

**Part 1 General**

**1.1 GENERAL**

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
  - .2 Ensure appropriate documentation is compiled into the BMM.
  - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
  - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

**1.2 COMMISSIONING OVERVIEW**

- .1 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .2 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the proven to operate satisfactorily under occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .3 Departmental Representative will issue Interim Acceptance Certificate when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M training has been completed.

**1.3 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS**

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.

- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

#### **1.4 PRE-CX REVIEW**

- .1 Before Construction:
  - .1 Review contract documents, confirm by writing to Departmental Representative
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
  - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
  - .1 Have completed Cx Plan up-to-date.
  - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
  - .3 Fully understand Cx requirements and procedures.
  - .4 Have Cx documentation shelf-ready.
  - .5 Understand completely design criteria and intent and special features.
  - .6 Submit complete start-up documentation to Departmental Representative..
  - .7 Have Cx schedules up-to-date.
  - .8 Ensure systems have been cleaned thoroughly.
  - .9 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

#### **1.5 CONFLICTS**

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

#### **1.6 COMMISSIONING DOCUMENTATION**

- .1 Departmental Representative to review and approve Cx documentation.
- .2 Provide completed and approved Cx documentation to Departmental Representative

#### **1.7 COMMISSIONING SCHEDULE**

- .1 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
  - .1 Approval of Cx reports.
  - .2 Verification of reported results.
  - .3 Repairs, retesting, re-commissioning, re-verification.

.4 Training.

**1.8 STARTING AND TESTING**

.1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

**1.9 WITNESSING OF STARTING AND TESTING**

.1 Provide 14 days notice prior to commencement.

.2 Departmental Representative to witness of start-up and testing.

.3 .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

**1.10 MANUFACTURER'S INVOLVEMENT**

.1 Obtain manufacturers installation, start-up and operations instructions prior to start-up of equipment and review with Departmental Representative

.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.

.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.2 Integrity of warranties:

.1 Verify with manufacturer that testing as specified will not void warranties.

**1.11 PROCEDURES**

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and testing in following distinct phases:

.1 Included in installation:

.1 Visual inspection of quality of installation.

.2 Start-up: follow accepted start-up procedures.

.3 Operational testing: document equipment performance.

.4 System PV: include repetition of tests after correcting deficiencies.

.5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.

.4 Document require tests on approved PV forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
  - .1 Rejected equipment to be remove from site and replace with new.
  - .2 Subject new equipment/systems to specified start-up procedures.

#### **1.12 START-UP DOCUMENTATION**

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
  - .1 Pre-start-up inspection reports.
  - .2 Signed installation/start-up check lists.
  - .3 Start-up reports,
  - .4 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

#### **1.13 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS**

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

#### **1.14 TEST RESULTS**

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

#### **1.15 START OF COMMISSIONING**

- .1 Notify Departmental Representative at least 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

#### **1.16 INSTRUMENTS / EQUIPMENT**

- .1 Submit to Departmental Representative for review and approval:

- .1 Complete list of instruments proposed to be used.
- .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.
  - .3 Equipment as required to complete work.

**1.17 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx:
  - .1 Under actual operating conditions, in all modes.
  - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.

**1.18 WITNESSING COMMISSIONING**

- .1 Departmental Representative to witness activities and verify results.

**1.19 AUTHORITIES HAVING JURISDICTION**

- .1 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .2 Provide copies to Departmental Representative within 5 days of test and with Cx report.

**1.20 COMMISSIONING CONSTRAINTS**

- .1 Since access into secure will be very difficult after re-occupancy it is necessary to complete Cx of the equipment in these areas on a daily block by block basis.

**1.21 EXTENT OF VERIFICATION**

- .1 Elsewhere:
  - .1 Provide manpower and instrumentation to verify all fixture and flush/control valve operation as they are completed.
- .2 Number and location to be at discretion of Departmental Representative.
- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results.
- .5 Perform additional commissioning until results are acceptable to Departmental Representative.

**1.22 REPEAT VERIFICATIONS**

- .1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
  - .1 Verification of reported results fail to receive Departmental Representative's approval.
  - .2 Repetition of second verification again fails to receive approval.
  - .3 Departmental Representative deems Contractor's request for second verification was premature.

**1.23 SUNDRY CHECKS AND ADJUSTMENTS**

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

**1.24 DEFICIENCIES, FAULTS, DEFECTS**

- .1 Correct deficiencies found during replacement and Cx to satisfaction of Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

**1.25 COMPLETION OF COMMISSIONING**

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty activities, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

**1.26 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

**1.27 OWNER'S PERFORMANCE TESTING**

- .1 Performance testing of equipment or system by Departmental Representative will not relieve Contractor from compliance with specified start-up and testing procedures.

**1.28 SAMPLE FORMS**

- .1 Sample testing and check forms to follow.

**SAMPLE FORM**

Public Works & Government Service Canada Maintenance Management  Western Region	Project Number Project Name  Lethbridge Project Location																																																				
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Component Verification Sheet																																																					
System: <b>Perimeter Radiation</b>	Equipment: <b>Radiation Control Valve</b>	Section: <b>Commisioning</b>																																																			
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Project:	<h2 style="margin: 0;">HOT WATER HEATING SYSTEM CHECK SHEET</h2>
Page 2	

**Public Works and Government  
 Services Canada**

**Project Number**  
**Project Name:**  
**Project Location:**

**System:**

**Location:**

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

**PRE-START CHECKS**

**CONTRACTOR    DEPARTMENTAL REP.**

Piping Installation Complete	( )	( )
Branch Isolation Valves Installed	( )	( )
Valves are Accessible	( )	( )
System is Free of Construction Debris and Dirt	( )	( )
Strainers Inspected Before Initial System Fill	( )	( )
Pipe Pressure Tests Complete	( )	( )
Press. Test of Entire Piping Sys. Done after all Connections Made	( )	( )
Pipe and Component Insulation Completed	( )	( )
Obtained Approval for Chemical Cleaning Procedures	( )	( )
All Valves Including Control Valves Opened for Chemical Cleaning	( )	( )
All Components Operational Prior to Cleaning	( )	( )
Indoor/Outdoor Installed and Wired	( )	( )
Indoor/Outdoor Controls and start-up function	( )	( )
Indoor/Outdoor Temperature Reset	( )	( )
System Pressure Bypass Operational	( )	( )

**START-UP CHECKS**

Air Venting of System Complete	( )	( )
Piping Expansion Checked to Insure Adequate Clearance	( )	( )
System Cleaning Procedures Completed As Specified	( )	( )
System Chemical Treatment Installed	( )	( )
Control Valves Active	( )	( )

**REMARKS**

Project:	<b>HOT WATER HEATING SYSTEM CHECK SHEET</b>
Page 2	

**System:**

**Location:**

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

**POST-START CHECKS**

	<b>CONTRACTOR</b>	<b>DEPARTMENTAL REP.</b>
Pressure Bypass Valve Operation	( )	( )
Strainers Cleaned After System Cleaning	( )	( )
Operational Tests Complete	( )	( )
System Checked for Water Noise	( )	( )
Valve Tagging Complete	( )	( )
Valve Tag Schedule Attached	( )	( )
Pipe Pressure Tests Report Attached	( )	( )
Chemical Cleaning Report Attached	( )	( )
Chemical Treatment Analysis Report Attached	( )	( )
System Balancing Report Attached	( )	( )
Warranty Certificates Attached	( )	( )

**REMARKS**

\_\_\_\_\_  
*(Signature of Contractor)*

\_\_\_\_\_  
*(Name of Contracting Firm)*

\_\_\_\_\_  
*(Date)*

\_\_\_\_\_  
*(Signature of Consultant)*

\_\_\_\_\_  
*(Name of Departmental Rep.)*

\_\_\_\_\_  
*(Date)*

Project:	GAS FIRED BOILER CHECK SHEET
Page 1	

**Public Works and Government  
 Services Canada**

**Project Number**  
**Project Name:**  
**Project Location:**

**INSTALLATION REVIEW**

**INDICATE ACCEPTABLE  
 WITH A ( ✓ ) MARK**

<i>ITEM</i>	<b>CONTRACTOR</b>	<b>CONSULTANT</b>
Installation and Mounting	( )	( )
Service Space	( )	( )
Pipe Support and Layout	( )	( )
Pipe Insulation	( )	( )
Isolating and Balance Valves	( )	( )
Balance Marks on Valves	( )	( )
Pressure and Temperature Gauges	( )	( )
Air Separator	( )	( )
Flue Piping	( )	( )
Draft Fan	( )	( )
Vibration and Noise	( )	( )
Drain Valves	( )	( )
Relief Valves	( )	( )
Safety Controls	( )	( )
Operation and Sequence of Controls	( )	( )
Chemical Treatment	( )	( )
Operation of Gas Valves	( )	( )
Burner Operation	( )	( )
Programmer Operation	( )	( )
Flame Detector	( )	( )
High and Low Gas Pressure Switch	( )	( )
Starters and Disconnects	( )	( )
Expansion Tank Connected	( )	( )
Domestic Water Make-up	( )	( )
Relief Valves Piped to F.D.	( )	( )

**REMARKS**

Project:

## GAS FIRED BOILER CHECK SHEET

Page 2

**TEST RESULTS**

<i>ITEM</i>	<i>RESULT</i>	<i>ITEM</i>	<i>RESULTS</i>
Operating Pressure kPa.	_____	High Limit Set.	_____
Flow Rate l/s	_____		
<i>BOILER FIRING RATE 33 %</i>		<i>BOILER FIRING RATE 67 %</i>	
Fluid Temp. Rise °C	_____	Fluid Temp. Rise °C	_____
Stack Temp. °C	_____	Stack Temp. °C	_____
Flue Gas - O <sub>2</sub>	_____	Flue Gas - O <sub>2</sub>	_____
Flue Gas - CO <sub>2</sub>	_____	Flue Gas - CO <sub>2</sub>	_____
Combustion Efficiency %	_____	Combustion Efficiency %	_____
<i>BOILER FIRING RATE 100 %</i>			
Fluid Temp. Rise °C	_____		
Stack Temp. °C	_____		
Flue Gas - O <sub>2</sub>	_____		
Flue Gas - CO <sub>2</sub>	_____		
Combustion Efficiency %	_____		
Specified Maximum Temperature Rise °C	_____		

**REMARKS**

\_\_\_\_\_  
*(Signature of Contractor)*                      *(Name of Contracting Firm)*                      *(Date)*

\_\_\_\_\_  
*(Signature of Consultant)*                      *(Name of Departmental Rep.)*                      *(Date)*

Project:   Page 1	<h1 style="margin: 0;">PUMP</h1> <h2 style="margin: 20px 0 0 0;">CHECK SHEET</h2>
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**Public Works and Government  
 Services Canada**

**Project Number**  
Project Name:  
Project Location:  
System

Unit Mnemonic  
Location:

**INSTALLATION REVIEW**

**INDICATE ACCEPTABLE  
 WITH A ( ✓ ) MARK**

<i>ITEM</i>	<b>CONTRACTOR</b>	<b>DEPARTMENTAL REP.</b>
Installation and Mounting	( )	( )
Flexible Connections	( )	( )
Piping Arrangement & Support	( )	( )
Pump Arrangement	( )	( )
Isolating / Balancing Valves	( )	( )
Check Valves	( )	( )
Pressure Gauges	( )	( )
Strainers / Particle Filters	( )	( )
Chemical Feeder	( )	( )
Alignment / Rotation	( )	( )
Specified Operation (Parallel/Single)	Specified Flow	_____
Pumped Fluid _____	Specified Head	_____

**TEST RESULTS**

<i>ITEM</i>	<i>RESULTS</i>	<i>ITEM</i>	<i>RESULTS</i>
	<i>SINGLE</i>		<i>SINGLE</i>
<u>Shut Off Head kPa.</u>		<u>Pump Head kPa.</u>	
Discharge _____		Discharge _____	
- Suction _____		- Suction _____	
= Total _____		= Total _____	
R.P.M. _____			

*(Attach Pump Curves with Operating Points Plotted on Curve)*

**REMARKS**

\_\_\_\_\_  
*(Signature of Contractor)*                      *(Name of Contracting Firm)*                      *(Date)*

\_\_\_\_\_  
*(Signature of Consultant)*                      *(Name of Departmental Rep.)*                      *(Date)*

**END OF SECTION**