the 1250kW generator set.

- Auxiliary lighting is mostly done with recessed spot lighting fixtures with compact fluorescent lamps.

- The general lighting fixtures of room 2S-207 are connected on the 347V and supplied by the normal electrical distribution, except for the emergency light fixtures that are supplied by the emergency electrical distribution of the 1250kW generator set.

- The general lighting fixtures of room 2C-200 are connected on the 347V and supplied by the normal electrical distribution, except for those installed over the table that are supplied by the emergency electrical distribution of the 1250kW generator set.

- Few general lighting fixtures are connected to the UPS electrical distribution at 120V and are mostly located in mission control rooms.

Structured cabling

- Structured cabling paths starts from the Radarsat server room then go under the main corridor raised floor to finish at each desk in office rooms, again under the raised floor.

- No special separation/protection for classified or sensitive data network cable is present under the raised floor and overhead cable trays.

Fire safety

- This part of the building is equipped with a pre-action system linked to the main building panel.
- A 3-stage signaling system with gyroscope and horn alerts the occupants in sequence, based on the incident severity and evacuation protocol.

Access control

- For rooms in P2N2 where access control is required for security reasons, the doors are equipped with a door magnet or striker and card readers.

SECTION 2

GUIDELINES

This section sets out criteria for development of the Mission control center. All the following guidelines concern critical points to consider for optimal configuration and operation of the satellite department.

These are objectives to achieve in order to ensure proper operational performance, according to the different room requirements. These objectives are operational, technical and logistical, and related to architectural, mechanical and electrical requirements.

2.1 ARCHITECTURE

These guidelines aim to orientate Mission control center optimal layout. As mentioned above, the P2N2 area is large enough to combine all required rooms for satellite operations, both for current missions and the RCM. Since it is possible to fit the program in P2N2, these objectives are to integrate the required facilities for future missions, to existing facilities, while ensuring proper space relationships without any impact on missions underway. It is important to understand that this is not a question of grafting rooms to existing ones. The main goal here is to integrate new rooms to existing ones to optimize departmental operations.

2.1.1 OPERATIONAL AND FUNCTIONAL OBJECTIVES

These objectives mainly concern space distribution and function. In order to ensure sustainable facilities as well as proper space positioning, it is essential to fully understand the interaction between rooms and functions. It is also critical to assign the necessary amount of space to allow for optimal satellite operations.

- Optimize use of space;
- Optimize department functionality;
- Respect room security and operational requirements;

2.1.2 TECHNICAL OBJECTIVES

It is also possible to achieve sustainability through space versatility. In order to integrate additional satellite programs, it is essential to provide spaces that need as few interventions as possible to accommodate the new mission. Thereby, these objectives more specifically involve the physical planning of the department.

- Reduce permanent installations to a minimum;
- Maintain as much flexibility as possible;
- Minimize room interventions when implementing the new satellite mission;

2.1.3 IMPLEMENTATION OBJECTIVES

Since satellite missions run 24 hours per day all year long, systems interruption for departmental reorganization is not a possible solution. The following objectives guide the adequate planning of the required interventions to implement the future satellite mission.

- Avoid impact on current operations in MCC area;
- Avoid impact on future operations when implementing a new satellite mission;
- Avoid impact on departments outside of MCC area;
- Plan phases in such a way that operations are never interrupted

2.2 MECHANICAL

2.2.1 FUNCTIONAL OBJECTIVES

These objectives are to:

- Provide the right ambient air quality to every room;
- Maintain optimal ambient conditions throughout the year;
- Keep ambient noise created by mechanical equipment to a minimum;

- Provide redundancy to critical rooms such as server and control rooms and particularly to telecommunications equipment rooms dedicated to Mission control center, including CSA's existing mission operation facilities;
- Provide all plumbing and HVAC services required by the project;
- Work with architects to coordinate the location and size of new mechanical rooms and allow for sufficient space for installation of new mechanical equipment and maintenance services.

2.2.2 TECHNICAL OBJECTIVES

These objectives are to:

- Meet or exceed the HVAC guidelines described herein;
- Use reliable equipment and accessories;
- Provide security and flexibility to new systems;
- Pay special attention to critical room requirements.

HVAC guidelines

All rooms are to be air conditioned as per detailed criteria described for each room (and zone) in the Technical Data Sheets attached in Appendix 5 to this document based on the following standards:

- Offices, conference rooms, cafeteria, kitchen and common areas are to be air conditioned to maintain minimum thermal comfort parameters (temperature and humidity) as per *ASHRAE standard 55-2010*, their ventilation and IAQ (indoor air quality) in compliance with *ASHRAE standard 62.1-2010.*

- Control rooms and Server rooms are to be air conditioned to maintain tightly controlled environmental parameters (temperature, humidity and filtration level) in compliance with *ASHRAE's Thermal Guidelines for Data Processing Environments*. Ventilation of these rooms must provide adequate outside air as per the following criteria: positive pressure relative to surrounding spaces, dilute indoor generated pollutants (such as VOCs) and satisfy *ASHRAE standard 62.1-2010* requirements for human occupancy.

- Mechanical and electrical rooms such as TELCO and Switch rooms are to be air conditioned to maintain a maximum of 27-30 °C and a minimum of 16°C to protect telecommunications equipment from overheating.

- Washrooms and locker rooms are to be ventilated as per local regulations such as *Québec's S-2.1 r.19 Règlement sur la santé et la sécurité au travail.*

Centralized electronic control devices shall be provided for all rooms in order to do remote monitoring and supervision through a BacNet compatible network connected to the existing CSA building management network. In addition to the maintained temperature control, a high temperature signal shall be sent to the operator when ambient air reaches 35 °C to inform him to start a shutdown sequence, as mentioned in *MDA's RCM GSF requirements report*.

2.2.3 RELIABILITY OBJECTIVES

Every room must be ventilated, heated and cooled in such a way that people working on satellite missions can continue their work in case of a mechanical failure or a power failure or both, depending on the room critical nature. Criteria are described in the guidelines above.

Critical rooms

- For the most critical rooms (level 3) the mechanical designer will have to provide full redundancy of dedicated HVAC equipment in order to avoid overheating the rooms or lack of ventilation air to the personnel in place at any time. Emergency electrical power must supply HVAC units and controls.

- For less critical rooms (level 2), where the lack of ventilation can be acceptable for a short period of time, the room can be air-conditioned by a central system, but assisted by an emergency dedicated system connected to the emergency power electrical supply.

- Non-critical rooms (level 1) can be air-conditioned by one of the four (4) central systems (#007, 011, 013 and 016) installed in the mechanical room at P2N3, already supplying these zones.

- Dedicated units shall be stand-alone type with chilled water cooling, dehumidification with electrical reheat capability, humidification, and good air filtration for cleanliness of the premises and acceptable indoor air quality as per ASHRAE standards.

2.2.5 FLEXIBILITY OBJECTIVES

The design shall take into account expansion and downsizing scenarios, without shutting down the activities of the MCC. Systems must continue to operate during the moving of materials.

Replacement of equipment shall be easy to do with a minimum of disturbance to RMC's operations.

2.2.6 CRITICAL ROOM REQUIREMENTS

Server room

- The actual RADARSAT server room has an expansion capability of 20 KW (heat dissipation) bringing it to 43 kW maximum without disturbance to the building chilled water systems and redundancy of HVAC unit.

- According to MDA's estimations, a total of 363,000 Btu/h of heat rejection may have to be cooled in the future server room after adding electric equipment in racks. This future capacity of 106 kW (363 000 Btu/h) of heat dissipation will have to be taken into account in the design process to provide for 24/7/365 air conditioning in that room. The very high average of 19 kW/rack density of electronic equipment compared to the actual 2.5 kW/rack will have to be addressed by the HVAC designer in order to avoid hot spots inside the room. Coordination with server room technicians must be performed in order to create, between shelves, hot aisles and cold aisles, by positioning the front and back of the server equipment in the same direction in the server racks, resulting in concentrating the warm air released in the same aisle and then facilitating the proper air cooling performance of the system.

- For security purposes, the designer should not assume that the closed-coupling rack cooling method, also known as “IN-ROW" cooling, will not have unauthorized personnel working in the server room.

UPS room

- If a new UPS room is required, it will have to be air conditioned.
- Fan-coil method (as existing) can be used with proper cooling performance.
- Twin redundant fan coils shall be provided to provide redundancy in case of failure or for service purposes.

Chilled water

- Redundant chilled water shall supply the existing and (if required) new UPS and server room fan coils cooling units.

2.3 ELECTRICITY

2.3.1 OPERATIONAL AND FUNCTIONAL OBJECTIVES:

In order to mitigate the risks of hazards on the continuity of the mission, the physical integration of the critical infrastructure is very important. These objectives are to:

- Isolate the components of the electrical distribution from other areas in dedicated rooms.
- Separate each redundant critical electrical distribution from each other.

2.3.2 TECHNICAL OBJECTIVES:

The nature of the RCM project at the Space Centre imposes many constraints regarding choices at the design stage. The main electrical principles to keep in mind during the life cycle of the project are: reliability, security and flexibility of the electrical systems. These principles must be integrated in this project as improvements in respect to the Agency's standards and industry good practices, but not limited to applicable provincial standards and electrical code. These objectives are:

Reliability

a) Design the selected locations where reliability is critical (i.e.: critical rooms, levels 1 to 3) in such a way that each and every component of the electrical distribution equipment is to be serviceable one at a time with no impact to the continuity of the mission.

b) Design the selected locations where reliability is critical, (i.e.: critical rooms, levels 1 to 3) in such a way that in the event of equipment failure, no less than the redundancy of the equipment is impacted.

c) Design in such a way that equipment in server rooms is powered by a high-availability and redundant UPS system.

d) Provide UPS power (and desirably emergency power to each workstation in selected locations).

e) Protect all components of the electrical equipment that powers selected locations as well as the telecommunications systems, including the cabling that must be installed in common areas, from external hazards and potential damage from water and fire, power quality problems, electrical interference, and people.

Flexibility

a) Design the electrical distribution so that it allows for a certain degree of reconfiguration.

b) Design must not limit future expansion or downsizing scenarios.

c) A design where future modifications of work in the facility room configuration have minimal impact on the occupant's activities.

d) Future equipment along with the extra space needed for installation must be taken into account and provided in the final design.

e) A design where modularity, interchangeability and reusability of the electrical distribution equipment and services are key factors in the design and specification phases.

f) Design for the next 20 years in collaboration with the agency.

2.4 SECURITY AND OPERATION

2.4.1 ARCHITECTURE

Internal security of the entire Space Centre is managed by the Security department of the Space Agency according to RCMP standards. Access control, security devices and any other security procedures are all assured by this department in order to keep it simple and standard throughout the building. These security measures are also applied to the MCC.

However, due to different programs existing within the same area, the MCC has operational requirements, which are developed by the department itself. These requirements are intended to control access to different zones according to the nature of the operations and users, and are specific to this department.

The following objectives meet both CSA security standards and the Mission control center operational needs.

- Meet John H. Chapman Space Centre security requirements;
- Meet the Mission control center operational requirements;

2.4.2 MECHANICAL

In locations with sensitive areas, preference should be given to HVAC units located so that they can be accessed through the main corridor for maintenance or repairs instead of having non-authorized personnel walking through the office spaces.

2.4.3 FIRE PROTECTION

First of all, the department must respect the CSA's in-house fire and safety guidelines. The rooms shall be protected by sprinklers, according to the national building Code, the CSA John H. Chapman's building standards and the NFPA-13 standard. Sensitive equipment in the majority of the rooms calls for pre-action-type sprinkler systems to protect the MCC from accidental sprinkler water flow. In addition, server rooms shall be protected by a clean agent-type fire suppression system that operates before the sprinkler action.

Portable extinguishers of proper classification shall be provided as per NFPA-10 standard for personnel protection.

According to a study conducted in November 2013, the actual smoke detection system has to be modified in order to improve its smoke aspiration performance. The designer should refer to this study report for more details.

2.4.4 ELECTRICITY

Electricity security objectives are to create a safe environment, both for staff and data equipment in the Mission control center. Therefore, particular interventions and technical solutions are in place in order to ensure security. The following are objectives to consider:

- Provide quality lighting for occupants by selecting energy efficient lighting fixtures according to the specific task to be performed.

- Take special security measures as required by the CSA, in order to prevent tampering, by-passing, wire-tapping or destructive damaging of telecommunications systems components, including cabling and access control devices to be installed in selected locations.

- Ensure that electrical equipment, installed in separate rooms, is accessible only by authorized personnel.

SECTION 3

SPACE PLANNING

The Canadian Space Agency manages, since 1995, satellite missions directly from the Space Centre in St-Hubert. All missions were planned, launched, controlled and monitored from this location. Over the last years, the number of satellite programs has increased as well as being more specialized. These missions were made possible thanks to political and private partnerships. Involvement of these partners in program implementation has major impacts on department development and resources used.

This section helps to understand how the Mission control center shall be organized in order to meet the operational and functional objectives stated in the previous section. The different tasks required for satellite programs, have their own relational particularities and resource requirements; therefore, the general layout of the area must reflect these requirements. This section indicates how rooms are arranged, in zones, and their relation with each other, as well as with main circulation.

3.1 ZONE IDENTIFICATION

The different rooms, required by the MCC, are grouped into 9 distinct zones according to their role within the department. These different zones have been determined by the agency staff and include rooms of similar or complementary function. The Room Area Schedule, in Appendix 1, shows room distribution throughout the zones

Zone 1 – Control

Zone 1 is dedicated to orbiting satellite control. The purpose of the rooms in this zone, is to control all of the satellites that the CSA has launched and will launch in space.

Zone 2 – Flight Production

Zone 2 is dedicated to satellite flight production according to the associated missions. These rooms are intended to produce the satellite's route in order to follow the missions' requirements.

Zone 3 – Engineering

This zone is dedicated to engineering support and analysis. It supports mission integration and tests, exercises and rehearsals, launch and early orbit and commissioning phases.

Zone 4 – Planning

This zone supports mission planning and image capture for the different programs. The rooms included in this zone are used to plan the satellite's tasks according to the mission stage and purpose.

Zone 5 – Simulation

This zone is dedicated to the satellite mission simulators. In order to make sure missions and tasks are feasible, they are run through the simulators. All missions have their own simulator.

Zone 6 – IT Support

This zone is dedicated to information technology for the Mission control center.

Zone 7 – Support spaces

This zone is dedicated to technical spaces supporting satellite missions and staff. It combines all the required rooms that support both equipment and staff in order to keep the mission operations running.

Zone 8 – Private Industry Partner (MDA)

Zone 8 is dedicated to private industry partners. It facilitates proximity to operations by these partners during mission stages. This zone is currently used by RadarSat 2 and MDA staff, a partner of the agency in satellite program development.

Zone 9 – Circulation

This zone includes the main circulations. It connects all the other zones.

3.2 SPACE ORGANIZATION

Given the critical nature of this department, it is clear that all required rooms, for proper progress of SatOps missions, must be in close proximity. Special situations might require interventions from different departments at different times and, sometimes, with short timeframes. Therefore, we have to understand that it is essential to have all of the spaces in the same area, facilitating access and communications. Furthermore, human and material resources can be shared by multiple missions,

reinforcing the need for rooms to be concentrated in a single area. Having rooms spread out throughout the Space Centre is to be avoided.

It is however important to mention that within the MCC, proximity links must be respected between functions. The proximity relationship table, in Appendix 2, shows the links to maintain between the different rooms. The main links to consider are the following:

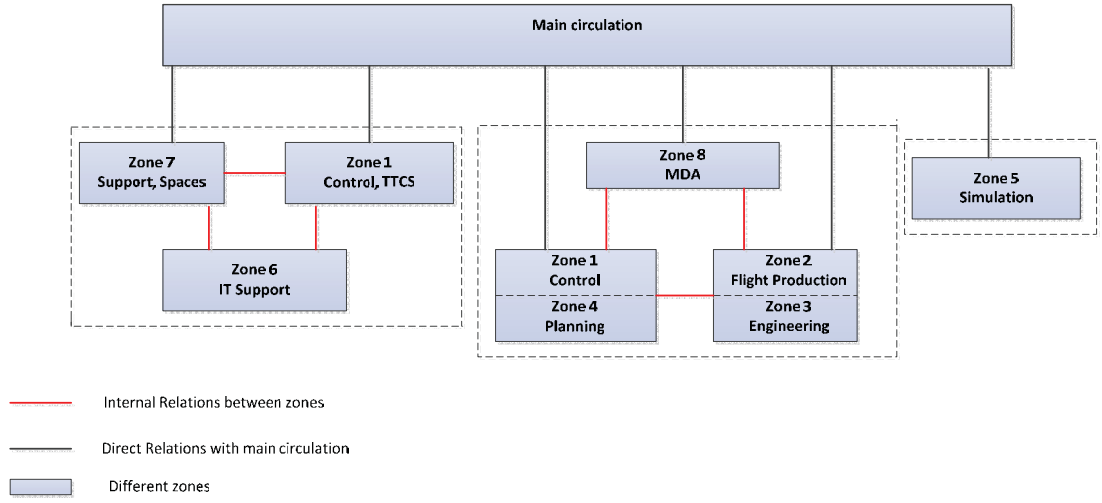

Figure 2 – Department organizational chart

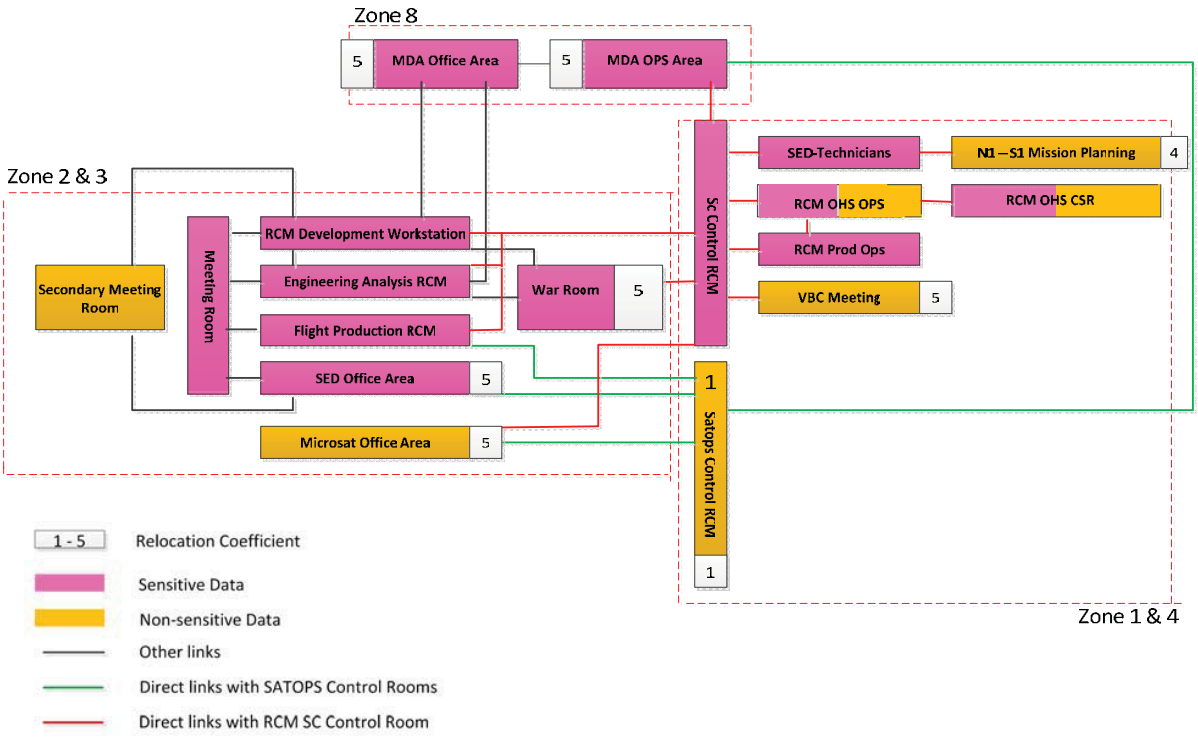

Figure 3 – Mission operation organizational chart

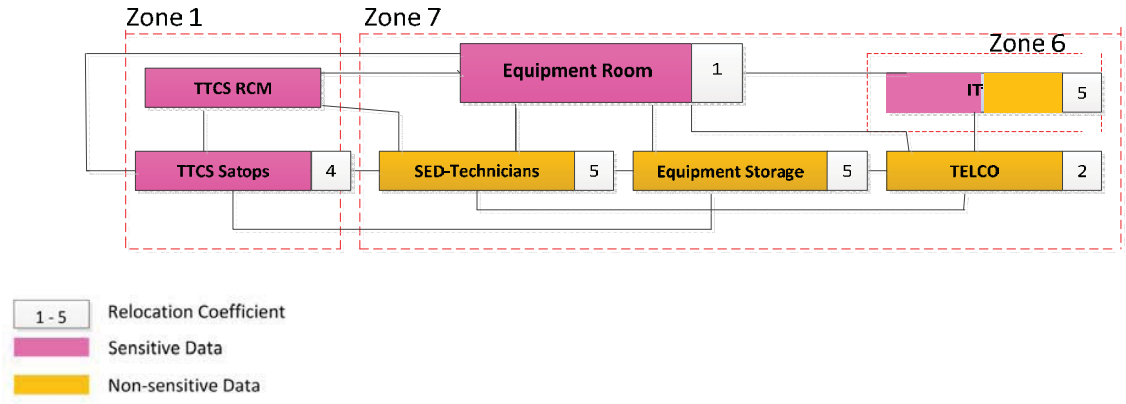

Figure 4 – Support space organizational chart

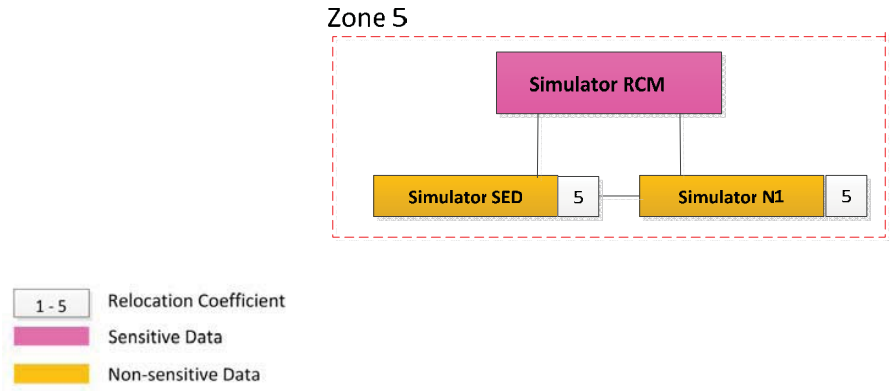

Figure 5 – Simulation organizational chart

By consulting these tables, it is clear that rooms of the same nature must be kept within the MCC . This simplifies service distribution by concentrating this through the functions. This will help increase the flexibility of the spaces, thus simplifying any future mission addition. The organizational charts are set up to show how important it is to group together rooms of similar functions such as the *RCM – Development Workstation, RCM – Engineering Analysis, RCM – Flight Production, SED Office Area* and *MicroSat Office Area*, which are all office spaces.

The *Department organizational chart* shows that zones need direct access to the main circulation. Due to operational requirements, distinct direct access is required for Zones 1 and 4 – *Control rooms / Order handling*, Zones 2 and 3 – *Flight production / Engineering*, Zone 8 – *MDA* and Zone 5 – *Simulation*. Connections between zones are also required independently from the main circulation for particular situations or mission phases. This same organizational chart also shows that there are three main zone groups: the first is dedicated to mission operations and includes Zones 1, 2, 3, 4 and 8, the second includes support spaces of Zones 1, 6 and 7, and the third is dedicated to the simulation area. Although these zones are separate, the small scale of the MCC makes it possible to create proximity relationships between them.

The organizational charts in Appendix 3, also demonstrate that some functions play a major role within the Mission control center. Thus the *Control rooms*, RCM - *SC Control room, Small meeting roo*m (*War room*), *SED – Office area Engineering, RCM - Engineering analysis, RCM - Development workstation* and

Equipment room, are key elements that guide the layout of the MCC. According to the organizational chart in Appendix 3, these rooms are the ones with the most proximity relationships considered to be *close proximity* and *contiguous proximity.* The above *Mission Operations* organizational chart demonstrates the relation between rooms of different zones, needed for MCC main activities. It shows the importance of control rooms within the department; it is imperative to understand that they must be considered to be the core of the department. Other rooms, such as the *flight production rooms, engineering rooms and planning rooms*, are used to support the control room's activity.

Since the entire building is secure, there is no need for room security levels within the Space Centre. On the other hand, classified information is handled in particular workstations, thereby creating sensitive workstations. The following table is based on the Technical Data Sheets (Appendix 5).

Zone Number and name	Non-sensitive workstations (number)	Sensitive workstations (number)	Differed workstations (number)
Zone 1 – Control	17	29	9
Zone 2 – Flight Production		8	1
Zone 3 – Engineering	28	54	4
Zone 4 – Planning	11	5	2
Zone 5 – Simulation	4	4	
Zone 6 – IT Support	3	3	
Zone 7 – Support spaces	11	2	
Zone 8 – MDA		13	
TOTAL	74	118	16

Table 1 – Workstation security level

This table shows that most of the workstations are sensitive. It is thus important to adequately coordinate their location within the department but also within the rooms. It is also possible to see that there are a certain number of differed workstations. Since they are not absolutely required for RCM operations, this allows for more flexibility in respect to space. In addition, they were considered in the total required MCC area even if not required for RCM's initial operations, thus keeping buffer spaces for future needs. These differed workstations are both sensitive and non-sensitive.

Another factor must be considered in regard to P2N2 layout planning. For the current facilities, there are rooms that cannot be relocated or are difficult to relocate. The rooms with a relocation coefficient of 1 or 2, as indicated on Technical Data Sheets, Appendix 5, cannot be moved due to the critical nature of the activities they house. Since the satellite programs run 24h per day, 365 days per year, room relocation that can create operational issues is impossible. There are 4 rooms with such a coefficient:

- Control Room S1-N1 (relocation coefficient – 1)
- Control Room R2 (relocation coefficient – 1)
- Equipment Room (relocation coefficient – 1)
- Telco Area, Utilities and Switches (relocation coefficient – 2)

According to the *Department Organizational Chart,* these rooms are part of two different zones. The two Control rooms are side by side, however, they are not adjacent to either the Equipment Room or

the Telco Area; the separation between these rooms makes it easier to work and arrange future layout, allowing complementary rooms to be grouped together.

SECTION 4

TECHNICAL REQUIREMENTS

This section provides technical solutions to achieve the previously mentioned guideline and objectives. These are practical solutions that allow for proper departmental operations, adequate service supply, operational control, and also allow for department sustainability over the next 20 years.

4.1 ARCHITECTURE

Without a doubt, the MCC's sustainability relies on an effective layout. However, over the next 20 years, future missions may require changes in staff, equipment, functions or phases. Therefore it is important to make sure that spaces can be easily modified to adapt to the new requirements. This can be achieved through technical solutions.

4.1.1 LAYOUT

RA-1 - Multimission

Arising out of team management more than being a technical solution, the implementation of multimission teams significantly reduces the need for layout modifications to accommodate new mission integration. By working on more than one mission at once, these teams allow to reduce material and service needs, thus decreasing physical space modifications required by material addition.

RA-2 - Permanent installation

It is important to mention that permanent facilities must be kept to a minimum. Therefore, the only permanent elements should be partitions. They shall be used to create boundaries between the zones highlighted in the organizational chart previously shown. This keeps zones separate from each other for operational purposes, while being free of any permanent fixture such as partitions or integrated furniture. Therefore, zones can be freely developed within these limits without conflicting with rooms in other zones.

RA-3 - Workstations

In these zones, similar workstations or equipment shall be grouped in islands, thereby avoiding the need to spread out services throughout the zones. By grouping furniture or equipment in such a way, this reduces and improves the space dedicated to circulation.

Ergonomic setup of the workstation is also part of the process. To make sure that employees are able to provide required mission monitoring, they need adequately planned workstations. This avoids future changes that might be required because of employees' discomfort or their inability to perform certain tasks. This mainly involves screen positioning, therefore it is important to consider this aspect when developing the spaces.

4.1.2 MOVABLE PARTITIONS

It will be necessary to create separations between functions to make sure that operational needs are addressed. However, this must be done without negatively impacting area flexibility.

RA-4 - Movable partitions

Movable partitions are designed especially for this type of use. They are meant to accommodate flexibility, changing needs and privacy. This type of system is easy to install or dismantle and reduces waste and dust related to traditional partitions. Mobilization for this type of product is minor, both in terms of time and space. According to room requirements, they can even be provided with electricity and data outlet, but can also house screens and furniture.

In order to optimize movable partition use, spaces shall be planned according to their modular size. By doing so, panels can be removed and installed elsewhere without any intervention or waste.

4.1.3 FINISHES

RA-5 - Finishes

To ensure flexibility, it is important to limit the number of finishes, both for floors, walls and ceilings. The less finishes there are, the less interventions will be needed in the event of a zone reorganisation. Therefore, if modifications are required, they will be simpler and faster.

Several key elements are important to consider for choice of finishes:

a. Installation process: Special attention must be paid to the product installation process. It needs to be quick and easy in order to reduce mobilization time to a minimum, thus avoiding impacts on mission operations. Products that can be installed in a single step should be favoured.

b. Strength and sustainability: The chosen products must be strong enough to withstand furniture and movable partition relocation on a regular basis. They must have a long service life to avoid repeated replacement.

c. Maintenance: The products must be easy to care for. Since the MCC operates year long, 24h per day, there is no ideal time for intensive or particular care that requires staff to move furniture. In addition, repairs must be quick and easy, again to reduce mobilization time.

It will also be important to keep a certain amount of extra material for replacement purposes. This will considerably reduce delays for minor interventions or repairs following department reorganisation.

4.1.4 SERVICES ACCESS

Electricity and data must be easily accessed through ceiling, floor, wall and movable partitions. Electricity or network interventions must be minor, so that plugging or unplugging of equipment is easy to do at all time.

RA-6 Access

In the current facilities, data wires run under the raised floor, which contributes to facilitating access and improvement of the network. Thereby, workstations and equipment must be supplied through the floor, helped with an access box. However, movable partitions can be powered by the top, so it is essential to make sure that electricity is distributed in a way to easily supply the partitions. Therefore, floor and ceiling systems must be designed for easy access to power and data connections when missions, workstations or equipment are added or relocated. Use of power poles is not an acceptable solution for electrical and/or data distribution.

The current raised floor includes fireproofed separations that control fire and smoke propagation. Even if the majority of the walls are supported by the raised floor, it is important to mention that there are existing walls that run down to the concrete slab. This must be taken into account for P2N2 planning. According to the National Building Code, all rooms have the same use and are located within the same suite, so no particular fire separation is required within the department. The only separation that requires special attention is the fire wall that separates the dorsal area from the P2N2.

4.1.5 SECURITY

In addition to electrical systems, security can be achieved as required.-

RA-7 – Confidential area

Within the mission operation centre, the server room is the only room that requires special security measures. These security measures are different from the ones controlling access to MCC. Other than intrusion detection, specific requirements are currently unidentified for this particular room. The

current server room already has this kind of security feature; it is thus possible to base future security features on the actual ones.

The Mission control center will need a confidential conference room. This room will be used for meetings where a few participants are involved in highly confidential conversations. This room should be about 20m² and be designed according to confidential environment requirements provided by the CSA. These requirements are very particular and shall be seriously considered for department planning. This kind of room implies a number of technical solutions to ensure security of the room.

4.2 MECHANICAL

This section provides an explanation of the technical mechanical requirements necessary to reach the objectives of the program, using the guidelines described previously in section 2.2 and taking in account the existing facilities described in section 1.5.2. The designer shall refer to the Technical Data Sheets (in Appendix 5) for more details on technical requirements for plumbing, heating, ventilation, air conditioning, humidification and fire prevention for each particular room.

4.2.1 HVAC CRITERIA

RM-1 Air conditioning

Provide air conditioning to all rooms as per detailed criteria described for each room (and zone) in the Technical Data Sheets, attached as an appendix, and in the guidelines described in 2.2 above.

4.2.2 USE OF EXISTING CSA MECHANICAL SYSTEMS

RM-2 Large HVAC systems contribution

The total space distribution is estimated to stay within the limits of P2N2, as described in the architectural sections. Four (4) large existing central HVAC systems #007, #011, #013, and #016 are currently providing heating, cooling and ventilation to a large proportion of the P2N2 area. These systems should be re-used to provide air conditioning to the new spaces defined by the RCM project program, but with similar surface and functions such as offices, conference rooms, and spaces of a low critical level (level 1) as described in the Technical Data Sheets in Appendix 5.

RM-3 Specific fan-coil AC units

a. The current telecommunications room and electrical switch rooms are cooled and ventilated by existing suspended fan-coil air conditioners #058, #059, #060. They should be re-used to provide the air-conditioning to the new similar spaces defined by the project program.

b. The current RADARSAT server room # 2B-205-A1 is cooled and ventilated by existing stand-alone fan-coil air conditioners # 2S-068-VA1 and their back-up unit # 2S-069-VA1. They should be re-used to provide the air-conditioning to the new arrangement of server rooms defined by the project program, if the heat dissipation load matches their maximum capacity. Otherwise, new air-conditioning units together with a chilled water production facility shall be provided and located in the mechanical rooms to be coordinated with architecture designer.

c. The current UPS rooms # 2B-302 and 2B-303 are cooled and ventilated by existing stand-alone fan-coil air conditioners # 2S-065-VA1 and their back-up unit # 2S-066-VA1. They should be re-used to provide the air-conditioning to the new arrangement of UPS rooms defined by the project program, if the heat dissipation load matches their maximum capacity. Otherwise, new

air-conditioning units together with chilled water production facility shall be provided and located in the mechanical rooms to be coordinated with architecture designer.

RM-4 Chilled and hot water network

a. The existing chilled water network will have to be re-used for the new or modified HVAC units for cooling purposes.

b. The Space Centre heating standard uses hot water from the existing network to control global energy performance and cost. The new HVAC design should follow that principle except for the dehumidification process by independent units that require reheat, because hot water is no longer available during the mild seasons.

RM-5 Fresh air system

a. The 100 % fresh air ventilation system #008-VA1 provides air changes to the areas conditioned by the stand-alone units URA-001 to 008 described herein, all with reheated, humidified and pre-cooled filter air.

b. This ventilation air is exhausted through the interlocked fan 008-VE1.

c. The designer should reuse that system to provide fresh air to dedicated rooms as per guideline ASHRAE 62.1-2010 standard and make modifications, if necessary.

4.2.3 MODIFICATION TO EXISTING CSA MECHANICAL SYSTEMS

RM-6 Stand-alone air conditioners

Eight (8) stand-alone air conditioners #URA-001 to 008 have to be replaced as described in the previous section 1.2.2 "Mechanical", paragraph—Building condition report". Those AC units have dehumidification capability, an independent humidifier, a chilled water cooling coil, an electric reheat coil and superior air filtration.

RM-7 Raised floor ventilation

Units labeled #URA-001,002, 003, 004, 005, and 006 supply their cool air through a raised floor with perforated air distribution tiles. This ventilation principle is no longer desirable by CSA management due to comfort problems observed by the occupants and also due to the difficulty of controlling sub-zone ambiances of different load variations. The designer will have to provide new units with ventilation via the ceiling. The new capacity will have to match the new loads of rooms #102, 106, 107, 108, 109, 303, 305, 401, 402, 403, 705, 707, 802, and corridor # 901. See room area schedule, Appendix 1, for space function correspondence.

RM-8 Ceiling ventilation

Units labeled URA-007, and 008 supply their cool air through ceiling diffusers. The designer will have to provide new units with ventilation via the ceiling. The new capacity will have to match the new loads of rooms #702, 502 and 503. See room area schedule, Appendix 1, for space function correspondence

4.2.4 RELIABILITY

RM-9 Existing HVAC units

General offices, conference rooms, kitchenette, storage and restrooms

Heat, cool and ventilate those rooms using as much as possible the large existing HVAC units 007, 011, 013 and 016. The designer should use the extra capacity of system 007 whenever possible.

RM-10 Critical operation level

Rooms with critical levels of operation

a. Three (3) critical levels of operation have been established by the MCC staff and all rooms have been associated with a critical level number.

b. Definition of critical levels:

- Level 1: Can be without power and cooling/no redundancy required;
- Level 2: Cannot be without power at any time but can be without cooling for 10 minutes maximum;
- Level 3: Cannot be without power and cooling at any time

c. Level 1 Critical rooms are:

- Conference rooms, technician area offices, equipment storage area, kitchenette, restrooms, configuration/data management offices, MDA offices. Provide HVAC to those rooms as indicated in above sub-sections RM-1 and RM-2.

d. Level 2 Critical rooms are:

- Control rooms, RCM production/operation offices, maintenance/spares/staging technical room, RCM flight production offices, RCM Engineering Analysis/support offices, small meeting (War) room, RCM development, workstation offices, SED engineering area offices, OHS operation/mission planning offices, OHS-CSR Offices, N1/S1 mission planning offices, simulator areas for RCM/SED/N1 technical rooms/office, miscellaneous area (listed room #504) offices, IT support offices, Microsat office and MDA OPS and office area (listed room #802).

- Connect the HVAC units dedicated to these areas to emergency power to reduce the risk of no cooling due to power failure.

- Provide multiple HVAC units positioned in such a way to create a redundancy by proximity, with the understanding that mechanical units would not all fail at the same time.

- Provide easy and fast access to each unit to reduce component repair time in order to bring cooling back in less than 10 minutes.

e. Level 3 Critical rooms are:

- Server rooms (listed room 701 in Saint-Hubert and 307-e in Ottawa facilities).

- UPS rooms (located at P2N3 in Saint-Hubert and included in listed room 307-e in Ottawa).

- TELCO area/utilities and switches technical rooms (listed room 703).

- Provide main and back-up HVAC units together with back-up chilled water in order to air-condition those rooms requiring cooling throughout the year. Automatic controls shall start-up the back-up systems (HVAC or chilled water) automatically upon receiving a shut-off signal from the main system, either due to a power shortage or mechanical failure of HVAC equipment. All equipment is to be connected to emergency power.

- Optional design for the server room in St-Hubert could be to gradually implement the new computer and electronic devices in the server room adjacent to room #2B-205.A1. That option avoids having to provide new fan-coil units c/w back-up, together with new chiller and accessories c/w back-up to comply with the new projected heat dissipation of 106 kW, by using the existing HVAC and chiller set-up already protected with back-up and emergency power connections. However this design option shall be coordinated with ***Shared Services Canada and CSA managements*** who have the authority of releasing computer and electronic device charges in the existing CSA server rooms. If that option is not accepted, the designer shall consider new HVAC and chilled water systems of approximately 35 tons of refrigeration and new mechanical rooms.

- The same option can be also considered for the server room at the BCF in Ottawa. The new servers and electronic devices are planned to be added in the existing room 307-e. The existing air conditioning capacity of 5-6 tons can hold around 80% of the future projected heat dissipation of the server to be implemented for the RCM program. Whenever the 6-ton capacity becomes too low, the new HVAC units will have to be installed in room #307-m (IT mechanical room) adjacent to the server room.

- The designer should modify the existing HVAC (#048, 049 and 050) installation of the TELCO area by:

  - Using two (2) instead of three (3) fan coils, both dedicated and sized to cool the whole TELCO area. One unit to be used as back-up of the other one, thus providing the necessary redundancy required by the critical level 3 of that TELCO area.

- The actual unit hanging above the Telecom equipment should be removed to protect the equipment from accidental water dripping.

- The new units have to be connected to an electrical emergency power supply.

- In the event that all of the new UPS final capacity cannot be installed in the existing room (located in P2N3), a new UPS room may have to be arranged and new A/C fan coil units shall then be provided. Preliminary capacity sizing: 10 tons.

4.2.5 FLEXIBILITY

RM-11 - Equipment size

To take in account possible expansion and downsizing scenarios, without shutting down either MCC activities, slight oversizing will be required with full capacity modulation.

RM-12 - Equipment position

In order to allow for the replacement of equipment with a minimum of disturbance on satellite operations, the designer should try to avoid having mechanical units sitting side-by-side.

4.2.6 SECURITY

RM-13 - Equipment location

For restricted sensitive areas, preference should be given to HVAC units designed and located so they can be accessed through a main corridor for maintenance service or repair, to avoid having unauthorized personnel walk through these areas.

4.2.7 FIRE PROTECTION

RM-14 - Pre-action sprinkler system

Install pre-action type sprinklers in all rooms according to the National Building Code, NFPA-13 standard and the CSA John H. Chapman Centre's standards.

RM-15 - Fire suppression system

Protect Server, TELCO and UPS rooms with clean agent type fire suppression system in addition to sprinklers as per NFPA standards. Modify the existing smoke aspirating detection system to improve its performance and coordinate final results with the fire protection system and the electrical fire alarm-central panel.

RM-16 - Extinguishers

Install portable extinguishers of the correct classification as per NFPA-10 standard for personnel protection.

4.3 ELECTRICITY

4.3.1 RELIABILITY

RE-1 - Power increase

In order to accommodate the increase of technical loads on the UPS power at the St-Hubert Campus, the existing redundant UPS system capacity must eventually be increased. The effect of equipping the servers with redundant power supplies is taken into account (~171kW), it must be increased by at least ~77.5kW. If not equipped with a redundant power supply (~115kW), it must then be increased by at least ~22kW. Load addition planning and decommissioning of older missions can help postpone, over the project, the life of some equipment acquisitions such as new UPS power, etc. Although, no actual UPS A or B must exceed 45% of its capacity during the time, the increases of UPS power is not yet implemented.

These numbers take into account the mission's entire load (day 1+growth+future) plus a 7.5kW of added workstation loads required for RCM integration.

It must be noted that these figures are solely based on basic calculations of the rated consumption label of the equipment. Also, these figures have been taken from the specification sheets of equipment compiled by MDA in table 4-1 and 4-2 of document RCM-SP-53-1973. The capacity reading information for both UPS A and B has been collected by the agency over a half-hour period.

RE-2 - UPS power increase

The Radarsat's antenna generator set of 310kW that backs up all the antennas, the power outlets on UPS in P2N2 and some mechanical loads has been unloaded of 75kW. In fact, this generator set was previously powering the original 150KVA of UPS B version and it now powers a 75kVA UPS instead. It is possible to believe that with the potential increase of critical UPS power outlets for the RCM mission and with some additional mechanical loads, this will not be problematic.

RE-3 - General set

In a worst-case scenario, the 600kW generator set has been evaluated by the agency's facility staff to be presently loaded at 300kW. Based on this statement and without any further information, it is believed that the generator set will be able to support at least a 77.5kW UPS load increase with some additional mechanical loads.

Recently, the 1250kW generator set has been unloading from 50HP of fire booster pumps. It is believed that the generator will be able to support at least a 77.5kW UPS load increase plus the mechanical load additions.

RE-4 - DFL UPS power increase

In order to accommodate the technical loads on the UPS power at David Florida Laboratories (new servers and IT desks loads to be added), the existing redundant UPS system capacity must be increased. Considering the effect of equipping the servers with redundant power supplies (~46kW), a new dedicated UPS of at least ~75kW must be added. If not equipped with a redundant power supply (~28.5kW), a new dedicated UPS of 50kW must be added.

RE-5 - Electrical distribution

For each critical distribution path, all components of the UPS electrical distributions will be installed in separate rooms.

Critical distribution electrical equipment will be sprinkler proof and should not be installed directly on the floor.

RE-6 - Mechanical back-up

Critical mechanical loads must be backed up by at least two generator sets.

RE-7 - Electromagnetic field

The electromagnetic field from the transformer must not impact other equipment functionality.

RE-8 - TVSS

Transient voltage surge suppressor (TVSS) must be installed in a manner to protect all the outlets on generator power of the MCC offices.

RE-9 - ITE racks

ITE racks ground must be connected to a single grounding bar in the server room.

In order to have a homogeneous IT equipment inventory, servers will be connected to 120V rack power distribution units.

Each rack in the server room will have at least two rack PDUs, each connected to a different UPS distribution path.

4.3.2 SECURITY

RE-10 - Network cable

Even if the classified equipment does not need special treatment, the information on the network might however require this. In such case, the network cable for classified equipment must be separated and secured accordingly in the server room.

RE-11 - Control conduits and boxes

For access control and video surveillance, conduits and wall boxes must be integrated in the design in coordination with the agency.

RE-12 - Fire safety

The current Space Agency guidelines for fire safety in mission control areas must be followed. The static transfer switch with its distribution path that supplies the critical loads in the office area at the St-Hubert Campus must be physically enclosed at a minimum to prevent access to it.

4.3.3 FLEXIBILITY

RE-13 - Lighting

New standards for general office lighting will be soon implemented at CSA facilities. In order to respect the stated flexibility principles, the dimming system must be versatile, easily integrates with the shading controls and yet be reprogrammable without the need for an electrician and a secured communications protocol must be used.

RE-14 - Raised floor electrification

All modular cabling associated to the raised floor must be modified to accommodate the new installations and services. At the exception of some loads to be fed by the wall and/or ceiling, every other connections must be fed by the raised floor electrical distribution.

RE-15

Electrical design shall take in account the expansion and downsizing scenarios that may occur without shutting down the activities of the MCC. Systems must continue to operate during displacement of material.

RE-16

Work on the electrical distribution shall be easy to do, with a minimum of disturbance to the MCC operations for non-critical areas and without unplanned interruption in critical areas, if unavoidable.

RE-17 - Outlets

Provide some wall outlets on generators in critical rooms of level 1, 2 and 3.

RE-18 - Power condition

Provide appropriate power condition to mechanical loads in respect to their criticality.

SECTION 5

IMPLEMENTATION AND PROJECT REALISATION

Mission integration to existing facilities will not be an easy task. Current missions require the department to run 24h per day, throughout the year, which makes it difficult to be reconfigured to accommodate additional functions.

This section addresses integration of future missions to current facilities. The critical nature of some rooms creates constraints within the Mission control center. The general reorganization of this area must take into account these constraints and must be adequately coordinated so that current operations are not affected. The following subsections indicate solutions that facilitate the integration of additional missions to the existing facilities.

5.1 ARCHITECTURE

5.1.1 RCM INTEGRATION

In order to properly integrate missions, it is imperative to plan all interventions by phases. These phases must take into account:

- Temporary installations in P2N2;
- Staff relocation in temporary facilities when possible;
- P2N2 main construction;
- Services implementation;
- Staff relocation in the new Mission control center.

Proceeding this way, it is possible, for critical rooms, to move from the old to the new room without operational issues or breakdowns. First, the new room is completely constructed, then all the required services are brought to it and finally, staff is moved in when the room is functional. Free spaces around the MCC can temporarily be used by non-essential department functions, thereby freeing up space for other functions.

5.1.2 FUTURE MISSION INTEGRATION

Fortunately, implementation of multimission teams will help to integrate new missions to the MCC. Since these teams are running more than one mission at once, there is no need to modify the physical space in P2N2. The absence of additional staff or equipment makes it much easier to integrate the mission without power, ventilation or operations interruptions.

Furthermore, satellite missions are divided into different stages, and the number of employees dedicated to the mission may change as it moves forward. Space must be intended to accommodate staff variation; it is thus important to consider this when planning the new Mission control center to make sure buffer zones are considered. The *RCM – Development Workstation* (room 304) is intended to be such a room; its function and occupation will vary according to the mission phases. It can eventually be used by more than one mission.

5.2 MECHANICAL

As mentioned in architecture sections, the services implementation will require a well-planned schedule to minimize shutdowns and temporary installations.

5.2.1 PROCESS

.1 Phases

Due to the kind of space to integrate in existing areas and to existing sensitive areas of the MCC, the mechanical services shall be implemented by phases.

.2 Temporary set-up

Coordinate the mechanical temporary set-up with temporary installations as per the architecture phases described in section 5.1.1 above.

.3 Shutdown

Coordinate shutdown on water, drainage, chilled water and ventilation with CSA and RCM management as per architecture phases described in section 5.1.1 above.

.4 New rooms

New mechanical rooms (if requested by the final design) may be processed independently (such as new chiller or mechanical room) from non-sensitive areas. But shutdowns will have to be coordinated as explained in the previous section.

5.2.2 PROJECT REALISATION

The technical requirements for zones and spaces are detailed in the Questionnaires and Technical Data Sheets (in Appendices 3 and 5).

The mechanical designer shall provide a concept that complies with the building standards and special needs while taking into account the next 20 years of operation.

.1 Non-critical level rooms

Addition or modification of HVAC on systems #007, 011, 013 and 016 should be done by using double duct terminal units that comply with CSA's standards.

.2 Server rooms

The high W/rack density proposed in the MDA document addresses a special attention to the risk of hot spots between racks or equipment if cooling performance is not adequate. Care should be taken to choose the proper cooling system to match the type of load.

.3 New mechanical rooms

A new chiller room (if necessary) for the new server room and new UPS room should be arranged as close as possible to the project to optimize piping lengths.

New HVAC mechanical rooms (if necessary) for the new server room and new UPS room shall be adjacent to their dedicated room to optimize duct work and the fire protection system.

5.3 ELECTRICAL

.1 Phases

Due to the type of spaces to integrate in the existing areas and to already sensitive areas of MCC, the electrical services shall be implemented by phases.

.2 Server rooms

It the event that gradual commissioning of the equipment avenue is considered prior to UPS increase load by the designer, as stated previously, no actual UPS A or B must exceed 45% of its capacity during that time otherwise the redundancy of equipment will be lost.

SECTION 6

ISSUES AND RISKS

This section is dedicated to issues and risks that arise from data compilation. Careful study of all the collected information allows to highlight situations that might be a challenge for missions integration into the Mission control center. These can be categorized as: management, technical, human and operational issues and risks. This section pinpoints elements that require particular attention.

6.1 ARCHITECTURE

First of all, it is noteworthy that all the previous sections are based on the information provided by the CSA and MDA; references can be found in section 8 at the end of this document. This information has been considered true, complete and relevant for this FTP. Furthermore, assumptions stated in section 1, have been considered all through data analysis as well as for the recommendations proposal.

Because of its complexity, project phasing was not addressed in-depth. Main guidelines were stated in section 5 in order to help the designer and owner understand what will be required for the MCC reorganisation. Giving the critical nature of this department's operations, phasing will be carefully developed internally by the CSA.

Costs involved for such a project were not evaluated in this report. This requires preliminary space blocking and phasing to be established; these are basic elements to consider in order to provide an accurate estimation of the project cost. This will be possible once MCC staff has set phasing and a preliminary blocking of spaces will be proposed.

Available space

An important outcome of this FTP is that the SatOps program, including RCM requirements, can be entirely planned within P2N2 of the Canadian Space Centre in St-Hubert. Even though the program is 42 square meters higher than the space available, it is reasonable to assume that the project is feasible. The shortfall in space only represents 2% of the total required area, which can be managed by modifying the circulation coefficient and downsizing rooms of minimal importance.

It is however important to mention that the entire available surface, in P2N2, will be used for current MCC missions and the RCM mission within few years. As indicated above, the critical nature of this department makes it impossible to disperse rooms throughout the agency. Since the CSA's intention is to plan this department for the next 20 years, particular attention must be paid to this point to ensure proper operations flow.

Multimission

Thanks to multimission integration, this issue can be mitigated. Use of the same resources, both human and material, for more than one mission reduces the space needs for the satellite program. However, it is worth mentioning that it is unlikely that no future missions will have specific requirements that cannot be addressed by the current facilities. That being said, some missions will reach their end, and free space might be available for other missions.

Buffer zones

In the *Implementation* section, it was mentioned that buffer zones are required to accommodate staff variation according to mission stage. No information was indicated on the number of employees according to these stages for future missions, other than the RCM. It was indicated for *RCM – Development Workstation* (room 304), which is playing this specific role, that 15 workstations were needed. It was assumed that this is adequate for all stages of the RCM mission, but will it be sufficient for future missions? Will it be sufficient if more than one mission is launched at the same time or if more than one partner is simultaneously involved?

Permanent installations

Even though flexibility must be put first, in order to accommodate missions for the next 20 years, operational requirements imply a certain level of permanence. As mentioned in *Section 4 – Technical Requirements*, security may require additional partitions and particular floor, walls and ceiling treatments that require a certain level steadiness. With that in mind, the department general layout must be planned in order to create the least possible limits.

Additional required space

According to the mechanical and electrical analysis of the existing equipment dedicated to P2N2, it has been pointed out that the anticipated charges might not be enough to support future missions integration to the MCC. As mentioned previously, additional redundant cooling systems and UPS may be required to support the MCC. These units need an approximate supplementary area of 60m² within the Space Centre, thus increasing the total area required by the Mission control center. Fortunately, these mechanical units can be installed outside P2N2, avoiding impacts on surface required in this area. These rooms will only be required if the existing equipment cannot handle the new mission requirements. If no space is available in the Space Centre to accommodate such units, alternative solutions will have to be considered when designing the new MCC.

6.2 MECHANICAL

6.2.1 ISSUES AND RISKS FROM WATER UTILISATION

Stand-alone HVAC units use chilled water for cooling load and domestic cold water for humidification. Pipes containing water shall be positioned away from cable trays and clear from the tops of electric/electronic devices to minimize the risk of water damage.

Independent HVAC systems shall use electric heating/reheat coils when de-humidification may be required during mild and warm seasons, keeping in mind that the hot water boilers are shut down during those periods.

6.2.2 ISSUES AND RISKS FROM HIGH HUMIDITY OF AMBIENT AIR

Care should be taken for rooms requiring humidity of 40% or more during winter. Condensation may occur on windows when the outside temperature is less than -15 °C. The manager should be able temporarily lower the humidity percentage in the room to eliminate condensation risks, especially in control rooms.

Avoid keeping the inside ambient air of control/server/TELCO/UPS rooms too dry (lower than 35% HR) in order to minimize the risk of static electricity.

6.2.3 ISSUES AND RISKS FROM VOCS AND FUME BY-PRODUCTS

Provide fume exhaust systems for UPS/server/TELCO rooms where electric equipment could overheat and produce VOCs and fumes. These systems shall operate on a smoke detection system.

Smoke detection systems shall be coordinated with fire protection and the fire-alarm system of the building.

6.3 ELECTRICITY

At the time this document was written, a study evaluating and proposing new standards for the lighting fixture retrofit at the St-Hubert Campus was underway. The final decision and directives were not yet published. When the report is released, the designer must follow the results of this study and integrate the concept into the design. This will be the case for some mission-specific requirements such as dedicated task lighting at desk level that might not be part of the specifications included in the study.

Another point to consider in the design is that the figures provided in the FTP for the IT server load addition are based on the rated consumption labels of equipment as provided by the MDA. The designer must not assume that these numbers represent actual demand. To avoid the pitfall of over sizing the infrastructure, it is suggested that the designer and agency agree to use an industry-proven method of estimating realistic future IT load demands, to be used as basic assumptions in the design.

Finally, the information received to validate actual UPS and generator set loads are instantaneous and do not provide the clear picture provided by monthly readings. Information compilation over a meaningful period will greatly help the designer to size the critical infrastructure more accurately. Nevertheless, more information on David Florida Laboratories server room facilities will be needed to complete the design, since the latest received information is preliminary.

6.4 ELECTROMECHANICAL

Over the mission duration, the satellites will be gathering both non-sensitive and sensitive data. Needless to say, some activities will be critical and cannot be disrupted. Unfortunately, currently, the impact and consequences of potential disruptions are unknown to the electrical and mechanical engineers and could not be reported in this FTP.

Prior to the design phase, a mission's risk assessment study should be conducted by the CSA to help establish the requirements, tolerances and consequence costs of the inherent activity disruption in the MCC programs. This may clarify the needs and goals to attain when considering the availability and reliability of the critical infrastructure to implement. Assistance from an external well-regarded specialist is strongly encouraged.

Unfortunately, it is hardly feasible in the present mandate to evaluate future demand on infrastructure because the activities within the overall Canadian space program for the next 20 years term are not known. The designer must, together with the agency, agree to a quantification of future demands, when considering availability and reliability of the critical infrastructure to be put in place.

SECTION 7

CONCLUSION

This functional and technical program establishes the possibility of integrating the RCM program to the Space Centre's current facilities, while allowing for subsequent missions to be integrated to the MCC. The P2N2 area is large enough to integrate all required rooms for satellite operations, both for current missions and the RCM. Close coordination of room layout combined with particular attention to the above-mentioned technical solutions, will allow the Mission control center to be functional.

As mentioned in the *Issues and Risks* section, it is important to highlight that the available space in P2N2, after RCM integration, will be fully used. Flexibility of the department will then primarily rely on the multimission team, which will control more than one mission at once.

However, it is important to understand that all the information collected for this document represents the ideal situation. It is possible, in order to facilitate the integration of future missions to the MCC, to deviate from these requirements. The main idea is to make sure that choices are made in order to optimize operations while thinking about the years to come.

MECHANICAL

The most important mechanical services required for the Mission control center on the Space Centre premises are available on site in respect to plumbing, heating, ventilation, air-conditioning and fire protection.

The designer will have to add new systems, or re-use existing ones, in order to comply with rooms requirements. This must be coordinated with the CSA Building Services Department to ensure compatibility between new components and existing networks, as well as minimize impacts of this integration on CSA operations that need to remain operational in P2N2.

Because delicate interventions may have to be performed on the mechanical systems in certain zones, after system start-up, a commissioning process is strongly recommended.

ELECTRICAL

Major challenges will come from the inherent constraints of designing a highly flexible environment in a critical, reliable and a high level of criticality as defining criteria.

Even if some data still need to be clarified and assessed, most of the electrical infrastructure needed is already at St-Hubert for the RCM. Perhaps in time, some IT load addition to the actual critical power capacity (i.e. redundant UPS power) will require an increase in the UPS systems.

There is a great opportunity in the RCM project to fine-tune and renew the existing infrastructures and design concepts of P2N2 at the CSA.

The preparation of this document was made possible thanks to the involvement of various stakeholders, whose areas of expertise, which are complementary, allowed for diligent analysis of the information collected. This multidisciplinary team consisted of architects and mechanical and electrical engineers.

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SECTION 8

REFERENCES

ASC - Documents
Current MCC REV2 2013-11-13
Espaces préliminaires RCM, 1A – 17 octobre 2013
PFT St-Hubert 0.3
Design Requirements 2013-11-13
RCM MCC_rec C 2013-10-31
RCM MCC_rev E 2013-11-13
RCM Workstations

MDA - Documents
Radarsat Constellation Mission, Révision Attendue 2013-10-31, 3
RCM-GL-52-7595_Acronym-Glossary_1-13_review
RCM-SP-53-1973_GS_Facility_Requirements_Spec_2-0_review

ASC – Plans
Plan existant (Mr Philippe Méhu email)
Plan proposé

Web Sites
http://www.asc-csa.gc.ca/fra/satellites/default.asp
http://www.asc-csa.gc.ca/eng/about/default.asp

Previous studies

- Centre de contrôle RCM – Étude de faisabilité – Option 1, Réaménagement du secteur des hautes baies – Centre spatial John H. Chapman, Marsh 31st, 2011, 50 pages, voir pages suivantes
- Centre de contrôle RCM – Étude de faisabilité – Option 2, Agrandissement – Centre spatial John H. Chapman, March 31st, 2011, 47 pages, voir pages suivantes
- Recommandations des systèmes de détection dans les salles principales de serveurs – Campus de St-Hubert (novembre 2013)

ACRONYMS

PCF:	Primary Control Facility
BCF:	Backup Control Facility
FTP:	Functional and Technical Program
P2N2:	P2N2 (of the Space Centre)
MCC:	Mission control center
MDA:	MacDonald, Dettwiler & Associates Inc.
RCM:	Radarsat Constellation Mission
CSA:	Canadian Space Agency

TABLE OF FIGURES