SECTION 01 92 00 – FACILITY OPERATION

1.01 SUMMARY:

A. [A16]**General**: This Section describes the facility operation for the new lock complexes from navigational and lock-operation perspectives and includes operational requirements.[A16]

1. [A16]The navigational description and consideration includes vessel approach, vessel-lock communications, vessel mooring, and vessel departure. [A16]

2. [A16]The lock-operation description and requirements explains the expected behavior of the machinery and related water movement. [A16]

B. **Related Sections**:

01 81 13	Lock Filling and Emptying (F-E) System.
[A19]01 81 13.13	Physical Model for Filling and Emptying System[A19]
01 81 16	Lock Structures.
01 81 16.16	Locks Appurtenances.
01 81 19	Lock Gates.
01 81 23	Culvert and Conduit Valves.
01 81 26	Communications, Control, Safety, and Security Systems.
40 96 45.13	Process Control Software for LMCS.
26 50 00	Lighting Systems.

1.02 REFERENCES:

A. [A16]**Autoridad del Canal de Panamá** (**ACP**): The following includes references used in the existing locks.[A16]

1. Regulation on Navigation in Panama Canal Waters. (http://www.pancanal.com/esp/maritime/regulations/index.html)

2. [A8]The Maritime Operation Manual of the ACP.[A8]

3. [A16]The following includes feasibility studies and reports which contain current data. [A16]

   a. Mediciones de Corrientes Marinas en la Bahía de Panamá. (http://www.pancanal.com/esp/plan/estudios/0309.html)

b. Feasibility Study of the Construction of an Artificial Island at the Pacific Entrance to the Canal. (http://www.pancanal.com/esp/plan/estudios/0257.html)

c. Feasibility Study of Island Development at the Pacific Entrance of the Panama Canal. (http://www.pancanal.com/esp/plan/estudios/0109.html)

d. Feasibility Study of Palo Seco/Farfán Land Reclamation to Develop a Port Facility. (http://www.pancanal.com/esp/plan/estudios/0273.html)

4. Evaluación Ambiental de Opciones para la Construcción de Nuevas Esclusas y la Profundización de las Entradas del Atlántico y del Pacífico del Canal de Panamá. (http://www.pancanal.com/esp/plan/estudios/0142.html) [A7]

1.03 [A16]REQUIREMENTS AND DESIGN CONSIDERATIONS:[A16]

A. **Navigation and Operation Conditions**:

1. [A8]Vessels meeting the parameters in Subparagraph 1.03 C.1 will be allowed to transit the locks day or night and under all weather conditions.[A8] [A17]Nighttime Transits shall be illuminated as per Section 26 50 00 (*Lighting Systems*).[A17]

2. Vessels will be handled by Employer pilots in and around the locks. Employer tugs will be used to assist positioning vessels. [A10]Transiting vessels shall moor using onboard lines and winches. [A10] [A16]Labor for mooring will be done by the Employer. The mooring system and the methods used by the Employer to moor shall be designed and provided by the Contractor so as to reduce manpower requirements and to minimize mooring and unmooring times.[A16] [A7]If the mooring system designed by the Contractor does not use mooring lines, then a back-up system using mooring lines shall be provided. [A7]

3. [A17]The Employer regulations listed in Paragraph 1.02 (*References*) are in effect at the existing locks and may be used as the basis for operating and navigating in the new locks, with changes recommended by the Contractor for optimal performance of the Works.[A17] [A19]The Contractor shall provide an operation manual that includes the recommended operating procedures for performing all required lockage scenarios and any other required operations for review by the Employer's Representative.[A19]

4. The design of the Works shall avoid damage to its devices or equipment due to contact with transiting vessels.

B. **Restrictions to be Considered**:

1. [A17]The Works shall be designed to comply with the Employer's approved navigation and operation conditions as set out in Subparagraph 1.03 A.3.[A17]

C. **Performance Parameters**:

1. [A17]For the purposes of this Contract, the following provisions will govern [A16] the different types and sizes of vessel navigation in the locks:[A17]

   a. [A17]**Maximum Allowable Length**: The maximum length of a vessel is the measured distance between its forward and after extremities, including bulbous bow and protrusions. It is also referred to as length overall or LOA.[A17] [A16]The maximum overall length for passenger and container vessels will be 366 m (1,200 feet), provided that all such vessels with lengths exceeding 335 m (1,100 feet) are equipped with operational bow thrusters of sufficient power (see 1.04 A.9.a.). The maximum length for other vessel types and for any vessel without an adequate bow thruster will be 335 m (1,100 feet)[1]. [A16]

   b. [A17]**Maximum Allowable Width**: The maximum beam (the maximum breadth of the hull measured at the outer surfaces of the shell plate) for commercial or non-commercial vessels making regular Transits will be 49 m (160 feet).[A17]

   c. [A17]**Maximum Allowable Draft**: The maximum permissible TFW Draft for Canal Transits will be 15.2 m (50 feet) at a minimum operational level for Gatun Lake of 24.7 m (81 feet) PLD.[A17] This provides a safe navigational margin of at least 1.5 m (5 feet) over critical elevations in the Canal navigational channels. The density of Gatun Lake is taken as 0.9954 g/cm^3 at 29.4 °C (85 °F).

   d. [A10] (Reserved) [A10]

   e. [A10] (Reserved) [A10]

   f. [A16]**Required Force to Moor a Vessel**: The minimum force required to hold a vessel shall be a force equivalent to the maximum capacity that can be attained by synthetic mooring lines that can be handled manually. [A17]Such lines shall be of sufficient strength as to hold the Design Vessel, at its maximum displacement, in the center of the chamber during the filling and emptying of the lock chambers, taking into account the Contractor's interpretation of the prevailing maximum winds on the basis of the Hydrometeorological Report, included in Volume VI, Part 7 of the Contract documents, subject to the provision of Sub-Clause 5.1 (*General Design Obligations*) of the Conditions of Contract, and assuming that eight lines are used (4 forward and 4 aft).[A17A16]

   g. [A10] (Reserved) [A10]

2. [A16]**Lockage Time and Cycle Time**: In calculating each of these times, two operation modes are considered, with and without the use of WSBs. [A16]

[1] Metric values shall govern; English units are included for reference and illustrative purposes and are rounded values.

a. [A17]Both Lockage Time and Cycle Time are based on gate opening and closing times, times for vessel movement in and out of lock chambers, and times for filling and emptying the chambers. See 01 42 16 for definitions of Cycle Time and Lockage Time.[A17]

b. [A17]The allowable totals for Lockage Time and Cycle Time are set for the Design Vessel; see Section 01 42 16 (*Definitions*) and Section 01 10 00 (*General Project Requirements*) for details on the Design Vessel.[A17] The time allowances must be complied with 99% of the time considering the yearly variation of tide and lake levels; see Section 01 81 13 [A10](*Filling and Emptying Systems*) [A10] for the method of calculating these variances.

c. [A16]The maximum allowable times for individual operations are shown in Table 01 92 00 – 1. [A16] These times shall be optimized by the Contractor to achieve or improve times, considering where applicable the performance criteria defined in Section 01 81 13 [A10](*Filling and Emptying Systems*).[A10]

1) **Vessel Moving Time**: [A19]As the time to move vessels in or out of a lock chamber (excluding mooring times) is largely dependent upon the actual operation carried out by the Employer, the times shown are considered as default times.[A19] [A16]For the purposes of this Contract, a default time of 17 minutes shall be used.[A16] [A7]The Contractor is not responsible for default times because they represent the assumed amount of time required to carry out activities that are the responsibility of the Employer. [A7]

2) **Opening and Closing Gates**: The maximum travel time for lock gates are defined in Section 01 81 19 (*Lock Gates*). [A16]The minimum allowable time is 4 minutes and the maximum allowable time is 5 minutes. [A16]

3) [A16]**Mooring and Unmooring Vessels**: For safety, vessels may use mooring lines and linesmen. Mooring and unmooring times are the responsibility of the Employer and are included in the vessel moving times. [A16]

[A7](Deleted text) [A7]

4) **Filling and Emptying Times**: [A19]Tables or the not-to-exceed times are given in Section 01 81 13 (*Filling and Emptying Systems*) and Section 01 81 13.13 (*Physical Model for Filling and Emptying System*). The nominal times are 17 minutes per chamber with the use of WSBs and 10 minutes without the use of WSBs.[A19]

5) **Single and Relay Lockages**: [A17]Refer to Subparagraph 1.04 A.7. for details on single and Relay Lockages.[A17]

[A16]**Table 01 92 00 – 1**: **Maximum Allowable Times for Lock Operations**[A16]

Ocean-lake or lake-ocean (maximum times in minutes)		[A17]Single Lockage[A17]		[A17]Relay Lockage[A17]	
		Without WSBs	With WSBs	Without WSBs	With WSBs
1	Open gate	5	5	5	5
2	Vessel moves into chamber [A10] (17 minutes by Employer)	x	x	X	x [A10]
3	Moor vessel [A10] (by Employer)[A10]	[A7]x	x	X	x [A7]
4	Close gate	5	5	5	5
5	Fill or empty chamber[2]	10	17	10	17
6	Open gate [A7] (deleted text)	5	5	5	5
[A10] 7	Unmoor vessel (by Employer) [A10]	x	x	X	x [A7]
[A10] 8	Vessel moves into chamber (17 minutes by Employer)	x	x	X	x [A10]
[A10] 9	Moor vessel (by Employer) [A10]	[A7]x	x	X	x [A7]
10	Close gate	5	5	5	5
11	Fill or empty chamber	10	17	10	17
12	Open gate [A7](deleted text) [A7]	5	5	(Next vessel enters first chamber)	(Next vessel enters first chamber)
13	[A7]Unmoor vessel [A10](by Employer) [A10]	x	x [A7]		
[A10] 14	Vessel moves into chamber (17 minutes by Employer)	x	x [A10]		
[A10] 15	Moor vessel (by Employer) [A10]	[A7]x	x [A7]		
16	Close gate	5	5		
17	Fill or empty chamber	10	17		
18	Open gate [A7](deleted text) [A7]	5	5		
[A10] 19	[A7]Unmoor vessel (by Employer) [A10]	x	x		
[A10] 20	Vessel exits (17 minutes by Employer) [A10]	x	x		
	[A16]**Maximum Allowable Times** [A16]	**133**	**154**	**74**	**88**
	Times influenced by Contractor's design	**65**	**86**	**40**	**54**
	Vessel movement time [A10]by Employer [A10]	**68**	**68**	**34**	**34** [A7]

[2] [A17]See Section 01 81 13 (*Filling and Emptying Systems*).[A17]

6) Table 01 92 00-2 shows a sequence of three consecutive ships in relay mode with times when operating with use of WSBs.

Table 01 92 00 – 2: Sequence of Three Ships in Relay Lockages

Ocean-lake or lake-ocean (maximum times in minutes)		Relay lockages with use of WSBs		
		First vessel	Second vessel	Third Vessel
1	Open gate	5	(Second vessel approaches locks)	(Third vessel approaches locks)
2	Vessel moves into chamber (17 minutes by Employer)	x		
3	Moor vessel (by Employer)	x		
4	Close gate	5		
5	Fill or empty chamber	17		
6	Open gate (deleted text)	5		
7	Unmoor vessel (by Employer)	x		
8	Vessel moves into chamber (17 minutes by Employer)	x		
9	Moor vessel (by Employer)	x		
10	Close gate	5		
11	Fill or empty chamber	17		
12	**Open gate (simultaneous)**	**5**	**5**	
13	Unmoor vessel (by Employer)	x	x	
14	Vessel moves into chamber (17 minutes by Employer)	x	x	
15	Moor vessel (by Employer)	x	x	
16	Close gate	5	5	
17	Fill or empty chamber	17	17	
18	Open gate	5	5	
19	Unmoor vessel (by Employer)	x	x	
20	Vessel exits (17 minutes by Employer)	x	x	
21	Moor vessel (by Employer)	(First vessel exits locks)	x	
22	Close gate		5	
23	Fill or empty chamber		17	
24	**Open gate (simultaneous)**		**5**	**5**
25	Unmoor vessel (by Employer)		x	x
26	Vessel moves into chamber (17 minutes by Employer)		x	x
27	Moor vessel (by Employer)		x	x
28	Close gate		5	5
29	Fill or empty chamber		17	17
30	Open gate		5	5
31	Unmoor vessel (by Employer)		x	x

Table 01 92 00 – 2: Sequence of Three Ships in Relay Lockages				
Ocean-lake or lake-ocean (maximum times in minutes)		Relay lockages with use of WSBs		
		First vessel	Second vessel	Third Vessel
32	Vessel exits (17 minutes by Employer)		x	x
33	Moor vessel (by Employer)			x
34	Close gate			5
35	Fill or empty chamber			17
36	**Open gate (simultaneous)**			**5**
37	Unmoor vessel (by Employer)			x
38	Vessel exits (17 minutes by Employer)		(Second vessel exits locks)	x
39				x
40				5
41				17
42				5
43	Unmoor vessel (by Employer)			X
44	Vessel exits (17 minutes by Employer)			(Third vessel exits locks)
	Through lockage time	**154**	**154**	**154**
	Times influenced by Contractor's design	**86**	**86**	**86**
	Vessel movement time by Employer	*68*	*68*	*68*
	Relay lockage time	**88**	**88**	**88**
	Times influenced by Contractor's design	**54**	**54**	**54**
	Vessel movement time by Employer	*34*	*34*	*34*

3. [A16] (Reserved) [A16]

1.04 SYSTEM DESCRIPTION:

A. [A16]**Operating Procedures in and Around the Locks**: For the purpose of this Contract, the following operation assumptions have been made:[A16]

1. **Responsibility in the Locks**: [A19]Pilots, tugboat captains/masters, lockmasters, and control house operators referred to hereunder form part of the Employer's Personnel.[A19]

a. **Pilots**: The pilot remains in full control of the navigation and movements of the vessel at all times.

b. **Tugboat Captains**: Tugboat captains will respond in a prompt and safe manner to the orders given by the pilot regarding the transiting and positioning of the vessel through the locks. The tugboat masters will at all times inform the pilots and lockmasters of any issues arising during the lockage regarding transiting vessels and/or the tugs they command.

c. **Lockmasters**: Lockmasters will be responsible for ordering the opening and closing of the gates and the filling and emptying of the lock chambers. [A19]They will supervise all lock personnel who participate in lockage operations and work in close coordination with the Employer's *División de Operaciones de Tránsito* (OPT).[A19]

d. **Control House Operators**: [A19]Control house operators will be responsible for carrying out lockmaster orders from the control house using the lock-operation console as described in Section 40 96 45.13 (*Process Control Software for LMCS*).[A19]

2. **Assignment of Tugs to Transiting Vessels**:

a. [A17]Vessels of up to 38 m (125 feet) in length may lock without the assistance of tugs, provided their beams do not exceed 24.4 m (80 feet), nor their displacements 20,000 tons at the time of their Transits.[A17]

b. Vessels with lengths exceeding 38 m, displacements of 20,000 tons or less, and beams that do not exceed 24.4 m will be handled with one tug with a bollard pull of not less than 40 tons.

c. Vessels with displacements that are over 20,000 tons and up to 40,000 tons will be handled with two tugs with a bollard pull not less than 40 tons each. However, if their beams do not exceed 27.7 m (91 feet), they may, at the discretion of the pilot, be handled with one tug with a bollard pull of at least 60 tons.

d. Vessels with displacements that are over 40,000 tons and up to 120,000 tons will require two tugs with a bollard pull of at least 60 tons each.

e. Vessels with displacements exceeding 120,000 tons will be assisted by three tugs with a bollard pull of not less than 60 tons each. If such vessels have operational bow thrusters, they may, at the discretion of the pilot, be handled with two tugs, each with the same minimum bollard pull.

3. **Positioning of Tugs**:

a. When vessels require the assistance of two tugs, one will be positioned on the bow and the other on the stern.

b. When three tugs are used, the additional tug will be placed either on the bow or the stern, based on the decision of the pilot and depending on vessel characteristics.

c. A single tug, when used, will be positioned at the bow. However, if the vessel is equipped with an operating bow thruster, the tug may be placed at the stern.

4. **Communications within the Locks**:

a. **Between Pilot, Tugboat Captains, and Lockmasters**: During the entire lockage operation, there will be two-way radio communications between Employer pilots on board, the tugboat captains, and the lockmasters. [A17]Additional radio frequencies will be provided during Relay Lockages and Tandem Lockages.[A17]

b. **Between Lockmasters and Control House Operators**: Lockmasters will also have two-way radio communications with the control house operators to coordinate the control of water and lock equipment.

5. **Using Approach Structures**: Vessels will use the lock approach structures to hold for a specific time, with the help of tugs or by mooring, while the lock operations are ready to receive them. This staging area is critical for improving Cycle Times. They will enable vessels to slide along them upon entering or leaving the locks without damaging either the vessels or the structures, thereby also aiding the vessels in their alignment with the lock chambers. [A16]See Section 01 10 00 (*General Project Requirements*), Subparagraph 1.04 A.3. (*Provisional Sums*).[A16]

6. **Mooring Procedure**: If the mooring system uses mooring lines and linesmen, vessel mooring lines will be made fast to bitts and capstans, located at 15-m (49-foot) intervals along both sides of the lock chambers. A crew of line handlers will meet vessels at the lock entrances in order to handle the lines. Vessel mooring lines will be transferred to the lock walls manually by throwing messenger lines. The lock crew will move with the vessel during the entire lockage and will secure it to and release it from the bitts located on top of the lock walls. [A19]The Contactor may propose an improved mooring method to reduce mooring times and submit it for review by the Employer's Representative.[A19]

7. **Passing Through the Locks**: Four different vessel arrangements within chambers are envisioned for moving vessels through the locks using different available means.

a. **Single Lockage**: This is the basic operation to pass a single vessel through the locks. To lock upstream, the starting conditions require that the lower level be empty and that the middle and upper levels be filled. To lock downstream, the starting conditions require that the upper level be filled and that the middle and lower levels be emptied. When there is a turnaround in the direction of vessels passing through the locks, the

lock complex must be reset to the starting condition, which may result in the emptying or filling of chambers with no vessels in them. [A17]The valve- and gate-operation procedures for filling or emptying chambers are the same for Tandem Lockages and Relay Lockages. The difference is that, in a single lockage, there are no other vessels passing through the lock complex.[A17]

b. **Tandem Lockage**: With a chamber length of up to 458 m (1,500 feet), two vessels may lock in tandem if their aggregate overall length is not more than 366 m (1,200 feet). The first vessel will moor to one side of the chamber, while the second vessel will moor behind it, either on the same or the opposite side of the chamber.

c. **Nesting**: Three or more smaller vessels will be moored nested together and will remain nested throughout their lockage.

d. **Relay Lockage**: In order to maximize lock throughput, the locks shall be operated under the relay mode. This means that vessels shall not have to wait for the preceding vessel to clear the locks, but can begin their lockages while the preceding vessels are in the middle chamber and the water level of the first chamber is at the level of the lock entrance. Lockages under the relay mode will work as follows:

1) The pilot will contact the lockmaster to coordinate the approach and the resources needed for the lockage. The lockmaster and the pilot will coordinate if the vessel will be centered during the lockage or if it will moor to a side of the lock chamber, as described in [A7]Subparagraph [A7] 1.04 A.8.

2) The vessel will proceed into the first chamber once the water level in the chamber is equalized and the gates are opened. The vessel will enter the chamber with the assistance of the number of tugs previously indicated in [A7]Subparagraph[A7] 1.04 A.2. [A17]Vessel speed when entering the chamber or moving from chamber to chamber will not exceed 2 knots for Post-Panamax vessels and 3 knots for all others. In all cases, the process of entering the first chamber will take not more than 17 minutes.[A17]

3) The mooring process will start when the vessel reaches the proper position in the chamber. After the sterns of a vessel and any accompanying tugs clear the gate(s) and the vessel is securely moored, the lockmaster will inform the pilot and order the gate(s) closed behind them. As soon as the gate(s) are closed, the filling or emptying of the chamber will start.

4) The next vessel should, at this time, be positioning itself alongside the approach structure at the entrance of the locks. This and all subsequent vessels will hold their positions on the approach structure with the assistance of two additional relay tugboats. If necessary, the vessel will moor to the structure. All

relaying vessels will be positioned with their bows as close as is safely possible to the lock chamber entrance. This process expedites the entry of the vessels into the chamber, reducing the loss of time and the risk of accidents.

5) The first vessel will, at this time, be raised or lowered in the first chamber. After the water in the first chamber reaches the desired level, the rolling gates separating the first and middle chambers will open and the vessel will unmoor to enable it to move to the middle chamber. If the mooring system uses mooring lines and linesmen, the linesmen will walk with the vessel messenger lines from chamber to chamber. [A7]As soon as the first vessel is safely positioned in the middle chamber, the vessel will moor, the rolling gate(s) will close behind it, and the filling or emptying of the middle chamber will start.[A7] [A19]Simultaneously, the first chamber will be spilled or filled during this time in preparation for the following vessel.[A19]

6) As soon as the water in the first chamber is leveled and the gates are opened, the next vessel will enter, repeating the process carried out by the previous vessel. Subsequent vessels will be locked in the same manner.

7) The first vessel will move from the middle chamber to the last chamber after the water is leveled and the gate(s) opened. [A7]When the vessel is safely positioned in the last chamber, the gate(s) will close. [A7] The filling or emptying of the chamber will proceed until the level is equalized. The gates will then open, permitting the vessel to depart the last chamber.

8) [A17]Once a Northbound vessel clears the locks, the approach structure at the north end will be available for mooring, if so required. Likewise, when a Southbound vessel clears the locks, the approach structure at the south end shall be available for mooring, if so required.[A17]

e. **Means of Moving from Chamber to Chamber**: The Employer will move vessels from the approach structures to the chamber, from chamber to chamber, and from chamber out to approach structure with the assistance of tugs (as indicated in [A7]Subparagraph[A7] 1.04 A.2.), vessel engines, and, if available, thrusters. [A16]It is assumed that this process will take 17 minutes, including mooring times; this assumed standard time will be under the responsibility of the Employer.[A16] The lockmaster and the pilot will coordinate whether the vessel will move in the center of the chamber, slide along the side of the chamber, or a combination of both.

8. **Securing Vessels in the Chamber**: [A19]In each following case, the Contractor shall design and provide optimized methods to secure vessels in the chambers as

per Subparagraph 1.03 A.2. and submit it for review by the Employer's Representative.[A19]

a. If the mooring system uses only mooring lines and linesmen, vessels whose beams exceed 36.6 m (120 feet) will be positioned in the center of the chamber, secured with 4 mooring lines (2 forward and 2 aft) and up to 8 lines (4 forward and 4 aft), as needed. Otherwise, the vessels shall be positioned as required by the Contractor's mooring system.

b. If the mooring system uses only mooring lines and linesmen, vessels whose beams exceed 30.5 m (100 feet), but are less than 36.5 m, may be positioned either in the center of the chamber or moored to the side, secured with 4 mooring lines (2 forward and 2 aft). Otherwise, the vessels shall be positioned as required by the Contractor's mooring system.

c. If the mooring system uses only mooring lines and linesmen, vessels with beams of less than 30.5 m will be positioned alongside the side of the lock chamber, secured with 4 mooring lines (2 forward and 2 aft). Otherwise, the vessels shall be positioned as required by the Contractor's mooring system.

[A10]9. **Vessel Description**:

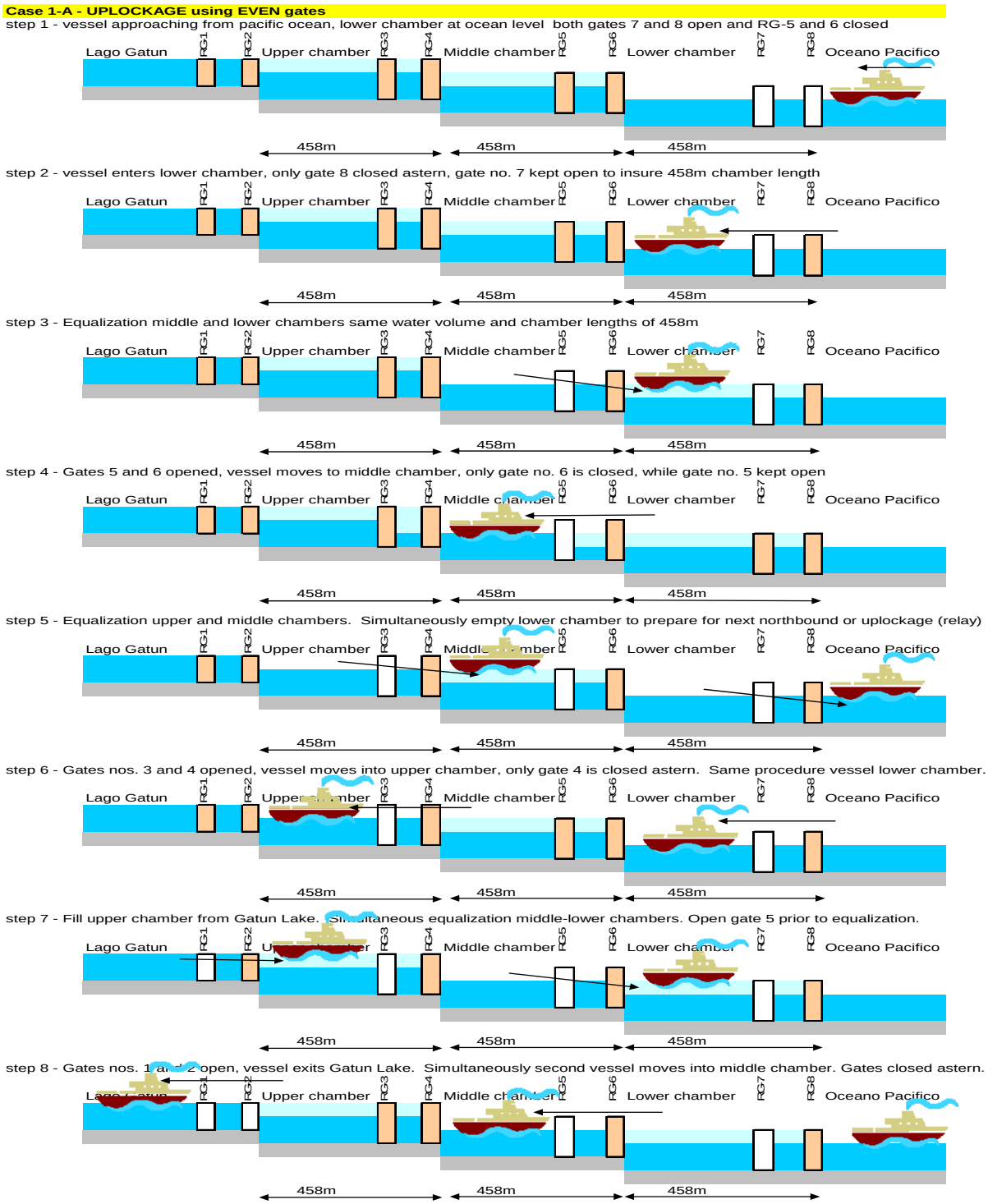
a. **Operating Bow Thrusters**: Passenger and container vessels whose length exceeds 335 m must be equipped with operational bow thrusters of sufficient thrust strength to effectively handle the vessels at their maximum draft displacements or at the maximum allowable draft displacement.

b. **Special Chocks and Bitts**: Vessels with large flared bows or unusually high freeboard, such as container vessels, may be required to fit additional chocks or recessed bollards into their hulls so that tugs can work without coming into contact with the bow flares or without the need for extra-long lines or inefficient leads.

c. [A16]**Speed of Winches Aboard Vessels**:[A16] Transiting vessels are required to have a rate of not less than 37 m (120 feet) per minute mooring winches on board vessels. [A10]

B. **Lock Operation**:

1. **Use of Gates**: Using redundant gates or a single gate at each end of the chamber impacts operating procedures, safety, chamber length, and water consumption. [A17]For illustrative purposes, see figure 01 92 00, this sequence is based with all gates in operating condition.[A17]



[A17]**Figure 01 92 00** - Illustration of Up Lockage with double set of gates ahead and cycle operation.[A17]

a. **Safety**:

1) [A17]A redundant set of gates shall be used, when available, in front of vessels as a safety precaution against the possibility of

vessel contact.[A17] [A16]Whenever gate redundancy is not available in front of the vessel, 2-stage vessel movements are used to reduce the risk of collision with the gate. [A16] The first step brings the vessel to a full stop at a safe distance from the gate, and the second step moves the vessel, dead slow, to the final position. These operational measures increase Lockage Time.

2) The gates are operated when water levels on either side of the gates are equalized or up to the permissible head defined in Section 01 81 19 (*Lock Gates*).

3) When placed out of service, the gates shall be fully retracted in their niches.

4) To reduce the impact of density currents in the lock approach area, gates at the ocean entrances shall be opened as much in advance as possible without reducing lock throughput.

b. **Different Chamber Lengths for Navigation**: Any of the chamber lengths may be used to lock vessels, depending on the service availability of the gates and size of the vessels. [A17]These scenarios may vary with gate availability.[A17]

1) [A7]The 427 m (1,400 feet) internal chamber length is configured by using inner gates at both ends. This is a non-standard or special operating condition. [A7]

2) The 458 m (1,500 feet) internal chamber length is configured by an outer gate and inner gate. When required gates are available, only one outer gate will be used behind the vessel and both inner and outer gates will be used in front of the vessel, for safety. [A7]This is the standard or normal operating condition. [A7]

3) The 488 m (1,600 feet) internal chamber length is configured by using only outer gates at both ends. [A7]This is a non-standard or special operating condition. [A7]

c. **Reducing Water Consumption**: [A17]When a vessel with a suitable draft can use a 427 m (1,400 ft) chamber length and water is held by both inner gates in the upper chamber, the Equalization level throughout each subsequent Equalization that utilizes the 458 m (1500 ft) length will be lower than it would if a 458 m (1,500 ft) chamber length is utilized for the upper level.[A17] [A16]This is not a standard operation procedure, but may be implemented by the Employer during periods of water shortage as a water-conservation measure. [A16]

2. **Use of Means of Equalization**: [A17]The operational procedures and safety measures shall make use of a means of Equalization for each gate for filling and emptying of the space between gates and for filling and emptying the chamber.[A17]

a. **Safety**:

1) [A16]**Selecting the Redundant Gate to Hold Water**: Typically, when a vessel approaches, the gate may not be holding water. Instead, the other gate in the redundant pair could. [A16]

2) **Controlling Water Level in the Lock Chambers**: [A17]The filling or emptying capacity of this means of Equalization shall be such that, upon failure to close, the flow rate will cause a slow change in the water level of the lock chamber and allow sufficient time to take other operational steps to control the water level.[A17]

b. **While Filling a Chamber**:

1) [A17]When redundant gates are used upstream, means of Equalizations shall be used to fill between the redundant gates and the chamber, at all times.[A17]

2) [A17]When redundant gates are used downstream, means of Equalizations shall be used to fill between the redundant gates, at all times.[A17]

3) [A17]When the chamber level cannot equalize to target levels due to different water volumes between the two chambers or due to lake and ocean level variances, the means of Equalizations between the equalizing bodies of water and all those upstream, shall be operated simultaneously to achieve target levels. When levels are reached, all means of Equalizations are returned to their previous positions.[A17]

c. **While Emptying a Chamber**:

1) [A17]When redundant gates are used upstream, means of Equalizations shall be used to empty between the redundant gates, at all times.[A17]

2) [A17]When redundant gates are used downstream, means of Equalizations shall be used to empty the chamber and between the redundant gates, at all times.[A17]

3) [A17]When the chamber level cannot equalize to target levels due to different water volumes between the two chambers or due to lake and ocean level variances, the means of Equalization between the equalizing bodies of water, and all those downstream, shall be operated simultaneously to spill water to achieve target levels. When levels are reached, all means of Equalization are returned to their previous positions.[A17]

3. [A16]**Use of Culvert Valves**: The operational procedures and safety measures shall make use of a minimum of 2 pairs of culvert valves in redundant arrangement where 1 pair is a backup of the other. [A16]

a. **Safety**:

1) If either culvert valve of any pair fails to close, the backup pair set shall close.

2) The Contractor shall design culvert valves to enable placing them out of service in the open position, without restricting culvert flow. This setting is contingent on:

a) A culvert valve design capable of controlled closing under its own weight and under full culvert water flow.

b) A culvert valve design with no or minimal probability of jamming in the open position.

c) [A17]A lock design capable of holding all possible Equalization levels without causing a flood or vessel contact with chamber floor.[A17]

b. [A8]**Filling the Chamber Without use of WSB**:[A8]

1) [A16]**Single-Culvert Operation**: For this operation the Contractor's design shall close all discharge culvert valves for the chamber being filled and then open intake valves for the active culvert.[A16] [A19]Single-culvert operation is a non-standard or special operating condition.[A19]

2) [A16]**Double-Culvert Operation**: For this operation the Contractor's design shall close all discharge culvert valves for the chamber being filled and then open all intake culvert valves.[A16] [A19]Double-culvert operation is the standard or normal operating condition.[A19]

c. [A8]**Emptying the Chamber Without use of WSB**:[A8]

1) [A16]**Single-Culvert Operation**: For this operation the Contractor's design shall close all intake culvert valves for the chamber being emptied and then open the discharge valves for the active culvert. [A16]

2) [A16]**Double-Culvert Operation**: For this operation the Contractor's design shall close all intake culvert valves for the chamber being emptied and then open all discharge culvert valves. [A16]

4. [A10]**Use of WSB Conduit Valves**: Operating sequence for WSBs is provided for information purposes only.[A10]

a. [A10] (Reserved) [A10]

b. [A10]**Filling the Chamber from WSBs**:[A10]

1) **Single-Culvert Operation**:

a) With all WSB conduit valves initially closed, open the bottom WSB conduit valves for the active culvert.

b) When the bottom WSB is nearly emptied, close its valves and open the intermediate WSB conduit valves for the active culvert.

c) When the intermediate WSB is nearly emptied, close its valves and open the top WSB conduit valves for the active culvert.

d) When the top WSB is nearly emptied, close its valves and open the intake valves for the active culvert.

2) **Double-Culvert Operation**:

a) With all WSB conduit valves initially closed, open both pairs of the bottom WSB conduit valves.

b) When the bottom WSB is nearly emptied, close its valves and open both pairs of the intermediate WSB conduit valves.

c) When the intermediate WSB is nearly emptied, close its valves and open both pairs of the top WSB conduit valves.

d) When the top WSB is nearly emptied, close its valves and open all intake culvert valves.

c. **Filling the WSBs from the Chamber**:

1) **Single-Culvert Operation**:

a) With all WSB conduit valves initially closed, open the top WSB conduit valves for the active culvert.

b) When the top WSB is nearly filled, close its valves and open the intermediate WSB conduit valves for the active culvert.

c) When the intermediate WSB is nearly filled, close its valves and open the bottom WSB conduit valves for the active culvert.

d) When the bottom WSB is nearly filled, close its valves and open the discharge culvert valves for the active culvert.

2) **Double-Culvert Operation**:

a) With all WSB conduit valves initially closed, open both pairs of the top WSB conduit valves.

b) When the top WSB is nearly filled, close its valves and open both pairs of the intermediate WSB conduit valves.

c) When the intermediate WSB is nearly filled, close its valves and open both pairs of the bottom WSB conduit valves.

d) When the bottom WSB is nearly filled, close all its valves and open all discharge culvert valves.

1.05 SUBMITTALS:

A. [A10]**Lock**[A10] **Operations Manual**:

1. [A10]Contractor shall submit a lock operations manual at the intermediate and final [A10] design phase for review and comments by the Employer.

2. [A17]Contractor shall submit a revision of the lock operations manual in accordance to Section 01 91 00 (*Tests on Completion and Tests After Completion*).[A17]

3. [A10] (Reserved)

B. (Reserved) [A10]

1.06 [A16]**QUALITY ASSURANCE**: It shall be provided in accordance with Section 01 40 00 (*Quality Requirements*) and per related Sections. Tests, inspections and verifications of facilities operations shall be carried out to verify compliance with requirements and criteria outlined in this Section. [A17]Procedures for facility performance evaluation, testing, planning, submittals, and commissioning requirements shall comply with Section 01 91 00 (*Tests on Completion and Tests After Completion*)[A17A16].

END OF SECTION