SECTION 01 91 00 –TESTS ON COMPLETION AND TESTS AFTER COMPLETION

[A16]1.01 SCOPE:

A. **Contents**: This Section includes the Employer's Requirements for the Tests on Completion as required by Sub-Clause 9.1 of the Conditions of Contract and for Tests after Completion as required by Sub-Clause 12.1 of the Conditions of Contract.

B. **Purpose**: The purpose of Tests on Completion and Tests after Completion is to demonstrate that the Works conform to the criteria as specified in the Employer's Requirements and perform as designed to meet both the design intent and the Employer's Requirements through a comprehensive and systematic process.

C. **Performance Requirements**: The Contractor's technical specifications that are produced during the design phase shall include detailed functional and operational performance requirements and shall include specific verification and testing requirements and procedures which when followed by the Contractor shall demonstrate to the Employer that the Works conform with the criteria as specified in the Employer's Requirements and perform as designed to meet both the design intent and the Employer's Requirements through a comprehensive and systematic process. The Contractor's Quality Management System specified in Section 01 40 00 (*Quality Requirements*) requires specific protocols and procedures which when implemented shall verify proper construction of the Works and demonstrate functional and operational performance of all systems for compliance with the design intent as specified in the Employer's Requirements.

D. **Related Sections**: The requirements of this section are in addition to Clause 9 [*Tests on Completion*] of the Conditions of Contract, and Clause 12 [*Tests after Completion*] of the Conditions of Contract. The following Sections of the Employer's Requirements contain additional requirements for Tests on Completion and Tests after Completion: Section 01 10 00 (*General Project Requirements*), Section 01 81 13 (*Filling and Emptying Systems*), [A19]Section 01 81 13.13 (*Physical Model for F-E System*),[A19] Section 01 81 19 (*Lock Gates*), Section 01 81 23 (*Culvert and Conduit Valves*), Section 01 81 26 (*Communications, Control, Safety and Security Systems*), Section 01 92 00 (*Facilities Operation*), and other sections, as applicable.[A16]

1.02 SUBMITTALS:

A. **Documentation**: The Contractor shall provide to the Employer's Representative the following items in accordance with Section 01 33 00 (*Submittal Procedures*) as soon as they become available.

[A16]1. Certified and reviewed start-up and testing reports for all systems, subsystems, Plant, and components.

2. Control schematics and control-sequence descriptions of the total system and all subsystems.

3. Records of required inspections for code compliance and documentation of approved permits and licenses to operate components of the system.

4. Operating data that shall include all necessary instructions to the Employer's operating staff in order to operate the system to specified performance standards.

5. (Reserved)[A16]

B. [A16]**Preliminary Commissioning Plan**: [A19]The Contractor shall submit for approval the preliminary commissioning plan to the Employer's Representative within 28 days after the completion of the design for a corresponding work package, in accordance with Section 01 33 00 (*Submittal Procedures*).[A19] This plan shall cover all aspects of the testing and commissioning process and shall include:

1. Responsibilities of each trade involved in or affected by the commissioning process.[A16]

2. Requirements for documentation as indicated in the Contract specifications.

3. Requirements for documentation of commissioning inspections and tests required by applicable codes and standards.

4. Requirements and format for a training program for operations and maintenance personnel.

5. List of needs and assumptions regarding participation by the Employer's Personnel.

C. [A16]**Commissioning Plan**: The Contractor's commissioning plan shall describe how the commissioning process will be organized, scheduled, and documented. [A19]It shall be prepared by the Contractor and submitted to the Employer's Representative for approval in accordance with Section 01 33 00 (Submittal Procedures) no later than 63 days prior to a request for commissioning of any system.[A19A16]

1. The plan shall include:

   a. The composition of the Contractor's commissioning team, including each Subcontractor's representation.

   b. A list of activities required to commission the system and its subsystems.

   c. [A16]A schedule for each activity from the Accepted Baseline Programme to make possible the coordination necessary between trades and trade divisions.

   d. Performance test plan, which includes detailed procedures for conducting all required performance tests, how various performance test parameters will be measured and/or calculated, and how the results will be reported.

   e. [A19]Trial operation test plan, which includes specific sequences, schedules, and other details pertaining to trial operations.[A19A16]

2. The commissioning plan shall be inclusive and have a process to perform and document the testing and commissioning activities required by this Section and other Sections of the Employer's Requirements.

D. **Training Plan and Training Equipment**: Training shall be as specified in the Contract and submitted in accordance with Section 01 79 00 (*Demonstration and Training*).

E. **Testing and Inspection Reports**: The testing and inspection reports shall be submitted to the Employer's Representative and to members of the commissioning team. Refer to Section 01 33 00 (*Submittal Procedures*) and all other pertinent Sections.

1.03 REQUIREMENTS:

A. [A16]**Contractor's Responsibilities**: The Contractor shall comply with the following requirements.

1. Except for water from Gatun Lake and for power to operate the lock complexes, furnish all labor, equipment, and Materials to accomplish complete system commissioning as specified in this Section. This includes all lock Operations until the date of the Taking-Over Certificate.

2. On the date of issuance of the Taking-Over Certificate, deliver a commissioned installation to the Employer that meets all requirements in accordance with the Contract.

3. Provide all necessary access facilities to those working on the installation of all systems so that the commissioning requirements can be fulfilled completely.

4. Consult with Subcontractors to ensure that sufficient time is allowed and fully identified on the Accepted Baseline Programme for the proper commissioning of all systems.

5. Exercise sole responsibility for planning, organizing, and implementing the commissioning process.

6. Assemble a commissioning team, comprised of qualified trade specialists who are coordinated by a competent, experienced supervisor.

7. Supply complete instruction and information relating to the operation and maintenance of all equipment and systems.

8. Coordinate with the commissioning team in each phase of the project to ensure compliance with all system-commissioning requirements.

9. Document all inspections and tests performed on the systems as part of the commissioning process.

10. Verify the existence and applicability of operation and maintenance (O&M) manuals, as-built drawings, record drawings and documents, spare part lists, special tool lists, and other items as may be required for support of the system. All such items shall have been prepared in accordance with Section 01 78 23 (*Operations Data*) and 01 93 00 (*Maintenance Services*). The Contractor shall make any and all necessary corrections and updates to O&M manuals if errors or discrepancies are discovered during the commissioning process.[A16]

[A16]B. **Verification of Functional and Operational Performance**: The Contractor shall demonstrate functional and operational compliance of all systems for compliance with the criteria as specified in the Employer's Requirements before Taking Over as specified in this Section and in related Sections. Some example systems or groups of electrical and mechanical components are listed below for illustration. This list is not complete. The requirements of this paragraph apply to all specific systems that are included in the Employer's Requirements whether or not they are listed below, in accordance with this section and with Section 01 10 00 (*General Project Requirements*).

1. Filling and emptying systems in accordance with Section 01 81 13 (*Filling and Emptying Systems*) [A19]and Section 01 81 13.13 (*Physical Model for F-E System*).[A19]

2. Culvert and conduit valve-Operation Systems in accordance with Section 01 81 23 (*Culvert and Conduit Valves*).

3. Lock gate operating systems in accordance with Sections 01 10 00 (*General Project Requirements*) and 01 81 19 (*Lock Gates*).

4. Culvert and conduit bulkhead installation and removal in accordance with Section 01 81 23 (*Culvert and Conduit Valves*).

5. Lock machinery and other control systems in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

6. Safety and security systems in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

7. Electrical systems in accordance with Section 01 81 29 (*Electrical and Lighting System*).

8. The functionality and operational compliance of all buildings and facilities required for the locks operations in accordance with Sections 01 81 36 (*O&M Buildings and Facilities – Program*) and 01 81 36.13 (*O&M Buildings and Facilities – Space Programming*).

9. Potable water systems in accordance with Sections 33 11 00 (*Water Utility Distribution Piping*) and 33 11 00.13 (*Water Utility Main Lines*).

10. Compressed air distribution piping in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).

11. Sewage collection systems in accordance with Sections 01 89 19 (*Sanitary Sewer / Wastewater*) and Section 40 95 13.22 (*Wastewater Treatment Control Systems*).

12. Fire alarm systems in accordance with Section 28 31 00 (*Fire Alarm Systems for Buildings*).

13. Fire protection systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).

14. Foam fire fighting systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).

15. Communication systems in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*).

16. Lock gate recess dewatering systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*) and 01 92 00.13 (*Dry Outages*).

17. Lock culvert and conduit dewatering systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*) and 01 92 00.13 (*Dry Outages*).

18. Valve pit dewatering systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*) and 01 92 00.13 (*Dry Outages*).

19. Lock chamber dewatering systems in accordance with Sections 01 86 13 (*Plant – Mechanical Systems and Equipment*) and 01 92 00.13 (*Dry Outages*).

20. Lighting systems in accordance with Section 01 81 29 (*Electrical and Lighting System*), and Section 26 50 00 (*Lighting Systems*).

21. Vessel control systems in accordance with Section 35 10 00 (*Waterway and Marine Signaling and Control Equipment*) and Section 35 12 00 (*Vessel Detection System* (*VDSs*)).

22. Air conditioning in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).

23. Plumbing systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).

24. Elevator systems in accordance with Section 01 86 13 (*Plant – Mechanical Systems and Equipment*).[A16]

C. **Commissioning Team**: The Contractor's commissioning team shall be as specified below. The Contractor shall manage the commissioning process to deliver fully functional and tested facilities that meet all Contract requirements. The Employer will be represented during the commissioning process by the Employer's Representative or his designee. All commissioning inspections and testing shall likewise be performed in the presence of the Employer's Representative or his designee.

1. [A16]**Contractor's Commissioning Team Responsibility**: The Contractor shall provide appropriate personnel to serve on the commissioning team, including a suitable representative of the Contractor's design team. The Contractor shall include manufacturers' representatives as members of the team. The Contractor shall consider the degree to which such participation is required to ensure fulfillment of all Contract requirements.[A16]

   a. [A16]Provision and demonstration of a fully commissioned system is the responsibility of the Contractor. Therefore, through their participation in the planning, management, and oversight of all construction activities related to equipment approvals, performance testing, and commissioning of the systems identified herein, the members of Contractor's commissioning team shall ensure and demonstrate to the Employer that all systems have been properly inspected, tested, and commissioned.

   b. The Employer's Personnel and the Contractor's Personnel involved in the design and construction are expected to participate fully as an adjunct to the Contractor's commissioning team. In this way the Employer shall be involved in the development of commissioning and performance-testing programs. The participation of the Employer's commissioning team members shall not relieve the Contractor of any responsibility for compliance with the requirements of the Contract.[A16]

2. **Contractor Commissioning Team Representatives**: The Contractor Commissioning Team representatives shall include, but not be limited to, the individuals listed below. The Contractor shall list within the commissioning plan any special requirements for qualification of the commissioning team members, such as previous work experience, licensing, registration, membership in societies, etc.

   a. Chief Quality Control Representative.

   b. Mechanical Representative.

   c. Electrical Representative.

   d. Testing and Inspection Representative.

e. Instrumentation and Controls Representative.

f. Safety and Fire-Protection Representative.

D. [A16]**Commissioning Process**: The Contractor shall prepare, through the quality manager, the commissioning schedule and requirements for the interface between all construction trades in order to prevent delays in the commissioning process. Each commissioning activity shall be clearly defined in the commissioning plan.

E. Not Used.

F. **Pre-Commissioning Meeting**: At least 28 calendar days prior to the start of a scheduled component functional test, the Contractor shall hold a pre-commissioning meeting with all Contractor and Employer team members in attendance. The purpose of the meeting is to prepare for the system-activation inspection and to ensure that all team members are ready to begin the commissioning process. The Contractor shall ensure that the time provided between the pre-commissioning meeting and the commissioning activities is adequate to allow each commissioning team member to assemble representatives of his group and prepare for the required testing and commissioning activities.

G. **Coordination of Operational and Maintenance Training**: The Contractor shall coordinate and direct training of the Employer's Personnel for the operation and maintenance of the system in accordance with the detailed requirements found in the technical and execution Sections of the Employer's Requirements, including Section 01 79 00 (*Demonstration and Testing*).[A16]

1.04 [A16]PRE-COMMISSIONING AND COMMISSIONING, INSPECTIONS AND TESTS:

A. **Testing and Instrumentation Equipment**: The Contractor shall provide the following.

1. All labor and supervision to properly conduct and document all testing.

2. All equipment and instrumentation necessary to fully execute, measure, document, and otherwise support inspection and testing activity.

3. Supplies and utilities necessary to carry out testing and instrumentation as part of the commissioning process, including such expendable items as electricity, water, fuels, chemicals, and other materials.

4. Equipment and devices required for access including, but not limited to, platforms, scaffolds, ladders, and personnel hoists. The Contractor shall also provide pertinent required safety equipment including, but not limited to, safety harnesses, hearing protection, gloves, boots, hard hats, safety glasses, and face shields.[A16]

B. [A16]**Pre-commissioning Tests**: The purpose of pre-commissioning is to demonstrate that each item of Plant can safely undertake the next stage in the commissioning process. Pre-commissioning shall include individual component installation inspection and functional testing to verify compliance with all checks, inspections, and startup testing that is specified in the individual specification Sections, recommended by the manufacturers, or required by referenced codes or standards. This effort shall ensure that all individual or discrete items of Plant and equipment have been completely and correctly installed throughout the construction process as each component is installed and activated.

1. **Component Functional Test**: Before starting commissioning tests, the Contractor shall complete the physical installation of the component and ensure that all services, such as electrical power, water, sewage piping, compressed air

piping, etc., have been connected, pre-tested, pre-commissioned, and started. The Contractor's commissioning team shall then perform the component functional tests to demonstrate that each individual component functions properly and safely and as specified including those that are described herein, specified in other parts of these Employer's Requirements, recommended by the manufacturers, or required by referenced codes or standards and is fit for purpose.

a. The equipment or item being tested shall be subjected to various full-load and partial-load conditions, as well as emergency operating and shutdown conditions.

b. The ability of the system to operate in the manner consistent with the design intent and in accordance with the Employer's Requirements shall be demonstrated to the Employer's Representative.

c. Equipment with separate automatic controls shall include, as a part of the test, operation in automatic mode.

d. Any deficiencies discovered during these tests shall be corrected and retesting performed in accordance with the applicable specification requirements.

C. **Commissioning Tests**: Commissioning tests shall include the specified operational tests to demonstrate that the Works can be operated safely and as specified under all available operating conditions. Commissioning tests shall also include component functional tests to demonstrate that each individual component functions properly and safely and as specified, and subsequent systems functional performance tests to demonstrate that each overall system functions properly and safely and as specified, without overheating, jamming, excessive noise or vibration, or evidence of excessive wear and as further described below.[A16]

[A16]1. **Systems Functional Test**: Before starting a system's functional test, the Contractor shall complete the component functional tests for all components of the system and shall ensure that all services, such as electrical power, water, sewer collection, compressed air piping, etc., for the entire system have been connected, pre-tested, pre-commissioned and started. The Contractor's commissioning team with assistance as required from Employer's Personnel shall then perform the system functional tests that are described herein, specified in other parts of these Employer's Requirements, recommended by the manufacturer, or required by referenced codes or standards. These tests shall be performed for all major systems, subsystems, and assemblies to demonstrate that discrete subsystems, when combined with the other subsystems to make up the overall operational system of the Works are fit for purpose and can safely be operated as specified under all conditions in the prescribed manner without overheating, jamming, excessive noise or vibration, or evidence of excessive wear.

a. The system being tested shall be subjected to various full-load and partial-load conditions, as well as emergency operating and shutdown conditions.

b. The ability of the system to operate in the manner consistent with the design intent and in accordance with the Employer's Requirements shall be demonstrated to the Employer's Representative.

c. Systems with separate automatic controls shall include, as a part of the test, operation in automatic mode.

d. Any deficiencies discovered during these inspections shall be corrected and the system retesting performed in accordance with the applicable specification requirements.

D. Not Used.[A16]

1.05 [A19]**PERFORMANCE TESTING**:[A19]

A. **General**: [A19]Following the pre-commissioning and commissioning tests, the Contractor shall carry out performance tests to demonstrate whether the Works conform to the criteria specified in the Employer's Requirements. Performance tests for the Atlantic lock complex shall be carried out independently from performance tests for the Pacific lock complex. All performance tests for either the Atlantic or Pacific lock complex must be successfully completed and accepted by the Employer's Representative before the Contractor shall begin trial operation at that respective lock complex.[A19]

B. [A19]**Performance Test Notice and Plan**: After successfully completing the commissioning tests, the Contractor shall give notice that it is ready to carry out performance tests. The performance tests shall be carried out in accordance with the Contractor's performance test plan as approved by the Employer's Representative.[A19]

C. **Performance Test Requirements**: [A19]Each performance test to be conducted by the Contractor shall be successfully carried out prior to trial operation and be performed in accordance with the specified requirements of that performance test. The detailed test procedures shall be clearly described in the Contractor's commissioning plan.[A19] The performance tests carried out by the Contractor shall be undertaken to demonstrate compliance with the following:

1. [A19]Measured filling and emptying times using Water-Saving Basins shall be as stated in Section 01 81 13 (*Filling and Emptying Systems*) Subparagraphs 1.06 A., 1.06 B, and 1.06 D.[A19]

2. [A19]Measured filling and emptying times not using Water-Saving Basins shall be as stated in Section 01 81 13 (*Filling and Emptying Systems*) Subparagraphs 1.06 A., 1.06 C, and 1.06 D.[A19]

3. [A19]Measured water slope in transverse and longitudinal directions in each chamber shall be as stated in Section 01 81 13 (*Filling and Emptying Systems*) Subparagraph 1.03 B.4.[A19] The Contractor shall accurately measure and record the water surface elevations during the various chamber filling and emptying operations to demonstrate that this requirement is met for each chamber and each different filling or emptying condition.

4. [A19]Measured flow velocities in culverts, conduits and ports shall be as stated in Section 01 81 13 (*Filling and Emptying Systems*) Subparagraph 1.03 B.6.[A19]

5. [A19]Compliance with the requirements of Section 01 81 13 (*Filling and Emptying Systems*) Subparagraph 1.03 B.8. regarding air entrapment, water hammer, and cavitation shall be demonstrated.[A19]

6. [A19]Measured surface velocities at lock intakes and discharges shall be as stated in Section 01 81 13 (*Filling and Emptying Systems*) Subparagraph 1.03 B.11.[A19]

7. [A19]Volume of water saved with the use of WSBs as compared to without the use of WSBs for a given lake and ocean level shall be calculated by the Contractor and submitted to the Employers Representative to demonstrate compliance with the requirements of Section 01 81 13 (*Filling and Emptying Systems*) Subparagraph 1.03 B.5.[A19]

8. Measured water depth over the gate sills and chamber floors shall be as stated in Section 01 10 00 (*General Project Requirements*) Subparagraph 1.02 G.2.

9. Gate buoyancy chambers, ballast tanks, and other hollow cavities shall meet the water tightness requirements of Section 01 81 19 (*Lock Gates*) Subparagraph 1.06 E.1.

10. [A19]Gate operation and measured maximum gate opening and closing and times shall meet the requirements of Section 01 81 19 (*Lock Gates*) Subparagraphs 1.04 U.1.d.and 1.06 E.3.[A19]

11. (Reserved)

12. Leakage through the gates and recess closures shall meet the requirements of Section 01 81 19 (*Lock Gates*) Subparagraph 1.06 E.3.

13. Conduit and culvert valve operation shall meet the requirements of Section 01 81 23 (*Culvert and Conduit Valves*) Subparagraph 1.06 E.1.

14. Measured conduit and culvert valve leakage shall meet the requirements of Section 01 81 23 (*Culvert and Conduit Valves*) Subparagraph 1.06 E.2.

15. Final field inspection tests of the communications, control, safety, and security systems shall be performed and shall meet the requirements of Section 01 81 26 (*Communications, Control, Safety, and Security Systems*) Subparagraph 1.06 E.

[A19]1.06 FAILURE TO PASS TESTS ON COMPLETION:

A. **General**: If the Works (or any part of the Works) fail to pass any of the Tests on Completion stated in this Section or elsewhere in the Employer's Requirements, Sub-Clause 9.3 *[Retesting*] of the Conditions of Contract and Sub-Clause 9.4 [*Failure to Pass Tests on Completion*] shall apply as stated therein.

The Parties expressly agree that the Employer shall be entitled to performance damages as stated in this Section, at the rates specified herein, pursuant to Sub-Clause 9.4(b) of the Conditions of Contract, for failure of any of the following Tests on Completion:

1. the performance tests to demonstrate the measured filling and emptying times using Water-Saving Basins as stated in Section 01 81 13 (*Filling and Emptying Systems*) paragraphs 1.06 A. and 1.06 B.; and/or

2. the performance tests to demonstrate the measured filling and emptying times not using Water-Saving Basins as stated in Section 01 81 13 (*Filling and Emptying Systems*) paragraphs 1.06 A. and 1.06 C.; and/or

3. the performance tests to demonstrate the required opening and closing times of the lock gates as stated in Section 01 81 19 (*Lock Gates*) paragraph 1.06 E.2.b.

B. **F-E Time Performance Damages**: Refer to Section 01 81 13 (*Filling and Emptying Systems*) paragraphs 1.06 A., 1.06 B., 1.06 C. and 1.06 D. for filling and emptying system performance test procedures, times and requirements.

1. The measured time for each of the 8 performance test cases shall be compared with the corresponding not-to-exceed time (NTET) for each of the 8 performance test cases, all of which are determined as explained in sections 1.06 A. to D. of Section 01 81 13 (*Filling and Emptying Systems*).

2. No F-E time performance damages shall be applied if the measured time for each of the eight (8) performance test cases is equal to or less than 105.0% of the applicable NTET.

3. Variable F-E time performance damages shall be applied if the measured time for any of the eight (8) performance test cases exceeds 105.0% of the corresponding NTET.

4. Where the measured time for more than one of the eight (8) F-E time cases exceeds 105.0% of the corresponding NTET the F-E time performance damage amount shall be based on the one test case that exceeds the NTET by the largest percentage. The performance damage amount shall be $2 million for every 0.1% that the measured time exceeds 105.0% of the corresponding NTET up to a maximum F-E time performance damage amount of $100 million for a measured time that equals or exceeds 110.0% of the corresponding NTET

5. The percentage calculation for determining performance damages as aforesaid shall be rounded to the nearest tenth of a percent (0.1%). All measurements, data, rounding method and reporting shall comply with "ASTM E29 Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications".

6. F-E time performance damages (if any) are independent of, and in addition to, (any) lock gate performance damages resulting from the lock gate performance tests.

C. **Lock Gate Performance Damages**: Refer to Section 01 81 19 (*Lock Gates*) paragraph 1.06 E. for lock gate performance test procedures, times and requirements. Lock gate performance damages shall apply as follows:

1. Lock gate performance damages in the amount of $100 million shall be applied where any one or more of the required 320 individual gate closing or gate opening test times resulting from the Atlantic locks gate performance tests or any one or more of the required 320 individual gate closing or gate opening test times resulting from the Pacific locks gate performance tests exceeds 360 seconds. In this event, no further lock gate performance damages shall be applied.

2. Where C.1. above does not apply, lock gate performance damages shall be applied if either the average of the 160 individual gate closing plus gate opening times resulting from the Atlantic locks gate performance tests or the average of the 160 individual gate closing plus gate opening times resulting from the Pacific locks gate performance tests exceeds 600.0 seconds. In such circumstances, the amount of the lock gate performance damages shall be calculated in accordance with the following formula:

   Lock Gate Performance Damages = [(**T**-600.0) x ($833,333.33)]

   Where "**T**" is the average time in seconds of the 160 individual gate closing plus gate opening times resulting from the Atlantic locks gate performance tests, or the average time in seconds of the 160 individual gate closing plus gate opening times resulting from the Pacific locks gate performance tests. If the average time

in seconds of the 160 individual gate closing plus gate opening times resulting from the Atlantic locks gate performance tests and the average of the 160 individual gate closing plus gate opening times resulting from the Pacific locks gate performance tests both exceed 600.0 seconds, performance damages shall be assessed as aforesaid on whichever is the greater failure.

3. The maximum lock gate performance damage amount calculated under paragraph C.2. above shall be $100 million, which equates to a total average gate closing plus gate opening test time of 720.0 seconds, or more.

4. For the avoidance of doubt, there shall be no lock gate performance damages if:

   a. all 640 final measured individual gate closing or gate opening test times are each less than or equal to 360 seconds; and

   b. the average of the 160 individual gate closing plus gate opening times resulting from the Atlantic locks gate performance tests is less than 600.0 seconds; and

   c. the average of the 160 individual gate closing plus gate opening times resulting from the Pacific locks gate performance tests is less than 600.0 seconds.

5. Lock gate performance damages (if any) for the lock gate performance tests are independent of, and in addition to, (any) performance damages resulting from the filling and emptying system performance tests.

D. Not Used.

1.07 [A19]TRIAL OPERATION:[A19]

A. **General**: [A19]Following the performance tests, the Contractor shall carry out trial operation to demonstrate that the Works perform reliably and in accordance with the Contract. Trial operation at the Atlantic lock complex shall be carried out independently from trial operation at the Pacific lock complex. Trial operation must be successfully completed for both lock complexes before submission of the Contractor's application for a Taking-Over Certificate.[A19]

B. **Trial Operation Requirements**:

1. [A19]Trial operation shall not commence until all lock complex components have successfully undergone performance testing in accordance with the requirements of this Section and until the Employer has approved all details of the Contractor's trial operation plan.[A19]

2. [A19]Trial operation for the Atlantic and Pacific locks shall be successfully performed without interruption for one day at each locks complex with Water-Saving Basins and one day at each locks complex without Water-Saving Basins. Trial operation may be performed on consecutive days, at the discretion of the Contractor. Trial operation for the Atlantic locks complex shall be performed on different days than trial operation for the Pacific locks complex.[A19]

3. Trial operation shall be conducted following the operating schedule and sequence outlined in this Section and in Section 01 92 00 (*Facility Operations*). If trial operation is suspended for more than 8 hours due to failure of any system or individual component, the trial operation period shall be restarted.

4. Trial operation shall demonstrate proper installation, adjustment, function, performance, and operation of equipment, systems, control devices, and required

interfaces, both individually and in conjunction with process instrumentation and control systems. [A19]Unless otherwise specified, trial operation shall be considered complete when, in the opinion of the Employer's Representative, the facility has operated in the manner intended with automatic control and without a significant interruption, per the Employer's Requirements.[A19]

5. At its sole discretion, the Employer may elect to pass vessels through the locks during trial operation. If this is to be done, the Contractor will be so notified not later than 63 days prior to the date for submission of the Contractor's commissioning plan as indicated on the Accepted Baseline Programme. The Contractor shall cooperate fully to accommodate such vessels. [A19]The presence or absence of such vessels shall not in any way change the Employer's Requirements regarding trial operation.[A19]

C. **Typical Lockage Sequences**:

1. Trial operation shall follow the typical Up Lockage and Down Lockage sequences specified in Section 01 92 00 (*Facility Operation,*) Table 01 92 00-1.

2. Trial operation shall simulate a second vessel entering the first lock chamber while the first vessel enters the last lock chamber as in a "relay" or half cycle operation.

3. [A19]For the Pacific locks case 1 and case 2, as defined below, shall be performed on the first day of the trial operation and case 5 and case 6 on the second day. For the Atlantic locks case 3 and case 4, as defined below, shall be performed on the first day of the trial operation and case 7 and case 8 on the second day.[A19]

D. **Trial Operation Schedule and Sequence Using Water-Saving Basins (WSBs)**:

1. [A19]Case 1 and case 2, as defined below, shall be performed on the first day of trial operation for the Pacific locks, before trial operation without WSBs. Case 3 and case 4, as defined below, shall be performed on the first day of trial operation for the Atlantic locks, before trial operation without WSBs.[A19]

2. [A19]Trial operation for each of the Atlantic and Pacific locks shall simulate full automatic lock operation by performing complete Up Lockage and Down Lockage sequences using Water-Saving Basins, per the schedules in this Section.[A19]

3. [A19]The trial operation schedule for the Pacific locks using WSBs shall be as follows. The target cycle time for each cycle using WSBs is 2 hours, 34 minutes.

PACIFIC THIRD LOCKS with use of WSBs		
Case 1: Up Lockage Northbound from Ocean to Lake	Arrives	Exits
Cycle N-1	2:00	
Cycle N-3		
Cycle N-5		
Cycle N-7		
Cycle N-9		
Cycle N-11		Not later than 11:54

Case 2: Down Lockage Southbound from Lake to Ocean	Arrives	Exits
Cycle S-2	15:00	
Cycle S-4		
Cycle S-6 Cycle S-8 Cycle S-10 Cycle S-12		Not later than 0:54

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4. [A19]The trial operation schedule for the Atlantic locks using WSBs shall be as follows. The target cycle time for each cycle using WSBs is 2 hours, 34 minutes.

ATLANTIC THIRD LOCKS with use of WSBs		
Case 3: Up Lockage Southbound from Ocean to Lake	Arrives	Exits
Cycle S-2	4:00	
Cycle S-4		
Cycle S-6		
Cycle S-8		
Cycle S-10		
Cycle S-12		Not later than 13:54
Case 4: Down Lockage Northbound from Lake to Ocean	Arrives	Exits
Cycle N-1	14:00	
Cycle N-3		
Cycle N-5 Cycle N-7 Cycle N-9 Cycle N-11		Not later than 23:54

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E. **Trial Operation Schedule and Sequence without Water-Saving Basins (WSBs):**

1. [A19]Case 5 and case 6, as defined below, shall be performed on the second day of trial operation for the Pacific locks, and shall only be conducted after successful completion of trial operation with WSBs. Case 7 and case 8, as defined below, shall be performed on the second day of trial operation for the Atlantic locks, and shall only be conducted after successful completion of trial operation with WSBs.[A19]

2. [A19]Trial operation for each of the Atlantic and Pacific locks shall simulate full automatic lock operation by performing complete Up Lockage and Down

Lockage sequences without using Water-Saving Basins, per the schedules in this Section.[A19]

3. [A19]The trial operation schedule for the Pacific locks without use of WSBs shall be as follows. The target cycle time for each cycle without use of WSBs is 2 hours, 13 minutes.

PACIFIC THIRD LOCKS without use of WSBs		
Case 5: Up Lockage Northbound from Ocean to Lake	Arrives	Exits
Cycle N-1	2:00	
Cycle N-3		
Cycle N-5		
Cycle N-7		
Cycle N-9		
Cycle N-11		
Cycle N-13		Not later than 11:37
Case 6: Down Lockage Southbound from Lake to Ocean	Arrives	Exits
Cycle S-2	15:00	
Cycle S-4		
Cycle S-6 Cycle S-8 Cycle S-10 Cycle S-12 Cycle S-14		Not later than 0:37

A19

4. [A19]The trial operation schedule for the Atlantic locks without use of WSBs shall be as follows. The target cycle time for each cycle without use of WSBs is 2 hours, 13 minutes.

ATLANTIC THIRD LOCKS without use of WSBs		
Case 7: Up Lockage Southbound from Ocean to Lake	Arrives	Exits
Cycle S-2	4:00	
Cycle S-4		
Cycle S-6		
Cycle S-8		
Cycle S-10		
Cycle S-12		
Cycle S-14		Not later than 13:37

Case 8: Down Lockage Northbound from Lake to Ocean	Arrives	Exits
Cycle N-1	14:00	
Cycle N-3		
Cycle N-5 Cycle N-7 Cycle N-9 Cycle N-11 Cycle N-13		Not later than 23:37

A19

1.08 [A16]**TESTS AFTER COMPLETION**:

A. **Overall Tests after Completion**: Tests after Completion in accordance with Sub-Clause 12 [*Tests after Completion*] will be performed at dates and times scheduled by the Employer, approximately two years after the date of the Taking-Over Certificate, to demonstrate the overall performance of the Works.

1. **Physical Inspection of the Works**: The Employer will conduct physical inspections of the Works to verify that the condition of the Works is substantially the same as at Taking Over. This may include dewatering and inspecting inside chambers, gate recesses, conduits and culverts.

2. **Performance Testing**: With the cooperation and assistance of the Contractor, the Employer may re-perform some or all of the performance tests that were done as part of Tests on Completion. The purpose of these Tests after Completion is to verify that the performance of the systems and the Works after 2 years is the same as it was at Taking Over. The Contractor shall fully coordinate and cooperate with the Employer's Representative to perform any such tests.

B. **Failure to Pass Tests after Completion**:

If the Works fail to pass any of the Tests after Completion stated in this Section or elsewhere in the Employer's Requirements, Sub-Clause 12.4 [*Failure to Pass Tests after Completion*] shall apply.

C. **Communications, Control, Safety and Security Systems Tests after Completion**: At its sole discretion, the Employer may require tests after completion for communications, control, safety and security systems at any time during the Defects Notification Period in accordance with Section 01 81 26 (*Communications, Control, Safety, and Security Systems*), Subparagraph 1.06 I.[A16]

END OF SECTION

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