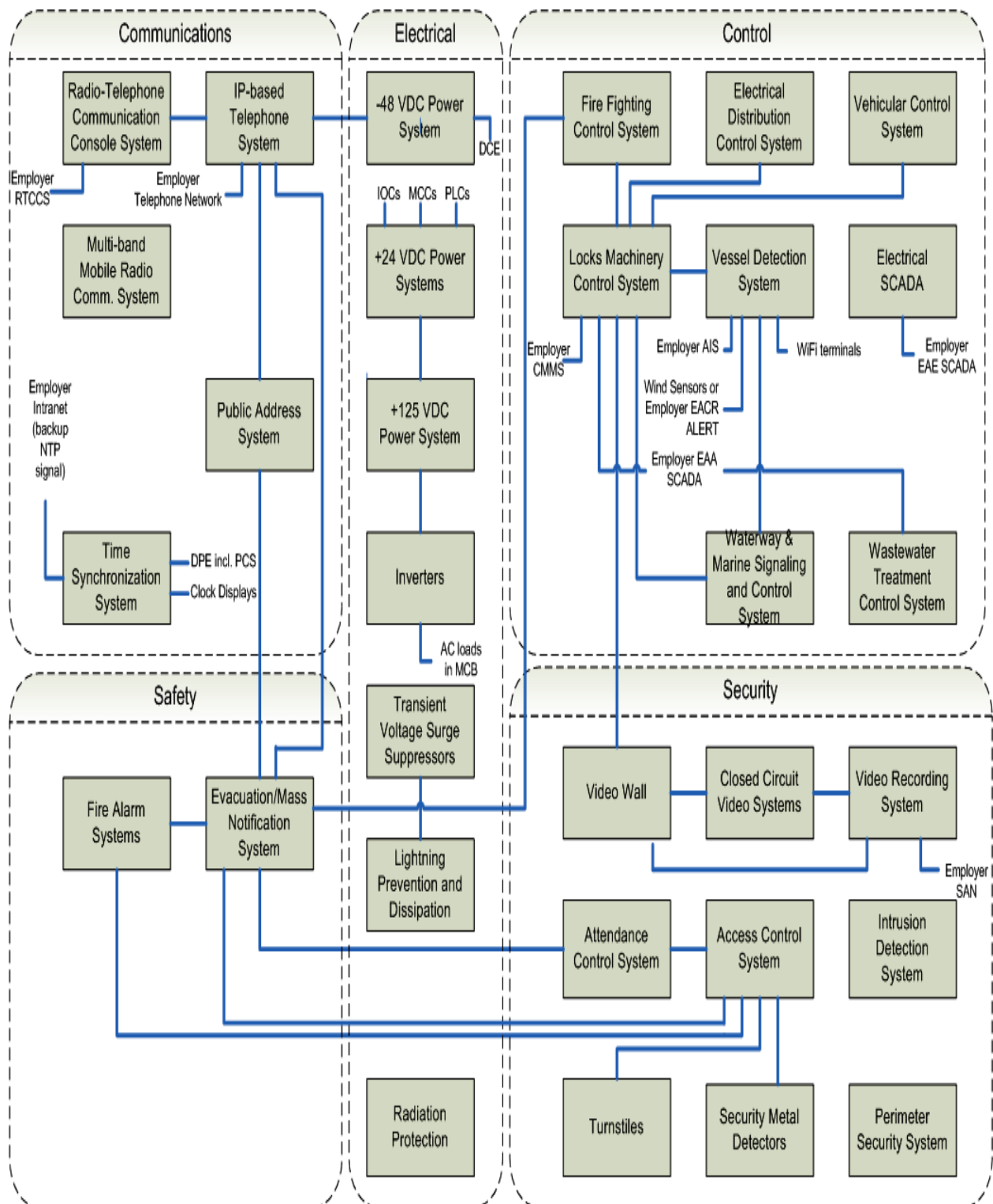


SECTION 01 81 26 – COMMUNICATIONS, CONTROL, SAFETY, AND SECURITY SYSTEMS

1.01 SUMMARY:

- A. ^{A16}This Section of the Employer's Requirement provides the overall view for communications, controls, safety, and security systems. Figure 01 81 26-1 illustrates a high level functional interconnection diagram. ^{A16}
- B. ^{A16}The detailed requirements are provided in other Sections of the Employer's Requirements which are listed in Tables 01 81 26-1 through -6 below. These Sections cover the detailed performance and other requirements for the Contractor to design, construct and deploy the communications, power sources, industrial process control, safety, and security related systems, for the ^{A16} ^{A17}Works. ^{A17}
- C. ^{A9}The nature of these systems and their importance upon the operation of the Third Set of Locks require that they exhibit highly reliable, high-safety, and low-risk levels of performance during continuous operation, as specified in related Sections. ^{A9}
- D. ^{A19}Each system shall include all design, procurement, manufacture, supply, delivery, installation, training, testing, commissioning, and setting to work as specified in the related Sections. ^{A19}
- E. **Products Supply Scope:**
1. **Auxiliary Electrical Systems:**
- a. Auxiliary electrical systems shall include DC equipment, inverters, lightning protection systems, and TVSSs in support for all other work areas specified in this Section.
- b. The Sections listed in Table 01 81 26-1 relate directly to works required for the sole purpose of providing the power supplies, over-voltage, and radiation protection devices, and electrical conditioning for the communications, controls, safety, and security systems of the ^{A17}Works: ^{A17}

Table 01 81 26-1: Power Source Related Sections			
1)	Section 13 49 00	-	Radiation protection
2)	Section 26 33 00	-	Direct current equipment
3)	Section 26 41 16	-	Lightning prevention and dissipation systems
4)	Section 26 43 13	-	Transient voltage surge suppressors
5)	Section 48 19 16	-	Inverters



^{A11} **Figure 01 81 26-1.**^{A11} Conceptual high level functional interconnection diagram for CCSS systems. Many communication links are not shown for clarity.

2. Communications:

- a. Communications shall include, but not be limited to the design, supply, installation and commissioning of all voice (telephone and public address), video (CCVS), data communication, time synchronization, radio-communications systems and services, using copper, fiber optic, and wireless technology, where applicable.^{A19} In addition, communications includes the supply and installation of all equipment racks and cabinets, DCE enclosures, radio transmission towers, inside plant and outside plant pathways, and cables.^{A19}
- b. Communications shall provide services for office automation, power sources, industrial process control, safety systems, security systems, and other associated systems that are required to coordinate the operation, maintenance, and administration of the new locks complexes.
- c. The Sections in Table 01 81 26-2 relate directly to works required for the sole purpose of providing communication systems to the^{A17} Works:
^{A17}

Table 01 81 26-2: Communications Related Sections			
1)	Section 01 14 00	-	Work restrictions (ref. waste disposal of dredged and excavated materials so that underwater communications cables are protected)
2)	Section 27 05 28	-	Communications pathways for inside plant
3)	Section 27 10 00	-	Structured cabling systems for communications inside plant
4)	Section 27 11 16	-	Cabinets, racks, frames, and enclosures
5)	Section 27 21 00	-	Data communications equipment
6)	Section 27 31 23	-	IP-based telephone systems
7)	Section 27 31 33	-	Radio-telephone communications console systems
8)	Section 27 37 00	-	Multi-band mobile radio-communications systems
9)	Section 27 51 16	-	Public address systems
10)	Section 27 53 13	-	Time synchronization systems
11)	Section 33 81 13	-	Communications transmission towers
12)	Section 33 81 26	-	Outside Plant pathways for underground communications
13)	Section 33 82 00	-	Cabling for underground communications outside Plant

- d.^{A19} Cables for communications route diversity in inside and outside plants shall not be in the same conduit, duct line, cable tray, or other pathway.^{A19}

3. **Process Control Systems (PCSs):**

- a. PCSs shall include consoles, DPE, industrial PCSs, instrumentation, operator control stations, sensors, signaling, video walls (multiple video array screen), and software.
- b. The Sections in Table 01 81 26-3 relate directly to works required for the sole purpose of providing the controls systems for the ^{A17}Works: ^{A17}

Table 01 81 26-3: PCS Related Sections			
1)	Section 01 92 00	-	Facility Operation
2)	Section 11 52 23	-	Video Walls
3)	Section 12 59 83	-	Custom Systems Furniture (ref. Consoles)
4)	Section 25 11 00	-	Data Processing Equipment
5)	Section 28 23 00	-	Closed Circuit Video Systems
6)	Section 35 10 00	-	Waterway and Marine Signaling and Control Equipment
7)	Section 35 12 00	-	Vessel Detection Systems
8)	Section 40 00 00	-	Process Systems Integration
9)	^{A19} (deleted) ^{A19}		
10)	Section 40 91 00	-	Primary Process Measurement Devices (ref Sensors and Instrumentation)
11)	Section 40 94 43	-	Programmable Logic Controllers
12)	Section 40 95 13	-	Process Control Hardware
13)	Section 40 95 13.13	-	Process Control Hardware for Locks Machinery Control Systems
14)	Section 40 95 13.16	-	Process Control Hardware for Fire Fighting Control Systems (FFCSs)
15)	Section 40 95 13.19	-	Process Control Hardware for Electrical Distribution Control Systems (EDCSs)
16)	Section 40 95 13.22	-	Wastewater Treatment Control Systems (WWTCSs)
17)	Section 40 95 73	-	Control Cables
18)	Section 40 96 45	-	Process Control Software
19)	Section 40 96 45.13	-	Process Control Software for LMCSs
20)	Section 40 96 45.16	-	Process Control Software for FFCSs
21)	Section 40 96 45.19	-	Process Control Software for EDCSs

4. **Safety:**

- a. Safety shall include fire alarm and personnel entry/exit control and evacuation systems.
- b. ^{A16}The Sections of the Employer’s Requirements listed in Table 01 81 26-4 relate directly to works required for the sole purpose of providing the safety systems for the ^{A16} ^{A17}Works: ^{A17}

Table 01 81 26-4: Safety Related Sections			
1)	Section 28 31 00	-	Fire Alarm Systems for Buildings
2)	Section 28 50 00	-	Evacuation Systems

5. **Security:**

- a. This work area shall include various alarm and detection, access control, and video surveillance systems.
- b. ^{A16}The Sections of the Employer's Requirements listed in Table 01 81 26-5 relate directly to works required for the sole purpose of providing the security systems for the ^{A16} ^{A17}Works: ^{A17}

Table 01 81 26-5: Security Related Sections			
1)	Section 01 87 00	-	Equipment and Furnishings (ref turnstiles)
2)	Section 28 13 00	-	Access Control Systems
3)	Section 28 13 53	-	Security Metal Detectors
4)	Section 28 16 00	-	Intrusion Detection Systems
5)	Section 28 16 43	-	Perimeter Security Systems
6)	Section 28 16 46	-	Vehicular Control Systems
7)	Section 28 23 00	-	Closed Circuit Video Systems
8)	Section 28 23 19	-	Video Recording Systems
9)	Section 28 60 00	-	Attendance Control Systems

6. **Other Related Sections:**

- a. ^{A16}Other related Sections refer to other relevant Employer's Requirements related to communications, PCSs, safety, and security. ^{A16}

Table 01 81 26-6: Other Related Sections			
1)	Section 01 25 00	-	Product Substitution Requirements
2)	Section 01 31 00	-	Project Management and Coordination
3)	Section 01 33 00	-	Submittal Procedures
4)	Section 01 35 23	-	Health and Safety Requirements
5)	Section 01 35 29	-	Health and Safety Management / Emergency Response Procedures
6)	Section 01 40 00	-	Quality Requirements
7)	Section 01 42 13	-	Acronyms and Units
8)	Section 01 42 16	-	Definitions
9)	Section 01 77 00	-	Taking-Over Procedures
10)	Section 01 78 23	-	^{A16} Operations Data ^{A16}
11)	Section 01 81 36	-	O&M Buildings and ^{A9} Facilities ^{A9} – Program
12)	Section 01 81 36-13	-	O&M Buildings and Facilities – Space Programming
13)	Section 01 91 00	-	^{A16} Commissioning and Testing ^{A16}
14)	Section 01 93 00	-	^{A16} Maintenance Services ^{A16}
15)	Section 09 96 00	-	Corrosion Control Coatings

Table 01 81 26-6: Other Related Sections			
16)	Section 26 05 26	-	Grounding and Bonding for Electrical Systems

1.02 ^{A16}REFERENCES: ^{A16}

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TOPN-98 Telecommunications Outside Plant Networks

B. **Alliance for Telecommunications Industry Solutions (ATIS, www.atis.org) Standards:**

^{A10}PP.0600311-07 DC Power Systems- Telecommunications Environment^{A10}

T1.313-03 Electrical Protection for Telecommunications Central Offices and Similar Type Facilities

C. **American National Standards Institute (ANSI, www.ansi.org) Standards:**

84.00.01-04 Functional Safety: Safety Instrumented Systems for the Process Industry

95.00.01-00 Enterprise-Control System Integration

61010-1-03 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

S3.5-97(07) Methods for the Calculation of the Speech Intelligibility Index

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D. ^{A17}**American Public Works Association (APWA; www.apwa.net):**

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E. **American Society of Civil Engineers (ASCE; www.asce.org) Standard:**

10-97 Design of Latticed Steel Transmission Structures

F. **American Society for Testing and Materials (ASTM; www.astm.org) International: Standards:**

A 153/A 153M-05 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A 304-05 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements

A 325-07(A) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A 385-05	Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
A 394-07	Steel Transmission Tower Bolts, Zinc- Coated and Bare
A 490-08(A)	Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
A 513-07	Electric Resistance-Welded Carbon and Alloy Steel Tubing for Use as Mechanical Tubing
D 256-06(A)	Determining the Izod Pendulum Impact Resistance of Plastics
D 638-03	Tensile Properties of Plastics
D 746-07	Brittleness Temperature of Plastics and Elastomers by Impact
D 790-07	Flexural Properties of Non-reinforced and Reinforced Plastics and Electrical Insulating Materials
D 1238-04(C)	Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D 1248-05	Polyethylene Plastic Extrusion Materials for Wire and Cable
D 1505-03	Density of Plastics by the Density-Gradient Technique
D 1693-08	Environmental Stress-Cracking of Ethylene Plastics
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D 2240-05	Rubber Property - Durometer Hardness
D 2247-02	Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
D 2412-02	Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D 2444-99(05)	Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
D 2837-04	Obtaining Hydrostatic Designs Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D 3035-08	Polyethylene (Pe) Plastic Pipe (Dr-Pr) Based on Controlled Outside Diameter
D 3350-06	Polyethylene Plastics Pipe and Fittings Materials
D 4883-03	Polyethylene by the Ultrasound Technique
E 84-08(A)	Surface Burning Characteristics of Building Materials
E 119-08(A)	Fire Tests of Building Construction and Materials

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| E 535-05(A) | Practice for Preparation of Fire Test Response Standards |
| E 814-06 | Fire Tests of Through-Penetration Fire Stops |
- G. **American Telephone & Telegraph (AT&T, att.sbc.com) Publication:**
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| OPEH-94 | Outside Plant Engineering Handbook |
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- H. **American Galvanizers Association (AGA, www.galvanizeit.org) Publications:**
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| | Inspection Manual for Hot-Dip Galvanized Products
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- I. **American Welding Society (AWS, www.aws.org) Standard:**
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- J. **Autoridad del Canal de Panamá (ACP, www.pancanal.com) Policies:**
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| AD-2005-02 | Protección de los Recursos Informáticos de la ACP de Ataques por Código Malicioso |
| AD-2005-04 | Uso Aprobado del Servicio de Internet en la ACP |
| IMXI-NO-04-004 | Administración de Parches para Sistemas Informáticos de la ACP |
| IMXI-NO-04-005 | Norma de Seguridad para Autenticación en los Sistemas Informáticos de la ACP |
| IMXI-NO-04-006 | Norma de Métricos de Seguridad para los Sistemas Informáticos de la ACP |
- K. **Autoridad Nacional de los Servicios Públicos (ASEP, www.asep.gob.pa) Regulation:**
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| PNAF-07 | Plan Nacional de Atribución de Frecuencias (National Frequency Assignment Plan,
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- L. **British Standards Institution (BS, www.bsstandards.co.uk) Standards:**
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| ISO/IEC 27002-05 | Information technology. Security techniques. Code of Practice for Information Security Management |
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- 002-06 Data Center Design and Implementation Best Practices
- ^{A10}NDRM-06 Network Design Reference Manual ^{A10}
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- N. **Canadian Standards Association (CSA, www.csa.ca) Standard:**
- C22.2 NO. 107.2-01(07) Battery Chargers
- O. **Ceilings & Interior Systems Construction Association (CISCA, <http://cisca.org>) Standard:**
- RTPAF-07 Recommended Test Procedures for Access Floors
- P. **Code of Federal Regulations ^{A10} (CFR): ^{A10}**
- 29 CFR 1910.165 Employee Alarm Systems
- 29 CFR 1926 Safety and Health Regulations for Construction
- 47 CFR Telecommunication (FCC Rules and Regulations (www.fcc.gov))
- Q. **Rural Utilities Service (RUS; www.usda.gov/rus) Bulletins:**
- 305-1-54(72) Joint Use of Facilities for Electrical and Telephone Service
- 1751F-641-95 Construction of Buried Plant
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- 1751F-815-95 Electrical Protection of Outside Plant
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- 1753F-401-95 Standard for Splicing Copper and Fiber Optic Cables
- R. ^{A10} (Reserved): ^{A10}
- S. **DNP User Group (DUG, www.dnp.org) Standard:**
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| 455 Series-00 | Standard Test Procedures for Fibers Optic Fibers, Cables, Transducers, Connecting and Terminating Devices |
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| EN 50128-01 | Railway Applications - Communication, Signaling and Processing Systems - Software for Railway Control and Protection Systems |
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W. U.S. Federal Specifications:

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X. HART Communication Foundation (HCF, www.hartcomm.org) Standard:

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802.3AE-02	Part 3: CSMA/CD Access Method and PHY Specifications - MAC Parameters, Physical Layer, & Management Parameters for 10 Gb/s Operation
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RFC 1305-92	Network Time Protocol (Version 3) Specification, Implementation and Analysis
RFC 3031-01	Multi-protocol Label Switching Architecture
GG.	International Telecommunications Union (ITU, www.itu.int) Standards, including ITU-R ^{A5} and ^{A5} ITU-T:
G.651-98	Series G: Transmission Systems and Media, Digital Systems and Networks Transmission Media Characteristics –Optical Fibre Cables Characteristics of a 50/125 µm Multimode Graded Index Optical Fibre Cable
G.652-05	Series G: Transmission Systems and Media, Digital Systems and Networks

	Transmission Media Characteristics –Optical Fibre Cables Characteristics of a Single-Mode Optical Fibre and Cable
G.653-06	Series G: Transmission Systems and Media, Digital Systems and Networks Transmission Media Characteristics –Optical Fibre Cables Characteristics of a Dispersion-Shifted Single-Mode Optical Fibre and Cable
^{A11} G.655-06	Series G: Transmission Systems and Media, Digital Systems and Networks Transmission Media Characteristics –Optical Fibre Cables Characteristics of a Non-Zero Dispersion-Shifted Single-Mode Optical Fibre and Cable ^{A11}
G.811-97	Series G: Transmission Systems and Media, Digital Systems and Networks Digital Transmission Systems - Digital Networks - Design Objectives for Digital Networks Timing Characteristics of Primary Reference Clocks
^{A10} G.812-04	Timing requirements of slave clocks suitable for use as node clocks in synchronization networks
G.823-00	The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy ^{A10}
H.263-05	Series H: Audiovisual and Multimedia Systems Infrastructure of Audiovisual Services – Coding of Moving Video Video Coding for Low Bit Rate Communication
H.264-05(06)	Series H: Audiovisual and Multimedia Systems Infrastructure of Audiovisual Services – Coding of Moving Video Advanced Video Coding for Generic Audiovisual Services
M.1371-3-07	Technical Characteristics for an Automatic Identification System Using Time Division Multiple Access in the VHF Maritime Mobile Band
HH. Junta Técnica de Ingeniería y Arquitectura (JTIA) Regulation:	
REP-04	Reglamento para el Diseño Estructural en la República de Panamá (Resolución No. 639 published in the Gaceta Oficial No. 25,181 dated November 22, 2004), plus corrections, including: Fe de Erratas-2005 (available from http://www.spia-

pma.org/Descargas/fe%20de%20erratas.pdf)

II. **Lightning Protection Institute (LPI, www.lightning.org) Standard:**

175-04 Standard of Practice for the Design, Installation & Inspection of Lightning Protection Systems

JJ. ^{A19}**U.S. Military (www.army.mil) Standards:** ^{A19}

MIL-STD-188 124B(3) Grounding, Bonding and Shielding For Common Long Haul/Tactical Communication Systems Including Ground Based Communications-Electronics Facilities and Equipments

^{A10}MIL-STD-461F Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment ^{A10}

MIL-STD-810F(3) Environmental Engineering Considerations and Laboratory Tests.

MIL-STD-1472F(1) Human Engineering Design Criteria for Military Systems, Equipment And Facilities.

KK. **National Electrical Manufacturers Association (NEMA; www.nema.org) Standards:**

250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)

LD 3-05 High-Pressure Decorative Laminates

^{A10} (Deleted text) ^{A10}

LS 1-92(00) Low Voltage Surge Protective Devices

TC 2-03 Electrical Polyvinyl Chloride (PVC) Conduit

TC 3-04 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

TC 6&8-03 PVC and ABS Plastic Utility Duct for Underground Installation

TC 9-04 Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

^{A10}WC-5-96 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

WC-7-98 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy ^{A10}

LL. **National Fire Protection Association (NFPA, www.nfpa.org) Codes:**

70-08 National Electrical Code

72-07	National Fire Alarm Code
76-05	Standard for the Fire Protection of Telecommunications Facilities
99-05	Standard for Health Care Facilities
101-06	Life Safety Code
110-05	Standard for Emergency and Standby Power Systems
130-07	Standard for Fixed Guideway Transit and Passenger Rail Systems
251-06	Standard Method of Fire Tests of Building Construction and Materials
^{A10} 262-06	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces ^{A10}
730-08	Guide for Premises Security
731-08	Standard for the Installation of Electronic Premises Security Systems
780-08	Standard for the Installation of Lightning Protection Systems

MM. National Institute of Justice (NIJ, www.ncjrs.gov) Standard:

0601.02-03	Walk-Trough Metal Detectors for Use in Concealed Weapon and Contraband Detection
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NN. National Institute of Standards and Technology (NIST, www.nist.gov) Federal Information Processing Standards (FIPSs):

^{A10} (Deleted text)^{A10}

FIPS 201-1-06	Personal Identity Verification of Federal Employees and Contractors
SP 800-14-96	Generally Accepted Principles and Practices for Securing Information Technology Systems
SP 800-30-02	Risk Management Guide for Information Technology Systems
SP 800-34-02	Contingency Planning Guide for Information Technology Systems
SP 800-37-04	Guide for the Security Certification and Accreditation of Federal Information Systems
SP 800-53-07(2)	Recommended Security Controls for Federal Information Systems

OO. National Research Council Washington DC Committee on Human Factors Guide:

HEGED-85	Human Engineering Guide to Equipment Design
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PP. North American Electric Reliability Corporation (NERC, www.nerc.com) Standard:

76-05	Urgent Action Cyber Security Standard
^{A11} CIP-002-1-08	Critical Cyber Asset Identification
CIP-003-1-08	Security Management Controls
CIP-004-1-08	Personnel and Training
CIP-005-1-08	Electronic Security Perimeter(s)
CIP-006-1-08	Physical Security of Critical Cyber Assets
CIP-007-1-08	Systems Security Management
CIP-008-1-08	Incident Reporting and Response Planning
CIP-009-1-08	Recovery Plans for Critical Cyber Assets ^{A11}

QQ. Research Council on Structural Connections (RSCS, www.boltcouncil.org) Specification:

Specification-04	Specification for Structural Joints Using ASTM A 325 or A 490 Bolts
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RR. Telcordia Technologies, Inc. (TT, www.telcordia.com, Formerly Bell Communications Research) Standards:

GR-63-CORE-06	Network Equipment – Construction System Requirements (NEBS): Physical Protection
GR-409-CORE-94	Generic Requirements for Premises Fiber Optic Cable
GR-2836-94	Generic Requirements for Assuring Corrosion Resistance of Telecommunication Equipment in Outside Plant
GR-2884-95	Generic Requirements for Multi-Bore Conduit
GR-4228-96	VRLA Battery String Certification Levels Based on Requirements for Safety and Performance

SS. Telecommunications Industry Association (TIA, www.tiaonline.org) Standards^{A10}(available from <http://global.ihs.com>):

222-G-07	Structural Standard for Antenna Supporting Structures and Antennas
232-F-02	Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

329-C-03	Minimum Standards for Communication Antennas, Base Station Antennas ^{A10}
422-94(05)	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
485-A-98(03)	Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
^{A10} 568-B-08	Commercial Building Telecommunications Cabling Standards
569-B-04	Commercial Building Standard for Telecommunications Pathways and Spaces
598-C-05	Optical Fiber Cable Color Coding
604-3-B-04	FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC
606-A-2007	Administration Standard for the Commercial Telecommunications Infrastructure
607-94	Commercial Building Grounding and Bonding Requirements Standard ^{A10}
758-A-04	Customer Owned Outside Plant Telecommunications Infrastructure Standard
^{A10} 942-05(08) ^{A10}	Telecommunications Infrastructure Standard for Data Centers
TSB 63-93	Reference Guide for Fiber Optic Test Procedures
TT. Underwriters Laboratories (UL, www.ul.com) Standards for Safety and Directories:	
94-96(06)	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
96-05	Lightning Protection Components
96A-07	Installation Requirements for Lightning Protection Systems
294-99(05)	Access Control System Units
467-07	Grounding and Bonding Equipment
^{A10} 486A-03	Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors ^{A10}
497B-04	Protectors for Data Communications and Fire Alarm Circuits
508-99(05)	Industrial Control Equipment
609-96(05)	Standard for Local Burglar Alarm Units and Systems
639-07	Standard for Intrusion-Detection Units
651-05(07)	Schedule 40 and 80 Rigid PVC Conduit and Fittings.

723-03(05)	Standard Test Method for Surface Burning Characteristics of Building Materials
^{A10} 910-98	Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air ^{A10}
924-06	Emergency Lighting and Power Equipment
1012-05(06)	Power Units Other Than Class 2
1037-99(04)	Standard for Antitheft Alarms and Devices
1076-95(05)	Proprietary Burglar Alarm Units and Systems
1283-05(07)	Electromagnetic Interference Filters
1449-06	Transient Voltage Surge Suppressors
1479-03(08)	Fire Tests of Through-Penetration Firestops
^{A10} 1581-06	Reference Standard for Electrical Wires, Cables, and Flexible Cords ^{A10}
1635-96(05)	Standard for Digital Alarm Communicator System Units
1641-99(05)	Standard for Installation and Classification of Residential Burglar Alarm Systems
1666-07	Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
1778-05(06)	Standard for Uninterruptible Power Systems
1801-03	Standard for Power Distribution Centers for Communications Equipment
1863-04	Communications-Circuit Accessories
^{A13} 2024-04	Standard for Optical Fiber and Communication Cable Raceway ^{A13}
60950-00(07)	Safety for Information Technology Equipment
60950-1-07	Information Technology Equipment - Safety - Part 1: General Requirements
BM-08	Building Materials Directory; Through Penetration Fire Stops Systems (XHEZ), and Fill, Void or Cavity Materials (XHHW)
FR-08	Fire Resistance Directory
Product Directory Code F-08	Electrical Construction Equipment Directory
UU.	United Nations Educational, Scientific, and Cultural Organization (www.unesco.org) Standard:
PSS-78	Practical Salinity Scale

VV. U. S. Army Corps of Engineers (USACE; www.usace.army.mil) Criteria:

UFC 4-020-02FA Security Engineering: Concept Design

UFC 4-020-04FA Security Engineering: Electronic Security Systems^{A10}

WW. U. S. Department of Labor (www.dol.gov) Act:

ADA-90 Americans with Disabilities Act (<http://www.ada.gov/>)

XX. Verizon (www.Verizon.Com) Publication:

OSPE-91 General Telephone and Electronics (GTE) OSP Engineering

YY. Warnock Hersen, WH Publication:

Certification Labeling

ZZ. World Health Organization (WHO, www.who.int), United Nations Environment Programme (UNEP, www.unep.org):

Water Pollution Control - A Guide to the Use of Water Quality Management Principles (edited by Richard Helmer and Ivanildo Hespanhol, London : E & FN Spon, 1997, URL: http://whqlibdoc.who.int/publications/1997/0419229108_eng.pdf)^{A17}

^{A19}AAA. Open DeviceNet Vendors Association (ODVA) Standard:

CIP Common Industrial Protocol^{A19}

1.03 REQUIREMENTS:

A. General:

1. The Contractor shall provide an integrated communications, control, safety, and security system, which includes but is not limited to those systems, specified in^{A9} Subparagraph 1.01 B. (Tables 01 81 26-1 through -5) above.^{A9}
2. Where applicable, the Contractor shall ensure that all systems, subsystems and equipment are fully integrated into an overall communications, control, safety, and security system.

- B. **Acronyms and Units:** Shall be interpreted in accordance with Section 01 42 13 (*Acronyms and Units*). Whenever an acronym has more than one meaning, the proper meaning depends on the context of the sentence where used.
- C. ^{A9}**Reference Items:**
1. Table Nos. 01 81 26-7 and 8 indicate reference items related to Paragraph 1.03 of various CCSS Sections.
 2. ^{A16}Such items have been incorporated as examples of the systems and equipment which employ high population levels of these items that the Employer uses.^{A16}

^{A9}TABLE 01 81 26-7: PCS Reference Items

No.	Reference Section	Item	2008 Model	Manufacturer	City	State	Country	Internet
1.	40 94 43	PLCs		Allen-Bradley (Rockwell Automation)	Milwaukee	WI	USA	www.rockwellautomation.com
2.	40 96 45	PCS Software for asset management	Factory Talk Asset Center	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
3.	40 96 45	PCS Software for security	Factory Talk Security	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
4.	40 96 45	PCS Software for interchange with Oracle and SAP	NetLinx	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
5.	40 96 45	PCS Software for standard reports	RSBizware	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
6.	40 96 45	PCS Software for reporting tool	RSHistorian	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
7.	40 96 45	PCS Software for CIP translation	RSLinx	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
8.	40 96 45	PCS Software for configuration	RSNetworx	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
9.	40 96 45	PCS Software for dBase management	RSSQL	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
10.	40 96 45	PCS Software for testing purposes and I/O simulation	RSTeststand	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
11.	40 96 45	PCS Software for operator and simulator HMI	RSView SE	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
12.	40 96 45	PCS Software for PLC software emulation	RSEmulate	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
13.	40 96 45	PCS Software for PLC software emulation	RSSoftLogix	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
14.	40 96 45	Maintenance Automation Control Center (MACC)	RSMacc	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
15.	40 96 45	Historian software	RS-Historian	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
16.	40 96 45	Enterprise series software	RSLogix	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com
17.	40 96 45	Enterprise Manufacturing Intelligence (EMI) software	Arena	Rockwell Software	Milwaukee	WI	USA	www.rockwellsoftware.com ^{A9}

A9 TABLE 01 81 26-8: Other Reference Items A9								
No.	A9 Reference Section A9	Item	A9 2008 Model A9	Manufacturer	City	State	Country	Internet
1.	01 87 00	Turnstiles		Automatic Control Systems, Inc.	Port Washington	NY	USA	www.automaticsystems.com
2.	07 84 00	Firestops		3M	St. Paul	MN	USA	www.3m.com
3.	09 69 00	Raised Access Floors		Access Floor Systems, Inc.	Covington	LA	USA	www.accessfloorsystems.com
4.	09 69 00	Raised Access Floors		Haworth, Inc.	Holland	MI	USA	www.haworth.com
5.	11 52 23	Video Walls		Americon	Camarillo	CA	USA	www.americon-large-screen.com
6.	11 52 23	Video Walls		Barco N. V.			Belgium	www.barco.com
7.	11 52 23	Video Walls		Christie	Cypress	CA	USA	www.christiedigital.com
8.	11 52 23	Video Walls		NEC Corporation	Tokyo		Japan	www.nec.com
9.	12 59 83	Custom Systems Furniture		Americon	Camarillo	CA	USA	www.americon-large-screen.com
10.	12 59 83	Custom Systems Furniture		Evans Consoles	Calgary	Alberta	Canada	www.evansonline.com
11.	12 59 83	Custom Systems Furniture		Wright Line	Worcester	MA	USA	www.wrightline.com
12.	12 59 83	Working Surfaces	Corian	Dupont	Wilmington	DE	USA	www.dupont.com and www.corian.com
13.	25 11 00	Touch Screen Protection	ARMR200	3M	St. Paul	MN	USA	www.3m.com
14.	25 11 00	Monitors		Dell	Austin	TX	USA	www.dell.com
15.	25 11 00	Monitors		NEC	Tokyo		Japan	www.nec.com
16.	25 11 00	Monitors		Viewsonic	Walnut	CA	USA	www.viewsonic.com
17.	25 11 00	Portable Terminals		Palm	Sunnyvale	CA	USA	www.palm.com
18.	25 11 00	Portable Terminals		A19 Research in Motion Limited (RIM Ltd.) A19	Waterloo	Ontario	Canada	www.blackberry.com
19.	25 11 00	Portable Terminals		Symbol Technologies	Holtsville	NY	USA	www.symbol.com
20.	25 11 00	Printers		Hewlett-Packard	Palo Alto	CA	USA	www.hp.com
21.	25 11 00	Printers		Lexmark	Lexington	KY	USA	www.lexmark.com
22.	25 11 00	Remote KBDs		Raritan	Somerset	NJ	USA	www.raritan.com
23.	25 11 00	Remote Mice		Raritan	Somerset	NJ	USA	www.raritan.com
24.	25 11 00	KVM Switches	Paragon II	Raritan	Somerset	NJ	USA	www.raritan.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
25.	25 11 00	Computer Video Extenders		IO Gear	Irvine	CA	USA	www.iogear.com
26.	25 11 00	Touch Sensitive Monitors		NEC	Tokyo		Japan	www.nec.com
27.	25 11 00	Touch Sensitive Monitors		Radiant Systems, Inc.	Alpharetta	GA	USA	www.alohapos.com
^{A9} 28.	25 11 00	Servers for Windows / Linux / Unix platforms	Proliant model BL25p	Hewlett-Packard	Palo Alto	CA	USA	www.hp.com
29.	25 11 00	Servers for Windows / Linux / Unix platforms		IBM	Armonk	NY	USA	www.ibm.com
30.	25 11 00	Servers for Linux / Unix platforms		Sun Microsystems	Santa Clara	CA	USA	www.sun.com
31.	25 11 00	Workstations		Dell	Austin	TX	USA	www.dell.com
32.	25 11 00	Workstations		HP	Palo Alto	CA	USA	www.hp.com
33.	25 11 00	Workstations		IBM	Armonk	NY	USA	www.ibm.com ^{A9}
34.	26 33 00	DC Equipment		Emerson Energy Systems	St. Louis	MO	USA	www.emersonenergy.com
35.	26 33 00	DC-DC Converters		C&D Technologies (Datel), Inc., Power Electronics Division	Mansfield	MA	USA	www.cd4power.com
36.	26 33 00	Power Supplies		Acopian	Easton	PA	USA	www.acopian.com
37.	26 33 00	Power Supplies		Lambda Americas Inc.	Neptune	NJ	USA	www.lambdapower.com
38.	26 33 00	Power Supplies		Sola	Rosemont	IL	USA	www.solaheviduty.com
39.	26 33 00	Power Supplies		Weidmuller USA	Richmond	VA	USA	www.weidmuller.com
40.	26 41 16	Lightning Protection		Erico Products, Inc.	Cleveland (Solon)	OH	USA	www.erico.com
41.	26 41 16	Lightning Protection		Harger Lightning Protection, Inc.	Livertyville	IL	USA	www.harger.com
42.	26 43 13	Transient Voltage Surge Suppressors		Leviton	Little Neck	NY	USA	www.leviton.com
43.	26 43 13	Transient Voltage Surge Suppressors		Oneac	Libertyville	IL	USA	www.oneac.com
44.	26 43 13	Transient Voltage Surge Suppressors		Polyphaser Corporation	Minden	NV	USA	www.polyphaser.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
45.	26 43 13	Transient Voltage Surge Suppressors		Weidmuller USA	Richmond	VA	USA	www.weidmuller.com
46.	26 43 13	Primary Protectors for 120/208 VAC Main Panelboards	57120-M3S	Leviton	Little Neck	NY	USA	www.leviton.com
47.	26 43 13	Secondary Protectors for 120/240 VAC Single Phase Panelboards	51120-3R	Leviton	Little Neck	NY	USA	www.leviton.com
48.	26 43 13	Secondary Protectors for 120/240 VAC Single Phase Panelboards	IS-PM240-SP	Polyphaser Corporation	Minden	NV	USA	www.polyphaser.com
49.	26 43 13	Protectors for Radio Frequency Transmission Lines	IS-B50LN-C1 (for applications that do not require DC continuity)	Polyphaser Corporation	Minden	NV	USA	www.polyphaser.com
50.	26 43 13	Protectors for CCTV Coaxial Lines	IS-75BB-1.5 or IS-IE75BB-1.5	Polyphaser Corporation	Minden	NV	USA	www.polyphaser.com
51.	26 43 13	Copper Telephone Lines	5S series	Oneac	Libertyville	IL	USA	www.oneac.com
^{A9} 52.	27 10 00	Connectorized Interconnection Blocks for Outside Plant Copper Cables	GCW826CFBHF	Emerson				www.emerson.com
53.	27 10 00	Copper Line Terminating Blocks	GW8X26	Emerson				www.emerson.com
54.	27 10 00	MDF Universal Frame	224705	Emerson				www.emerson.com
55.	27 10 00	MDF Security Guard Rails	224715	Emerson				www.emerson.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
56.	27 10 00	MDF Ground Bar	235005	Emerson				www.emerson.com
57.	27 10 00	MDF Lateral Safety Rail	224722	Emerson				www.emerson.com
58.	27 10 00	MDF Vertical Mounting Bar	P44036	Emerson				www.emerson.com ^{A9}
59.	27 10 00	ODF		ADC Telecommunications, Inc.	Minneapolis	MN	USA	www.adc.com
60.	27 10 00	ODF		Alcoa Fujikura, Ltd. (AFL) Telecommunications	Duncan	SC	USA	www.afltele.com
61.	27 10 00	ODF		Corning Cabling Systems, Inc.	Hickory	NC	USA	www.corningcablesystems.com
62.	27 10 00	ODF		Panduit Corporation	Tinley Park	IL	USA	www.panduit.com
63.	27 10 00	ODF		The Siemon Company	Watertown	CT	USA	www.siemon.com
64.	27 11 16	Open Racks	Mighty Mo II or III	Legrand Ortronics, Inc.	New London	CT	USA	www.ortronics.com
65.	27 11 16	Open Racks	Omega, part No. RAA-00004	Molex Premise Networks	Hudson	NH	USA	www.molexpn.com
66.	27 11 16	PLC Cabinets		Bosch Group's Rexroth Corporation	Hoffman Estates	IL	USA	www.rexroth.com
67.	27 11 16	Server Cabinets		Hewlett-Packard		CA	USA	www.hp.com
68.	27 21 00	Modems		Hayes or U. S. Robotics	Monticello	MN	USA	www.modemexpress.com
69.	27 21 00	Fiber Optic Modem		American Fibertek			USA	
70.	27 21 00	Fiber Optic Modem (FOM)		Optelecom			USA	
71.	27 21 00	Fiber Optic Modem (FOM)		Phoenix Digital	Scottsdale	AZ	USA	www.phoenixdigitalcorp.com
72.	27 21 00	SAN Switches		Brocade			USA	www.brocade.com
^{A9} 73.	27 21 00	Access Concentrator Switches	86xx series	Tellabs	Naperville	IL	USA	www.tellabs.com
74.	27 21 00	Ethernet Data Switches		Cisco Systems, Inc.	San Jose	CA	USA	www.cisco.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
75.	27 21 00	SAN Switches		Brocade Communications Systems, Inc.	San Jose	CA	USA	www.brocade.com ^{A9}
76.	27 31 23	Outdoor analog telephone sets		<u>Hubbell Gai-tronics, Inc.</u>	Mohnton	PA	USA	www.gaitronics.com
^{A9} 77.	27 31 23	Gateways		Per Nortel requirements				
78.	27 31 33	Radio-telephone console systems		Per Avtec requirements (subject to change)				^{A9}
79.	27 37 00	Multi-band RF communications systems		Andrew Corporation	Westchester	IL	USA	www.andrew.com
80.	27 51 16	Public Address Systems		Bogen	Ramsey	NJ	USA	www.bogen.com
81.	27 51 16	Public Address Systems		QSC Audio Products, Inc.	Costa Mesa	CA	USA	www.qscaudio.com
82.	27 51 16	Cables for PASs		Belden	Richmond	IN	USA	www.belden.com
83.	28 13 00	Door Locks	EML-2071 SGL 628	Dorma GmbH & Co. KG	Ennepetal		Germany	www.dorma.com
84.	28 13 00	Door Strikes for hollow door metal jams with keyed door knobs	7140	<u>Adams Rite</u>	Pomona	CA	USA	www.adamsrite.com
85.	28 13 00	Enclosures	NexWatch	Honeywell			USA	
86.	28 13 00	Exit Pushbuttons	SD-7201GC-PE1	Seco-Larm			USA	
87.	28 13 00	Magnetic Contacts		American Security Equipment Company (AMSECO)	St. Louis	MO	USA	www.amseco-kai.com
88.	28 13 00	Magnetic Contacts		GE Security, Inc.	Bradenton	FL	USA	www.gesecurity.com
89.	28 13 00	Magnetic Contacts		Honeywell Security (includes former Ademco)			USA	www.security.honeywell.com
90.	28 13 00	Magnetic Contacts		Sentrol	Tualatin	OR	USA	www.sentrol.com
91.	28 13 00	Power Supplies	AL400ULX	Altronix				
^{A9} 92.	28 13 00	Access Control Systems	OnGuard PROI-2006 v5.12.10	Lenel Systems International, Inc.	Pittsford	NY	USA	www.lenel.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
93.	28 13 00	Biometric Readers	LNL-BIO007	Lenel Systems International, Inc.	Pittsford	NY	USA	www.lenel.com
94.	28 13 00	ACS Controller	LNL-2000	Lenel Systems International, Inc.	Pittsford	NY	USA	www.lenel.com
95.	28 13 00	Biometric Reader Interface Gateway	LNL-500B	Lenel Systems International, Inc.	Pittsford	NY	USA	www.lenel.com
96.	28 13 00	Dual Reader Interface Module	LNL-1320	Lenel Systems International, Inc.	Pittsford	NY	USA	www.lenel.com ^{A9}
97.	28 13 53	Security Metal Detectors		Garrett Metal Detectors	Garland	TX	USA	www.garrett.com
98.	28 13 53	Security Metal Detectors		L3 Communications	Woburn	MA	USA	www.dsrxray.com
^{A9} 99.	28 13 53	Security Metal Detectors	PMD2-Ranger	Costruzioni Elettroniche Industriali Automatismi (CEIA)	Arezzo		Italy	www.ceia.net ^{A9}
100.	28 16 00	Intrusion Detection Systems		^{A9} Radionics, Inc. (Bosch Security Systems) ^{A9}	Salinas	CA	USA	^{A9} www.radionics.com and www.boschsecurity.com ^{A9}
101.	28 16 00	Alarm Sensors		GE Security, Inc.	Bradenton	FL	USA	www.gesecurity.com
102.	28 16 00	Contact Loop Wire	208-22-7-2J	Atlas Wire & Cable Corp.	Montebello	CA	USA	-
103.	28 16 00	Retractable Cords		Belden Wire and Cable	Richmond	IN	USA	www.belden.com
104.	28 16 00	Glass Break Detectors	ShatterPro 1 5800 Series	Sentrol	Tualatin	OR	USA	www.sentrol.com
105.	28 16 00	Vibration/Shock Sensors	824L Viper	International Electronics Inc.				-
^{A9} 106.	28 16 43	PPSs or FIDSs	Intrepid MicroPoint	Southwest Microwave Inc.	Tempe	AZ	USA	www.southwestmicrowave.com ^{A9}
107.	28 16 46	Vehicular Control Systems		Federal APD, Inc.	Novi	MI	USA	www.federalapd.com
108.	28 23 19	Video Recording Systems		DVTel, Inc.	Ridgefield Park	NJ	USA	www.dvtel.com
109.	28 23 19	Video Recording Systems		Genetec Inc.	Saint-Laurent	Quebec	Canada	www.genetec.com
110.	28 23 19	Video Recording Systems		Nice Systems Ltd.	Raánana		Israel	www.nice.com
111.	28 23 19	Video Recording Systems		SYS Technologies C-Video	San Diego	CA	USA	www.cvideo.com

^{A9}TABLE 01 81 26-8: Other Reference Items^{A9}

No.	^{A9} Reference Section ^{A9}	Item	^{A9} 2008 Model ^{A9}	Manufacturer	City	State	Country	Internet
112.	33 81 13	Communications Towers		Radian's Rohn Products Division	Oakville	ON	Canada	www.radiancorp.com
113.	33 81 26	Cable Racks and Trays for MHs		Underground Devices	Northbrook	IL	USA	www.udevices.com
114.	33 81 26	Plugs for 4" PVC conduit	<u>P258NT or P258NTB</u>	Carlon	Cleveland	OH	USA	www.carlon.com
115.	40 00 00	Fiber Optic Communications Network Bypasses and Splitters	SyncLink series	Allen-Bradley (Rockwell Automation)	Milwaukee	WI	USA	www.rockwellautomation.com
116.	40 91 00	Air Quality Transducers		International Sensor Technology (IST)	Irvine	CA	USA	www.intlsensor.com
117.	40 91 00	Level Switches		Endress+Hauser Group	Reinach		Switzerland	www.endress.com
118.	40 91 00	Flow Transducers (DPI type)		Honeywell	Morris Township	NJ	USA	www.honeywell.com
119.	40 91 00	Level Transducers for Liquids		Saab Rosemount Tank Radar AB	GÖTEBORG		Sweden	www.saab.tankradar.com
120.	40 91 00	Pressure Transducers (PPI type)		Honeywell	Morris Township	NJ	USA	www.honeywell.com
121.	40 91 00	Water Quality Sensors		Sea-Bird Electronics, Inc.	Bellevue	WA	USA	www.seabird.com
122.	40 91 00	Power Quality Analyzing Protection Devices	G44xx	Elspec Ltd.			Israel	www.elspec-ltd.com
^{A19} 123.	40 91 00	Outdoor Laser Measurement Systems	LMS211	Sick AG	Waldkirch		Germany	www.sick.com ^{A19}

D. Computer and Software Systems:

1. General:

- a. ^{A16}The Contractor shall furnish all computer based systems and software required for the successful completion of the Works.^{A16}
- b. Recently developed software modules may be acceptable to supplement field proven software, and recent enhancements to field proven software may be acceptable provided that the Contractor demonstrates that the specified system functions can be satisfied.
- c. Unless otherwise specified, all software shall be in English, or English and Spanish (user selectable).
- d. All software shall have the cut/paste and copy/paste feature of MS Windows, and shall be able to export/import or copy data to/from MS Office.
- e. The Employer prefers software with high portability, no or low royalties and no or low cost for upgrades.
- f. Beta software is unacceptable. ^{A9}As of 2008 and except for Linux, the Employer finds open source software unacceptable.^{A9}

2. Application Programs:

- a. The Employer shall become the full owner of all application programs written by the Contractor to meet the Contract requirements. The Employer shall be able to make unrestricted use of application software.
- b. The Contractor shall make available the source code of all application programs so that the Employer can analyze, copy, modify, reuse, and sell such software as deemed necessary and at no extra cost.

3. Date Stamp Compliance:

- a. Software and embedded systems shall meet the requirements specified below for all relevant dates up to at least year 2050. Particularly important are the following transitions:
 - 1) From February 28 to March 1 on regular years
 - 2) From February 29 to March 1 on leap years
- b. The following capabilities shall be true individually and when working with other parts of the system:

- 1) Accurately calculate, compare, display, interpret, recognize, retrieve, sequence, store, transmit, or otherwise accurately process and act on all date information.
- 2) The system shall experience no crash, degradation or interruption of performance, malfunction, or requirement for human intervention as a result of processing or acting on date information.
- 3) The systems shall correctly handle and recognize all leap years and calendar logic. Only valid dates shall be used.
- 4) Store and structure date data to accommodate the eight-digit range. The system shall be capable of using ANSI date format (YYYY/MM/DD).
- 5) ^{A9}Provide all necessary interfaces and other appropriate means for assuring that non-compliant date data are automatically corrected before entering or leaving the system, and without user prompt. ^{A9}

4. **Information Technology Assurance and Security:**

- a. ^{A16}IT security shall be built into systems from the commencement of the design, continued throughout the project duration, and incorporated as part of the commissioning process per Section 01 91 00 (*Commissioning and Testing*) ^{A16}.
- b. The Contractor shall propose an information security scheme for systems using data communications for input/output from/to other systems and wireless terminals considering adequate combination of the following techniques:
 - 1) Access control based on IEEE 802.1X, network admission control (NAC), pre-shared key (PSK), and radius
 - 2) Adequate disposal of garbage and waste, including recycle bin
 - 3) ^{A10}Automatic VLAN assignment (AVA), both dynamic and static ^{A10}
 - 4) Automatic logout upon user defined timeout
 - 5) ^{A10}Authentication, authorization, and accounting (AAA). ^{A10} Authentication ^{A10}shall be based ^{A10}on extensible authentication protocol (EAP) and WiFi protected access (WPA2 or newer) ^{A10}as applicable, ^{A10}including passwords and user name accounts
 - 6) Block pop-ups

- 7) Certification of systems in accordance with NIST SP 800-37
- 8) Code of practice per BSI 7799
- 9) Conformance with IETF RFC 1281
- 10) Contingency planning in accordance with NIST SP 800-34
- 11) Data encryption, including triple DES or better
- 12) Denial of service (DoS) prevention
- 13) Digital certificates, including public key infrastructure (PKI) type
- 14) Disable automatic macro execution.
- 15) Disable SSO (except as allowed for PCSs).
- 16) Domain controllers (one independent controller per locks site)
- 17) Do not run programs from a non-trustworthy source.
- 18) ^{A9}Advanced filtering to prevent suspicious traffic from leaving/entering the network.^{A9}
- 19) Enforcement of security policies, including NAC
- 20) FIPS certification and compliance
- 21) Governance
- 22) HTTPS and SFTP
- 23) Implementation of access control lists (ACLs) based on time of day.
- 24) Isolation of some networks
- 25) Keeping web browsers up to date with the latest security fixes
- 26) Limit active contents of web pages, including active X, java, and javascript.
- 27) Lock down switch ports.
- 28) Maintain tight physical security of the LAN.
- 29) Network-based intrusion prevention systems (IPSs)

- 30) OS hardening by disabling all non-essential services, user IDs, and privileges
- 31) Periodic and frequent antivirus updates, preferably automated.
- 32) Periodic data backup
- 33) Periodic password changes
- 34) Privilege levels
- 35) Read only.
- 36) Risk assessment and management in accordance with NIST SP 800-30
- 37) Security controls in accordance with NIST SP 800-53.
- 38) Sub-netting
- 39) Turn off all services that are not essential to the operation.
- 40) ^{A9}Use of Ethernet interfaces for remote connections instead of dial-up modems. Should modems be required, units shall be diagnostic modem type, and shall be turned off always except when really needed.^{A9}
- 41) Turn on phishing filter.
- 42) Uni-directional data transmission
- 43) Use of best practices in accordance with NIST SP 800-14
- 44) Use of dedicated or private lines of copper and fiber optic cables within the boundaries of this project and not connected to public switches
- 45) Use of firewalls, including personal firewalls on client stations, to do the following:
 - a) Application layer firewalling.
 - b) Determine what types of network traffic should and should not be allowed to enter and exit the network.
 - c) Enforce and impose security policies.
 - d) Isolate and subdivide Employer internal network into various security zones.

- e) Stateful packet inspection.
- ^{A9}f) Block all network traffic other than that required for day-to-day operations.^{A9}
- 46) Use of IPv6 or latest.
- 47) ^{A19}Use of LAN management tool to detect network sniffing and operation of network interface cards (NICs) in promiscuous mode.^{A19}
- 48) Use of network address translation (NAT) and port address translation (PAT) to hide private topology and IP addresses from external networks.
- 49) ^{A19}Use of OWASP type security for web based applications (more information available in www.owasp.org and www.cgisecurity.com/owasp websites).^{A19}
- 50) Use of password authentication protocol (PAP) to allow a remote node to establish its identity using a two-way handshake.
- 51) Use of WLANS and secure multimedia controllers (SMCs).
- 52) Use lifetime limitations and randomness in the choice of keys for encryption.
- 53) Use of several layers of defense.
- 54) Use of Web push technology.
- 55) Use of WPA2 and AES in accordance with IEEE 802.11i or better protection for wireless links.
- 56) Use security appliances.
- 57) Use of software to disable the use of USB ports except for authorized personnel.
- 58) Use of standard tunneling protocols.
- 59) Use vulnerability scanners (hardware, software or both) .
- 60) ^{A19}Unified threat management (UTM) devices combining different network security applications such as Anti-Virus, DoS, Firewall, IPS/IDS, and VPN applications into one hardware system.^{A19}
- 61) ^{A9}Use of virtual private networks (VPNs) to secure remote connections^{A9}.

- 62) Web server (outside firewall).
- ^{A3}63) Restrict wireless data transmission as required for strictly essential locks operations.
- 64) ^{A11}Protect in accordance with NERC Critical Infrastructure Protection CIP-002-1 through CIP-009-1. ^{A11}
- 65) ^{A5}Use policy based multipath capabilities and QoS for application control. ^{A5 A3}
- ^{A5}66) Use ports in the IETF RFC 793 to name the ends of logical connections.
- 67) Assign well known ports in accordance with IANA assignments for port numbers.
- 68) Protection of network perimeter and devices. ^{A5}
- 69) ^{A9}Use of intelligent bandwidth and traffic management. ^{A9}
- ^{A9}70) Limiting applications to relevant users and groups.
- 71) Limiting the number of concurrent connections and sessions.
- 72) Use router switches to divide internetwork into separate networks, enable mesh topology, filter traffic according to protocols used, and limit broadcast traffic.
- 73) ^{A16}Disable data communications to remote equipment whenever its MAC address is changed, unless the new MAC address is in the authorized list. ^{A16}
- 74) Other protection techniques as deemed necessary by the ^{A5}Contractor's ^{A5}designer.
- c. The Contractor shall ensure all supplied systems comply with the Employer's policies on Internet access, network security, and user account names and passwords.
- d. Digital systems shall use a scheme with the highest possible level of authentication when interconnected to other internal and/or external networks, and when remote access is allowed.
- e. Digital systems shall have the following type of users:
 - 1) **Administrative Users:** Shall be able to access the systems after complying with a strong authentication scheme. Such scheme shall include something the user is (i.e., user name), knows (i.e.,

password), and has (i.e., key or intelligent card, fingerprint or other biometric factor, or token).

- 2) **Operators:** Shall be able to access systems when providing the correct user name and password. No other special authentication shall be required because access control will exist for their working areas.

- f. ^{A19}To ensure that the Contractor develops the software systems that are fit for purpose and comply with the Employers Internet and Intranet requirements, the Contractor shall present his proposals during the design review to the Employer's Representative and the Employer's information technology authorities for review.^{A19} During the development of the systems designs the Contractor shall arrange, through the Employer's Representative, frequent meetings with the Employers IT department to ensure that the layers of protection are adequate, and software policies being applied are current and acceptable to the Employer.

5. **Licensing:**

- a. All commercial software packages or modules ^{A5}as required elsewhere^{A5} shall be ^{A5}available with^{A5} a license agreement that does not convey ownership to the Employer. ^{A10}Licenses shall be issued to the name of the Employer for no less than five years from the date of the Taking-Over Certificate and shall include all options whether specified or not.^{A10}
- b. Software licenses shall be provided before issuance of ^{A17}Taking-Over Certificate^{A17} for each software package, as applicable.
- c. The number of fixed and floating users shall be clearly indicated for multi-user packages. Licenses shall be given for all software in the equipped or larger configuration.
- d. ^{A9}The Contractor shall provide copies of all development software as required for reading, accessing, and modifying these, as well as all corresponding licensing keys.^{A9} ^{A10}Software development shall be in accordance with IEEE 1074.^{A10}
- e. ^{A17}Sub-Clause Nos. 1.10 and 4.4.3 of the Conditions of Contract shall apply.^{A17}

6. **Networking:**

a. **General:**

- 1) The Contractor shall ensure that those electronic media systems that are required to be configured into Networks are based on open standards used by the Employer and provide means for effectively partitioning of networks into subnets.

- 2) Unless otherwise specified, networks for office automation and process control shall be fully separated.
- b. **Local Area Networking:** Unless otherwise recommended by the system manufacturer and reviewed by the Employer's Representative, LAN equipment shall be fast/gigabit Ethernet or better type ^{A10}, autosensing, ^{A10} with 100/1000Base-T or faster connections.
- c. **Process Control System (PCS) Networking:** Shall use communications protocols specified on Section 40 95 13 (*Process Control Hardware*).
- d. **Storage Area Networking:** Unless otherwise recommended by the system manufacturer and reviewed by the Employer's Representative, SAN equipment shall be fiber channel 2Mbps or better (Brocade Communications Systems, Inc.).
- e. **Wide Area Networking:**
 - 1) Access and transportation of data through Employer WAN shall reutilize existing infrastructure whenever possible.
 - ^{A5}2) WAN shall be optimized for application acceleration and improvement of system response times. ^{A5}
7. **Screen Saving:** Digital devices with screens shall have means to save the screens from having image persistence problems. This shall include, but not be limited to, screen savers for video monitors and video walls.
8. **Software Development:** All software development for ^{A5}CCSS applications^{A5} shall follow a formal process of development and documentation.
 - a. **Software Design Document:** ^{A5}Shall^{A5} contain all the software requirements to a level of detail sufficient to allow validation and verification activities and processes. Each requirement shall have a unique identifier to support testing and traceability and shall be stated in such a way that an objective test can be defined for it.
 - b. **Quality Control for Software Development and Future Updates:** Contractor should describe how the source code shall be managed, builds and releases and prepared for validation. It should include but not limited to:
 - 1) Configuration management
 - 2) Software build/release
 - 3) Issue tracking

9. **Storage Media:** The Contractor shall furnish software in CD-ROM^{A5}, DVD-ROM, or Blu-ray DVD-ROM^{A5} so that the Employer may reinstall all required software at no extra cost should storage media need to be replaced in the future.
10. **Time Synchronization:** All servers, workstations, and all other devices provided with internal clock(s) shall be synchronized to accurate time reference(s) specified on Section 27 53 13 (*Time Synchronization Systems*). This applies to CCSS systems as well as office automation equipment.
11. **Upgrades:** All hardware firmware, commercial software and developed software provided shall be upgraded to the latest versions, and re-commissioned for review by the Employer's Representative prior to the taking over process. This shall include all software patches, releases, and versions made available by the system manufacturer or developer.
12. **Virtualization:**
 - a. **Infrastructure Virtualization:** Only where server virtualization is acceptable, a virtual infrastructure may be used for the following:
 - 1) Cluster assignment.
 - 2) Dynamic and intelligent reassignment of pool of resources, including CPU, interconnect, memory, and storage.
 - 3) High availability based on predefined policies.
 - 4) Load distribution.
 - b. **Server Virtualization:**
 - 1) Server virtualization may be acceptable to increase application level of service, hardware utilization, reliability, and scalability. This shall be done by dividing the resources of physical servers to maximize use by virtual servers.
 - 2) Unless otherwise specified, server virtualization is only acceptable for non-critical servers, and the ratio of virtual to physical servers shall not exceed 10.

^{A3}13. **Web Enabling:**

- a. All electronic systems shall, whenever practical, be IP enabled and shall include software and devices needed to allow authorized remote users to view special display and systems control pages using standard web browsers, including the latest versions of Microsoft Internet Explorer and^{A9} other popular web browsers.^{A9} This shall include access via the Internet and Intranet.

- b. The HMI shall be based on standard DHTML, HTML, Javascripts, and XML, and this feature shall include multi-user support and require a valid user account and password for access control. This shall be compliant with the applicable requirements of IETF, ISO 8879, and WHATWG.^{A3}

E. Coordination and Interoperability:

1. The Contractor shall be responsible for providing a fully coordinated set of hardware and software compatible and interoperable with existing devices used by the Employer at the time of installation and required for successful completion of the work, such as SAN, telephone system, and WAN devices.
2. The Contractor shall ensure that not only are the communications, controls, safety, and security systems fully integrated and coordinated but the end user systems, such as power systems, HVAC systems, building services, and locks systems are also fully integrated and coordinated into a seamless operations network for the entire Third Set of Locks.
3. ^{A9}Figure 01 81 26-1 (on page 2) illustrates connections between new and existing systems.^{A9}
4. ^{A9}Unless otherwise specified or recommended by the Contractor and reviewed by the Employer's Representative, data interchange between different systems shall be done using secure TCP/IP connections and Ethernet type interfaces.^{A9}

F. Corrosion Protection:

1. The Contractor shall protect all furnished metallic items against the effects of corrosion in the applicable environment.
2. Corrosion protection shall be in accordance with Section 09 96 00 (*Corrosion Control Coatings*).
3. Unless otherwise specified,
 - a. Aluminum shall be anodized or irradiated with an adequate corrosion resistant material, and shall not be in contact with earth or concrete. Protection of aluminum shall include adequate fittings and chemical treatment where connected to dissimilar metal(s).
 - b. Steel hardware and ferrous metals shall be hot dip galvanized. These include anchors, attachments, bodies, bolts, boxes, braces, clamps, eye nuts, fittings, guards, locknuts, nuts, pins, rods, shims, thimbles, and washers, except where specified for corrosion resistant steels.
4. ^{A19}When assembling any combination of dissimilar metals in the systems, the Contractor shall employ the following methods or combinations of methods to decrease electrolytic corrosion, unless electrical, ESD, fungus, harmonics, lightning, maintenance, mechanical, noise, radiation, reliability, RFI (radio-

frequency interference), structural, thermal, or vibration considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:^{A19}

- a. Interposition of a bimetallic clamp or material compatible to each dissimilar metal, specifically designed to decrease electrolytic potential differences and prevent galvanic corrosion. When outdoors, such clamps and materials shall be sealed with appropriate caulking. Cadmium or zinc plate on steel in contact with aluminum, and stainless steel between galvanized steel and copper are acceptable examples. Copper galvanized (zinc) steel and copper steel are unacceptable combinations.
- b. Interposition of an inert material between the dissimilar metals to act as a mechanical and insulating barrier. When outdoors, such materials shall be sealed with appropriate caulking. Phenol gaskets between nickel plated brass and aluminum is an acceptable example.
- c. Application of organic coatings to the contact faces of each of the dissimilar metals. A paint coat of two-component epoxy zinc-chromate primer on steel and aluminum surfaces in contact is an acceptable example.
- d. Design of dissimilar metal or similar metal contacts in order that the area of the cathodic metal is relatively smaller than the area of the anodic metal. Screws of stainless steel in contact with aluminum are acceptable examples.
- e. Limitation of aeration amount reaching the dissimilar metal faces. Surfaces of contact sealed with zinc chromate primer, vinyl films, or equivalent are acceptable examples.
- f. Weatherproofing all outdoor connections by using appropriate connector boots and silicon grease or spray.
- g. Other method(s) recommended by the Contractor and reviewed by the Employer's Representative.

G. **Definitions:** Shall be interpreted in accordance with Section 01 42 16 (*Definitions*).

1. ^{A17}**Communications, Tracking, and Navigation (CTAN):** The CTAN is the Employer's system used by Canal pilots as a navigational tool and by marine traffic controllers as a tracking system for transiting vessels and floating equipment. It was designed to enhance both navigational safety and operational effectiveness, is based on Global Positioning System (GPS) technology, and is part of the Employer's Enhanced Vessel Traffic Management System (EVTMS).
2. **Enhanced Traffic Management System (EVTMS):** The EVTMS is an Employer's computerized system that integrates vessel tracking with a maritime-operations database, providing a true picture of Canal resources and transiting

vessels at any given time. The EVTMS is a valuable tool for marine-traffic scheduling and for providing an accurate historical vessel-Transit database.

3. **Information Technology Security:** Shall be as defined by the U.S. government's National Information Assurance (IA) Glossary.^{A17}
4. **Total Cost of Ownership (TCO):** Shall consist of an assessment of the total cost of owning an asset, which includes:
 - a. ^{A17}Direct costs
 - 1) Procuring the asset
 - 2) Implementing the asset
 - b. Indirect costs, includes planned and unplanned costs related to the following:
 - 1) Maintenance
 - 2) Change (hardware and software) and change management (software)
 - 3) Designing changes (hardware and software) and development (software)
 - 4) Training support personnel and system users
 - 5) Failures and outages
 - 6) Diminished performance (delays and customer waiting)
 - 7) Security breaches (recovery of)
 - 8) Disaster preparedness and recovery
 - 9) Testing infrastructure and software
 - 10) Quality assurance
 - 11) Marginal incremental growth
 - 12) Decommissioning and disposal
5. **Other Definitions:** Shall be interpreted in accordance with Section 01 42 16 (*Definitions*).^{A17}

H. **Demarcation Points:**

1. For work items in locks complexes, demarcation points for connections to telephone systems and WAN shall be Gatun building 24/26, and Miraflores building 7D. The Contractor shall include all work from Atlantic and Pacific locks complexes to both of these buildings.
2. For work items in areas outside the locks complexes, the demarcation points shall be the corresponding telecommunications equipment rooms. The Contractor

shall include all work from such rooms to the applicable remote equipment, such as servers and SAN.

I. Electrostatic Discharge (ESD) Protection:

1. The Contractor shall implement and maintain an ESD control program in accordance with ^{A10}EIA JEDEC JESD 625, ^{A10}IEC 61000-4-2, ^{A10}and NEMA LD3 ^{A10}to protect all furnished items against possible effects of ^{A10}ESD. ^{A10}
2. The Contractor shall use the following methods or combinations of methods to protect against ESD unless corrosion, fungus, harmonics, lightning, maintenance, mechanical, noise, radiation, reliability, RFI, or thermal considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:
 - a. Grounding of components, modules, and work areas. A primary grounding path shall be used to continuously drain any developing static to ground. This may include conductive mats or floors, grounded tablemats, and static controlled workstations.
 - b. Grounding and protecting people who handle ESD susceptible items. This may include conductive shoes, finger cots, gloves, heel straps, sleeve protectors, smocks, and expandable elastic wrist straps for personnel.
 - c. Removal of static generators from static controlled areas. This includes common plastic items such as coffee cups, packaging materials, plastic bags, and work order holders.
 - d. Use of static conductive, static-dissipative, and anti-static materials, as required, including spraying anti-static solutions.
 - e. Use of static protective containers whenever protected transfer or storage is required.
 - f. Use of electric air ionizers (as a last resource). Nuclear air ionizers are unacceptable.

J. Equipment Operating Environment:

1. **General:**
 - a. All furnished items shall be suitable for the environmental conditions specified in the various Sections, or those conditions prevailing within the environs of the ^{A17}Canal, ^{A17} whichever is the strictest.
 - b. All furnished items shall be suitable for delivery, storage, and service under tropical conditions of high temperature, high humidity, salty atmosphere, providing an environment conducive to the propagation of mildew and fungus.

2. **Outdoor Operational Conditions:** Unless otherwise specified, all items of equipment and material intended for outdoors shall be capable of working continuously and delivering the required performance, without damage or degradation in a humid tropical environment as described in Table 01 81 26-9.

^{A9} Table 01 81 26-9: Outdoor Operational Conditions^{A9}	
Air Pollution	Dust and gases from smoke
Altitude	Anywhere between sea level and 610 m (2000')
Ambient Temperature	Between 10°C (50°F) and 40°C (104°F), with an average of 30°C (86°F)
Rainfall	To 17.78 cm/hr (7 in/hr), with a yearly average of 4,830 mm (190 in)
Relative Humidity	From 60 to 95%, non-condensing, with an average of 88%
Shock	0.4g in any direction
Solar Radiation	Up to 750 Langley’s per day, with a daily average of 450 Langleys
Vibration	5 Hz to 30 Hz with peak random vibrations of 2 g
^{A19} Wind Speed	130 km/h (80 mi/h) steady, in any direction, gust factor of 1.3 ^{A19}
Other	Salty water in air, fog

3. **Indoor Operational Conditions:** Unless otherwise specified, and regardless of any applicable air conditioning, all items intended for indoor installation shall be capable of working continuously and delivering the required performance without damage or performance degradation, in an environment described in Table 01 81 26-10.

^{A9} Table 01 81 26-10: Indoor Operational Conditions^{A9}	
Air Pollution	Dust and gases from smoke
Altitude	Anywhere between sea level and 610 m (2,000')
Ambient Temperature	Between 10°C (50°F) and 40°C (104°F), with an average of 25°C (77°F)
Relative Humidity	From 50 to 95%, non-condensing, with an average of 88%
Shock	0.4g in any direction
Vibration	5 Hz to 30 Hz with peak random vibrations of 2 g

4. **Compensation:** The above parameters are ambient ranges only. Environmental effects can cause more extreme conditions (e.g., heat build up, humidity problems, and vibration problems) inside equipment enclosures and cabinets. The Contractor shall be responsible for considering de-rating factors and for compensating for such environmental effects.

5. **Lightning:** The Contractor shall note and compensate for in his design the fact that Panama has a high level of electro-statically disturbed environment. Isokeraunic maps show more than 200 thunderstorm days per year in Panama.

K. **Equipment Performance Requirements**

1. All communications, control, safety and security systems and equipment and systems supplied for this project shall exhibit the performance requirements specified below
2. **Fault Tolerance:** The following systems shall be fault tolerant:
 - a. DC power systems, ref. Section 26 33 00 (*Direct Current Equipment*).
 - b. EDCSs, ref. Section 40 95 13.19 (*Electrical Distribution Control Systems*).
 - c. FFCSSs, ref. Section 40 95 13.16 (*Fire Fighting Control Systems*).
 - d. LMCSSs, ref. Section 40 95 13.13 (*Locks Machinery Control Systems*).
 - e. PLCs, ref. Section 40 94 43 (*Programmable Logic Controllers*).
 - f. Instrumentation, sensors, and transducers, ref. Section 40 91 00 (*Primary Process Measurement Devices*).
 - g. VDSs, ref. Section 35 12 00 (*Vessel Detection Systems*).
 - h. Signaling and control equipment, ref. Section 35 10 00 (*Waterway and Marine Signaling and Control Equipment*).
3. For the above systems,
 - a. Instances of single point of failure in hardware or software are unacceptable
 - b. System failures shall be automatically self-healing and shall require no or minimal human intervention to achieve restoration.
 - c. Systems and equipment shall be designed to incorporate “graceful degradation” features such that the systems or equipment shall continue to function in a degraded mode, without requiring immediate repairs or human intervention.
 - d. Degraded equipment or system operation may require the equipment or systems software to perform additional checks and calculations before advising any of the operation staff of the “go-no-go” status of the function being performed. It may also require the operators to perform additional verbal confirmation of current status, but at no time shall it result in an unsafe situation.

4. **Redundancy:** ^{A9}Unless N+x (i.e., N+1) is specified in CCSS related Sections, the Contractor shall note that the following redundancy requirements refer to a minimum redundancy of 2 units. Higher redundancy may be provided as needed to achieve the system availability specified in CCSS related Sections.^{A9}
 - a. **Base station RF Mobile Communication Systems:**
 - 1) CPUs, fans, and power supplies shall be redundant.
 - b. **Server Computers:**
 - 1) CPUs, fans, and power supplies shall be redundant.
 - 2) The Ethernet network interface card shall be redundant.
 - c. **Process Control Systems:**
 - 1) The power supply redundancy for PCSs shall be as described in Section 26 33 00 (*Direct Current Equipment*).
 - 2) The Ethernet and ControlNet network interface modules shall be redundant for master PLCs.
 - d. **Power Supplies:** Each power supply referred to above shall be capable of comfortably and continuously supporting 100% of the connected load.
 - e. ^{A9}**Route Diversity:** Physical separation of cables and pathways shall be as required to avoid taking 2 or more redundant paths out of service upon a single physical failure (such as a broken conduit or cable).^{A9}
5. ^{A19}**Printed Circuit Boards:** The Contractor shall note the following requirements with respect to the provision of printed circuit boards:^{A19}
 - a. ^{A19}Printed circuit boards shall have successfully passed a suitable burn-in time to minimize infant mortality.^{A19}
 - b. ^{A19}Whenever possible, printed circuit boards shall be hot swappable and plug-and-play type.^{A19}
6. **Connectors:**
 - a. **Coaxial Cable Connectors:** Depending on cable outer diameter, connectors shall be BNC, F, or N type.
 - b. **Fiber Optic Cable Connectors:**
 - 1) Whenever possible, connectors shall be of the same type(s) standardized by the Employer at the time of installation. As of 2007, the Employer standard is type SC for multimode fibers, and FC/PC or SC for single mode fibers.

- 2) Small form factor (SFF) LC and MT-RJ type connectors are acceptable connector alternatives for DCE only if provided with appropriate patch panels (with SC connectors) and hybrid patch cords.
 - 3) Except for MT-RJ type connectors, ferrules shall be made of zirconium ceramic or better quality material.
 - 4) Fiber optic connectors shall meet the applicable requirements of EIA 568, ISO/IEC 11801, and EIA 604-3 (FOCIS).
 - 5) Connector insertion loss shall not exceed 0.5 dB.
- c. **UTP Cable Connectors:** Shall be RJ-45 type for DCE and telephone sets.
7. **Safety:** The Contractor shall note the following requirements with respect to safety:
 - a. Units and accessories shall comply with the applicable requirements of UL 1863 or an adequate equivalent from a similar reputable international entity.
 - b. RF levels shall not exceed the safe levels of ANSI C95.1.
 - c. All cable and equipment to be installed in confined or enclosed areas shall be flame retardant, have low smoke, fume, toxicity and zero halogen / corrosion properties. Toxic fume emissions shall be negligible or low-level. ^{A10}Fumes and smoke shall be quantified in accordance with test procedures of IEC 332-3-21, IEC 60754-2, IEEE 1202, NFPA 262, UL 910, and/or UL 1581, as applicable. ^{A10}
 - d. SIL level 2 or better is required for emergency stop, and optional for every other control system functions.
8. **System Expandability:** The systems shall be able to expand easily to accommodate changes to the methods and requirements for operation of the 3rd Set of Locks. Unless otherwise specified elsewhere the minimum level of expandability with the minimum of additional hardware shall be as follows:
 - a. **Power Source:**
 - 1) 50 % spare load capacity for all type power supplies unless otherwise specified.
 - 2) For DC power sources, expandability shall be as specified in Section 26 33 00 (*Direct Current Equipment*).
 - b. **All PLCs and I/O Concentrator Number of Spare I/O:**
 - 1) 10%, equipped with the project supply

- 2) 40% minimum remaining total capacity per each processor
- c. **PLC CPU Free Memory (after user program and data):**
 - 1) 40% of total installed capacity
- d. **Unused PLC Communication Connections:**
 - 1) 30% of total PLC CPU capacity
- e. **Server or Workstation Resources:**
 - 1) 60% free memory resources with average workload
 - 2) 80% free mass storage capacity after commissioning.
- f. **Installation Space for Expansion Equipment:**
 - 1) 10% of total area, reserved inside enclosures, control cabinets and equipment racks.
 - 2) 100% of space, reserved for future additional enclosures, control cabinets and equipment racks.
 - 3) Reserved areas shall be clearly marked and labeled as such.
- 9. **Equipment Nameplates:**
 - a. Major components of equipment shall have manufacturer's name, address, catalog number, model, style, voltage or current rating, or type identified on a plate securely and conspicuously engraved or attached to each item of equipment.
 - b. Nameplates shall be permanent, non-corrosive, and non-heat sensitive plates securely attached to the equipment.
 - c. All equipment shall incorporate a barcode system that identifies each item of equipment by type, model and serial number. This information shall be provided in a consolidated database at the time of taking over of the Works and shall be used for audit purposes and maintenance records and shall be incorporated into the Employer's CMMS.
- 10. **Useful Life:** The systems shall be designed for and have extended useful life.^{A9}Durability shall be in accordance with the applicable requirements of MIL-STD-810.^{A9} Assuming regular software updates, useful life shall be as follows or longer ^{A9}from the date of the Taking-Over Certificate.^{A9}
 - a. Fifteen (15) years for all PCSs, and their corresponding instrumentation and transducers.
 - b. Six (6) years for all other information management type systems.

- c. Ten (10) years for all other items.

11. **Duplicate Equipment:**

- a. Unless otherwise specified, where two or more pieces of equipment performing the same function are required, these shall be exact model numbers produced by the same manufacturer, ^{A11}interchangeable, ^{A11} and shall be standardized as a spare part stock item.
- b. An allowed exception to this requirement applies to FOMs in accordance with Section 27 21 00 (*Direct Current Equipment*), to reduce possible common mode failure (CMF).

L. **Ergonomics:**

- 1. Systems' devices to be used or seen by humans shall be designed using the best practices in ergonomics and shall provide suitable adjustable ranges of operation to maximize the comfort of the users and operators.
- 2. CCSS systems shall meet or exceed the ergonomic requirements of CFR 1910.165 (OSHA), MIL-STD-1472F, ISO 11064, and National Research Council Washington DC Committee on Human Factors Guide HEGED.
- 3. The Contractor shall engage the services of a professionally qualified ergonomics design consultant to ensure that all aspects of operators' areas and the HMI designs are fully coordinated and incorporate the most up to date ergonomic techniques and principles. A third party specialist is only required should the Contractor lack in-house expertise in ergonomics.
- 4. The design and layout of the control, equipment, workshops, and offices shall consider the following audible, comfort, visual, and other factors:
 - a. Low noise, with SPL below 60 dBA in a control room office environment.
 - b. Wherever personnel are expected to work for long periods, such as offices, repair shops, and operation control rooms, equipment producing a sound pressure level of more than 3 dB above ambient shall likely be unacceptable.
 - c. For items to be used by several people, create a flexible arrangement that most closely satisfies the needs of the extremes as well as those in between these extremes. For example, the smallest and tallest, thinnest and broadest persons. Also, all control consoles and desks shall be designed to accommodate the smallest 10 percentile of women and the largest 10 percentile of men, by providing adjustable modules, chairs and other equipment.

- d. Good workstation arrangement to minimize the risk of developing an injury.
- e. Keep most frequently used items close and easily reachable.
- f. ^{A9}Use chairs that provide arm support, with elbows relaxed and close to body; stable footrest; good backrest; reclined posture; and lumbar support. ^{A9}
- g. Ensure displays are de-cluttered and exclude irrelevant data and details.
- h. Lighting level neither too dim nor too bright and shall be adjustable from a light dimmer control preferably located on the operator's console.
- i. Monitor screens not backed to, or facing a bright window or light source.

M. Fungus/Humidity Protection:

- 1. ^{A9}The Contractor shall protect all furnished items against humidity and fungus growth in the applicable environment, and indicate the recommended intervals between re-treatment. ^{A9}
- 2. Unless otherwise specified,
 - a. All new equipment and materials shall be fungus resistant and shall not be fungus nutrients. The Contractor shall not use untreated organic materials, such as cotton, paper, or wood.
 - b. Materials susceptible to deterioration from climatic conditions should be avoided when possible, or permanently protected if used. When elimination or permanent protection of such materials is not possible, the corresponding manufacturer shall apply a suitable treatment to protect for a minimum of at least twelve (12) months.
 - c. The manufacturer shall impregnate operating coils of relays and meters with a fungus inhibiting varnish. Otherwise, coils shall be made impervious to fungus growth.
 - d. Marking strips and nameplates shall be of plastic laminate or anodized aluminum.
 - e. Doors of panels shall be close fitting, and ventilating openings, if any, shall be suitably screened to prevent entrance of insects and rodents. Closed cabinets and similar equipment shall be completely vermin proof.
- 3. ^{A19}The Contractor shall employ the following methods or combinations of methods to protect against fungus and "tropicalize" all printed circuit boards, unless corrosion, electrical, ESD, harmonics, lightning, maintenance, mechanical, noise, radiation, reliability, RFI, thermal, or vibration considerations preclude the employment of such methods and such exceptions are reviewed by the

Employer's Representative.^{A19} This applies regardless of any insulation and air conditioning that may be already in use or specified elsewhere.

- a. Application of an adequate spray to protect against fungus growth and humidity. These spray coatings shall conform to IEC 60664-3, IEC 61086, or both.
- b. Application of an adequate special moisture and fungus resistant varnish or resin coating. This shall be applied to parts subject to the formation of a fungus culture medium due to the presence or deposit of nutrient substances. This includes the following materials: linen, cellulose, nitrate, regenerated cellulose, untreated wood, jute, plastic materials (using cotton, linen, or wood flour as fillers), leather, cork, paper, cardboard, organic fiberboard, organic felts, and generally other products of animal or vegetable origin.
- c. Space heaters or dehydrators within closed rooms, equipment cabinets, and enclosures.
- d. Where equipment is placed in cases and / or cabinets these shall have doors and cable openings that provide a completely sealed enclosure, such that the equipment is wholly or partly enclosed in a hermetically sealed case. These cases and cabinets may be pressurized to several meters of atmospheric pressure to prevent the ingress of water. Such pressurization shall be performed using an inert gas or air and a security valve. Where air is used, the air shall pass through a desiccant chamber to ensure the air contained in the enclosure is dry. The cabinet and / or case shall also be equipped with a suitable amount of desiccant, which shall be replaced periodically, during routine maintenance.
- e. All method(s) of fungus and humidity protection recommended by the Contractor will be reviewed by the Employer's Representative.

N. **Health and Safety Management:** Shall be in accordance with Section 01 35 23 (*Health and Safety Requirements*).

O. **Installation:**

1. **General:**

- a. All equipment and materials shall be installed as required by NFPA 70, the manufacturer's recommendations, and the requirements specified in the applicable Sections of these specifications. Should there be any ambiguity or discrepancy, the Contractor shall perform installation work according to the strictest specification of them to the benefit of the Employer.
- b. ^{A10}Installation personnel shall be qualified or certified to perform the intended work. ^{A10}The entire installation shall be done in a neat, orderly, and professional manner.

- c. Conduit, boxes, fittings, and equipment shall be kept free of dirt and trash during the course of installation.
- d. Defective materials or equipment damaged in the course of installation or test shall be replaced or repaired in a manner meeting with the approval of the Employer's Representative.

2. **Cutting, Repairing, Patching, and Refinishing:**

- a. Concrete walls and floors shall be cut with a mechanical power driven concrete saw. Cutting of masonry, tile work and all other materials shall be done in a neat, workmanlike manner using mechanical power driven tools whenever possible.
- b. Plain and reinforcing concrete for patching shall be 20.68 MPa (3,000 psi). For masonry, tile work and all other materials, alike or comparable material, matching as nearly as possible the existing material and workmanship, shall be used. Plaster shall be carried back at least 150 mm (6 in) beyond edge of cut in order to provide a suitable bond.
- c. Caulking compound and putty shall not be used for patching.

3. **Painting:**

- a. Equipment which has been painted by the manufacturer shall not be painted, except for touch-up.
- b. Where touch-up painting is required, a paint matching the original paint shall be used as approved by the Employer's Representative.

4. **Repair of Existing Work:**

- a. The job shall be carefully laid out in advance. Where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary, this work shall be carefully done.
- b. Any damage to buildings, piping, wiring, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Employer.

P. **Lightning Protection:**

- 1. The Contractor shall protect all furnished items against lightning and surges, as required in the applicable environment, and in accordance with Section 26 41 16 (*Lightning Prevention and Dissipation Systems*) and all applicable requirements of IEEE C62.41, LPI 175, NFPA 70 and 780, and UL 1449.

2. Surge protectors and TVSSs shall be in accordance with Section 26 46 13 (*Transient Voltage Surge Suppressors*).
3. The Contractor shall use the following methods or combinations of methods to protect against lightning unless corrosion, electrical, electrostatic discharge (ESD), fungus, harmonics, maintenance, mechanical, noise, radiation, reliability, RFI, thermal, or vibration considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:
 - a. Grounding and bonding equipment, including the use of grounding kits. Grounding and bonding shall be designed and constructed in accordance with NFPA 70 and Section 26 05 26 (*Grounding and Bonding for Electrical Systems*), and shall ensure that whenever possible, a single point ground (SPG) per site is attained.
 - b. Using protectors in accordance with Section 26 43 13 (*Transient Voltage Surge Suppressors*) and as required for protecting from destruction of components, disruptions, performance degradation, or any permanent harm. This includes protectors for all applicable communication lines, power lines, and RF transmission lines.
 - c. ^{A17}Keeping copper cables as short as possible to reduce possible induction problems.
 - d. Using all dielectric fiber optic cables as much as possible. ^{A17}

Q. Maintainability:

1. All designs shall be undertaken to ensure that maintenance requirements are ^{A10}minimized ^{A10} and shall consider full life cycle costs including spare parts, servicing, maintenance manpower and equipment replacement costs for a minimum design life as specified in Paragraph 1.03 K.11.
2. The Contractor shall incorporate the following maintainability design concepts:
 - a. ^{A9}Materials shall be selected to provide corrosion- and wear-resistance protection that is adequate for the environment and service. ^{A9} Should a material not be replaceable with a corrosion resistant one, the susceptibility shall be mitigated with coatings as appropriate for the environment as described in Paragraph 1.03 E.
 - b. Materials shall be light weight whenever possible, to minimize the need to utilize excessive manpower or cranes for maintenance. Should this not be possible, the facilities shall include fixed equipment for handling bulky, heavy, and difficult to maneuver items.
 - c. Electronic components shall be protected against power fluctuations and electrical discharges.

3. All designs shall be conducted to ensure ease of maintenance and provide comfort to maintenance personnel. This shall include, but not be limited to, the following:
 - a. The need to conduct periodic physical inspections shall be minimized, and equipment status and condition shall, in as far as it is practical, be remotely monitored. Where checking of the health and status of working equipment is necessary, the Contractor shall incorporate methods of inspection that can be accommodated without the need to power-down the equipment under inspection and / or the location from where the inspection is to be undertaken.
 - b. The design shall be made so that routine testing and inspections are either automated or made through easily accessible, visible points.^{A3}This includes accessibility to reapply corrosion protection treatments.^{A3}
 - c. The design shall be made so that recalibration and cleaning requirements are minimized, and can be conducted during properly scheduled maintenance periods.
4. The design shall pay special attention to the environmental impact due to possible breakdowns or failures, and shall include measures to mitigate their impact. This shall consider equipment reliability and probability of failure, as well as economic mitigation costs.
5. The systems shall be designed to allow all routine and preventative equipment maintenance to be accomplished within non-operative windows, to be determined by the natural daily traffic conditions at the Locks.

R. Obsolescence Protection:

1. Systems shall be built so that the change of one component will not lead to change other major parts or software, especially when these two parts have different lifetimes.
 - a. **Non-critical Components:** These are standard components (for example, developed with standard software, communicating with standard, wide-spread protocols), simple (for example, switches and analogical sensors), or world-spread, with certainty in substituting the component by another one from the same or another brand name. Such substitutions shall be direct and without need for adaptations.
 - b. **Critical Components:** These are components with specific software or hardware developed by a single manufacturer (i.e., PLCs). In this case, the same devices from the same manufacturer shall be used, and this Contract requires developing specific maintenance contracts with such applicable manufacturers.

2. For critical components,
 - a. **Contractor Requirements:** The Contractor shall maintain all critical items for no less than three years from date of commissioning. Should maintenance not be possible due to lack of spare parts or factory support driven obsolescence, the Contractor shall replace such items at no extra cost to the Employer with up-to-date versions.
 - b. **Manufacturer Requirements:** System manufacturers shall do the following:
 - 1) Show proof of record of integrating previous equipment during very long period of time, for example, because their new development was always upward compatible with their previous one.
 - 2) Make a commitment and guarantee that he will maintain adequate spare parts, software, and technical support at reasonable cost for the proposed equipment for an extended period of time of at least 10 years after date of installation. This shall include equal or newer equivalent replacement models.
3. The design of CCSS systems shall be postponed as late as possible. Also, design conferences shall emphasize future proofing and compliance with this paragraph.
4. Discontinued, obsolete, used, or refurbished items are unacceptable.

S. **Power Distortion and Harmonic Protection:**

1. The Contractor shall protect all furnished items against harmful effects of distortion and harmonics in alternating current lines.
2. The Contractor shall use the following methods or combinations of methods to protect against power distortion and harmonics unless corrosion, ESD, fungus, lightning, maintenance, mechanical, noise, radiation, reliability, RFI, or thermal considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:
 - a. Design for individual and total voltage distortion, as well as individual and total current distortion in accordance with the requirements of IEEE 519.
 - b. Limitation of harmonic content as required meeting power quality standards.
 - c. Use of harmonic content control filter(s) or other suitable devices to prevent radiation of harmonics from and to the electrical distribution system.
 - d. Use of oversized neutral conductors.

- e. Proper load balancing.
- f. ^{A19}Correcting power factor for individual devices representing large electrical loads, and for groups of devices representing small electrical loads individually. ^{A19}

T. **Power Supplies:**

- 1. **Communications and Controls Power Supplies:** Unless otherwise specified the communication, control, safety and security systems shall be provided with power sources of the following types, and shall include all necessary internal power distribution panels.
 - a. ^{A19}Power supplies in any equipment or device shall be power factor corrected in accordance with subparagraph 1.03 S. 2. f. above. ^{A19}
 - b. DPE and peripherals shall operate on 110 VAC, 60 Hz.
 - c. All telecommunications equipment and DCE shall operate on -48 VDC, positive grounded battery protected supply, ^{A9}in accordance with Section 26 33 00 (*Direct Current Equipment*). ^{A9}
 - d. ^{A19}All equipment or devices shall have a DC-DC converter or power supply capable of converting station service into all voltages required. ^{A19}
 - e. ^{A9}Inverted (uninterruptible like) power-supply systems shall support all computer-based systems located in equipment and operating rooms of the main control buildings, in accordance with Section 48 19 16 (*Inverters*).
 - f. Depending on the design of DC power systems, small inverters or UPSs may be required for CCVS equipment. ^{A9}

U. **Project Management:** Shall be in accordance with Section 01 31 00 (*Project Management and Coordination*).

V. **Radio Frequency Devices:**

- 1. RF devices shall meet the requirements of the Republic of Panama's ASEP PNAF.
- 2. ^{A19}Whenever ASEP PNAF does not cover specific requirements, RF devices shall then meet the requirements of U.S. FCC Rules and Regulation. ^{A19}
- 3. The Employer will take care of requesting ASEP allocation of additional frequencies that may be required to complete the work under this Contract, considering data from the Contractor.

- ^{A10}4. Operating frequencies shall be low enough so that rain fade does not disable reception at the required distances, received signal strength and bandwidth remain adequate, and system reliability and S/N are not compromised. Over the air use of frequencies above 20 GHz is strongly discouraged. ^{A10}

W. ^{A19}**RFI / EMI (Electromagnetic Interference) Suppression and Protection.** ^{A19}

1. The Contractor shall protect the furnished items against RFI/EMI, and shall suppress RFI/EMI emanating from the items.
2. Unless otherwise specified,
 - a. The Contractor shall design, bond, shield, and construct all subdivisions and parts of the equipment to prevent conductive, inductive (near field), and radiated RFI and EMI from, to, and within the system. This applies particularly for susceptible system functions and enclosures, which could allow interference from, or could interfere with data processing, communication, or similar systems and services, or could interfere with the system itself.
 - b. Subassemblies shall include shielding and other protective features, as necessary to prevent interference to the system from electrical equipment and external cabling. This includes cases where the system cables are installed with and adjacent to primary power and other utility cabling.
 - c. The Contractor shall suppress RFI and EMI, or attenuate at the source(s), coupling path(s), and receiver(s) to negligible levels, as required to meet the applicable ASEP and FCC Rules and Regulations. Even though the Employer does not require the Contractor to suppress or attenuate RFI/EMI at the source(s) when such source(s) are devices furnished by others, the Contractor shall identify such source(s), if any, whenever feasible.
3. The Contractor shall employ the following methods or combinations of methods to protect the items from RFI and EMI as required, unless corrosion, electrical, electrostatic discharge (ESD), fungus, harmonics, lightning, maintenance, mechanical, noise, radiation, reliability, thermal, or vibration considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:
 - a. Bonding and grounding of radiating elements
 - b. Proper routing of wiring, proper location of parts, and reduction of current loop area
 - c. Segregation of interference producing circuits into compartments
 - d. Shielding with metal enclosures, EMI/RFI gaskets, lossy potting compound, and coatings

- e. Using miscellaneous devices such as absorbers, attenuators, cavities, circulators, ferrite beads, filters, isolation transformers, isolators, protectors, RF chokes, RFI capacitors, and suppressors.
- f. Other method(s) suggested by the Contractor and reviewed by the Employer’s Representative.

X. Spare Parts:

- 1. Spares shall be furnished as recommended by the designer/integrator and systems manufacturer.
- 2. ^{A17}For the duration of the three-year ^{A17} ^{A16} maintenance support contract, the Contractor shall perform the following in accordance with Section 01 93 00 (*Maintenance Services*): ^{A16}
 - a. Own and maintain an on-site inventory at both the Atlantic and Pacific locks. These inventories shall consist of all recommended spare parts for all supplied systems at the recommended inventory levels that can maintain an operational performance without operation delays attributable to lack of spare parts.
 - b. Custody and dispatch the inventory with review by the Employer’s Representative.
 - c. Withdraw inventory in the performance of maintenance support duties.
 - d. Update the inventory lists monthly in coordination with the Employer’s Representative, report to the Employer all inventory used, listing part numbers, item description and cost.
 - e. Restock to recommended inventory levels.
 - f. Be responsible of assuring enough stock and continually revise stock levels to uphold operational performance considering re-stocking “long lead” times.
- 3. Upon the expiration of the period of ^{A17} the three-year ^{A17} maintenance support contract, the Employer shall have the option to acquire the on-site inventory or continue to receive the services from the Contractor, by means of a separate contract.

Y. Standard Products:

- 1. The Contractor shall ensure that whenever practical Materials and equipment shall be standard cataloged products of manufacturers and suppliers regularly engaged in the commercial production and supply of these products and shall be the latest standard design that conforms to the specifications just before shipping for hardware, and FFIT for software.

2. All items shall be new products of standard, ^{A10}reliable, ^{A10} modular, field proven design that does not require further research and development, ^{A9}as specified in related Sections. ^{A9}

Z. Systems Suppliers:

1. Communications, control, safety, and security systems and sub-systems shall be provided by a multitude of different manufacturers and suppliers, and configured into an integrated system or systems by a systems integrator and / or designer. Each party shall be required to conform with the following as it is applicable:
 - a. All manufacturers, suppliers, designers and systems integrators shall be ISO 9001 certified.
 - b. Minimum manufacturer experience shall be as follows:
 - 1) ^{A19}Ten (10) years for DC power systems. ^{A19}
 - 2) Fifteen (15) years for DCE, DPE, public address systems, safety systems, security systems, telephone systems, towers, and transducers.
 - 3) Ten (10) years for all other items not specified.
 - 4) ^{A10}In accordance with Subparagraph 1.04 D.5. for PCSs and PLCs. ^{A10}
 - c. Systems designers and systems integrators shall have a minimum experience of 10 (ten) years and shall have completed the design and integration of a similar project in the past 5 (five) years.
 - d. Equipment suppliers shall have a good after-sales repair service center in the Republic of Panama, and capability of providing a short duration response time during regular working hours.
2. **Systems Integration Personnel:** The Contractor shall ensure that all communications, control, safety and security integration works shall be executed by experienced personnel, in that-
 - a. All communications, control, safety and security integration system designs shall be prepared by competent, certified communications, control, safety, and security integration personnel.
 - b. Well-trained and qualified personnel under the leadership of an experienced integration test manager shall execute all communications, control, safety and security system testing.

- AA. Testability:** CCSS systems shall be equipped with test items, including an adequate combination of available diagnostic software, LAN ports for laptop PCs, and test points for test equipment connection.

BB. Thermal Protection:

1. The Contractor shall protect all furnished items against thermal effects in the local environment.
2. Unless otherwise specified, cooling fans shall be redundant.
3. ^{A19}The Contractor shall clearly indicate the heat dissipation at full load (in calories per hour or Btu/h) and any necessary cooling/ventilation requirements for each new piece of equipment, as applicable. ^{A19}
4. When using forced-air cooling/ventilation,
 - a. All air intakes shall have permanent reusable filters.
 - b. All blower motors shall be the heavy duty, brushless type.
 - c. Vibration generated by the blowers shall be ^{A10}within industry accepted standards ^{A10} and shall not interfere with system performance.
 - d. Operating blower noise shall be at sound levels below 55 dBA (normal conversation) so as not to interfere in the immediate operations areas.
 - e. The Contractor shall clearly indicate cooling fan cubic meters per second (cubic feet per minute) capacities.
5. The Contractor shall employ the following methods or combinations of methods to protect the equipment and materials from excessive temperature rise, unless corrosion, electrical, ESD, fungus, harmonics, maintenance, mechanical, noise, radiation, reliability, RFI, or vibration considerations preclude the employment of such methods and such exceptions are reviewed by the Employer’s Representative. These apply particularly when instability and runaway conditions could result.
 - a. Use of conduction and radiation techniques such as heat dissipation by appropriate heat sinks. The design of all new equipment and materials shall allow the free flow of convective currents, particularly around power supplies and sources.
 - b. Isolation or separation of heat generating components from each other
 - c. Orientation of each component to maximize heat transfer from the device to the system ambient and to obtain a nearly uniform average temperature over an enclosure surface
 - d. Use of forced air cooling/ventilation for the applicable system equipment enclosures

- e. Post shut down blower delay circuit to avoid thermal shock of components.
- f. Other method(s) suggested by the Contractor and reviewed by the Employer's Representative.

CC. Vibration Protection:

- 1. The Contractor shall protect all furnished items against possible effects of vibration. Vibration shall be quantified in accordance with Employer specifications or the manufacturer's estimate, whichever is the strictest case.
- 2. The Contractor shall use the following methods or combinations of methods to protect against vibration unless corrosion, electrical, ESD, fungus, harmonics, lightning, maintenance, mechanical, noise, radiation, reliability, RFI, or thermal considerations preclude the employment of such methods and such exceptions are reviewed by the Employer's Representative:
 - a. Anti-vibration dampers
 - b. Attach equipment to floors and walls.
 - c. Hold-down brackets, to insure that all modules and printed circuit boards remain firmly seated.
 - d. Shock mounts.

1.04 DESIGN CRITERIA/SYSTEM PERFORMANCE:

A. General:

- 1. **Problem to be Solved:** The Contractor shall provide systems that solve the following general needs for communications, controls, safety, and security systems. Further details are specified in the respective related Sections.
 - a. **Common Needs for All Systems:**
 - 1) ^{A10}A safe and reliable system adequate for continuous duty and with minimal impact to operations throughout the expected useful life. ^{A10}
 - 2) A system that is suitable for the adverse environment conditions of the installation site, or that is protected by a controlled environment.
 - 3) Electronic security for process control, process information, and auditable traceability of process activity
 - b. **Communication, Safety, and Security Systems:**

- 1) A system capable servicing all needs related to voice, video, data communication, time synchronization and other as needed, with appropriate scalable bandwidths and capacity for future expansion.
- 2) ^{A9}Hardware and software system that can be easily modified, tested, and re-deployed by Employer's Personnel.^{A9}

c. **Power Sources:**

- 1) A stable, reliable, protected and safe power source that is well structured to allow multiple power sources for robustness by means of fault tolerance, circuit self-healing capabilities with capacity for future expansion.
- 2) A power source including condition monitoring features capable of conducting diagnostics and annunciation of faults with linked help text with repair recommendations for supervising personnel, for ease of maintenance and superior availability.

d. **Process Control Systems:**

- 1) Highly reliable systems for vital locks operations shall have redundant communication paths, each with redundant protocol for robustness and fault tolerance, and circuit self-healing capabilities with capacity for future expansion. Where non-vital monitoring and control is needed, such as fire-fighting control systems (FFCSs), this communications redundancy is not required.
- 2) The PCSs require condition monitoring features capable of conducting diagnostics and annunciation of faults with linked help text with repair recommendations for supervising personnel, for ease of maintenance and superior availability.
- 3) ^{A9}Hardware and software systems that can be easily modified, tested, and re-deploy by Employer's Personnel.^{A9}

e. **Safety Systems:**

- 1) Shall protect life and property in the new locks complexes.

f. **Security Systems:**

- 1) ^{A9}Shall detect and provide warning whenever humans or things of similar or larger size approach the new lock complexes from land, water, or both.^{A9}
- 2) Shall detect all possible threats coming from land and water into the new locks complexes.

^{A9}g. **Communications Systems:**

- 1) Shall facilitate communication among Employer's Personnel assigned to maintenance, operations, and other duties.^{A9}

2. **Restrictions to be Considered:**

- a. ^{A9}All systems shall be well integrated, making use of available features and technology benefits to leverage the equipment-investment legacy while incorporating new and improved technology.^{A9}

^{A9}**TABLE 01 81 26-11: Prescriptive Items^{A9}**

No.	Section	Item	^{A9} 2008 Model^{A9}	Manufacturer	City	State	Country	Internet
1	25 11 00	Anti-virus ^{A5} and Anti-spyware ^{A5} Software	McAfee VirusScan Enterprise ^{A5} + Anti-spyware ^{A5}	Network Associates Technology, Inc.	Santa Clara	CA	USA	www.mcafee.com
2	25 11 00	Operating System for Servers	Windows Longhorn	Microsoft	Redmond	WA	USA	www.microsoft.com
3	25 11 00	Virtual Operating System	ESX	VMWare				www.vmware.com
4	25 11 00	Operating System for Workstations	Vista Enterprise	Microsoft	Redmond	WA	USA	www.microsoft.com
5	25 11 00	Operating System for WiFi devices	^{A9} Windows Mobile ^{A9}	Microsoft	Redmond	WA	USA	www.microsoft.com
^{A9} 6	25 11 00	Open Source Operating System	Linux	(Depends on distribution)				^{A9}
^{A9} 7 ^{A9}	33 81 13	Tubular Safety Rails	Tubular Rail System	Antenna Products	Mineral Wells	TX	USA	www.antennaproducts.com

- b. ^{A9}Table 01 81 26-11 indicates prescriptive items standardized by the Employer. Substitutions are not allowed.
- c. Work shall be planned to minimize interruptions to existing communications cables and services. This includes, but is not limited to, the following:
 - 1) Trans Isthmian duct line near south part of the Atlantic locks.
 - 2) Aerial fiber optic cable between Agua Clara substation and Gatun Locks, which runs near the northern part of the Atlantic locks.
 - 3) Aerial fiber optic cable between Miraflores Locks and Howard (Panama Pacific), which runs near the Pacific locks.^{A9}

B. Design and Coordination Requirements:

- 1. The Contractor shall use structured methods of analysis for each process function development of any part of the process control system. These methods shall be reviewed by the health and safety manager in accordance with Section 01 35 29 (*Health and Safety Management / Emergency Response Procedures*) and by the Employer's Representative.
- 2. ^{A19}For all different, separate, and distinct facilities within a locks complex, the Contractor shall provide process-system's integration that makes an entire equipment set be operable and controllable as required by the Employer, and that is safe, reliable, easy to maintain, and fit for the intended purposes, as specified elsewhere.^{A19}

a. Equipment Fit for Purpose:

- 1) The Contractor shall use specific method for process analysis such as Structured Systems Analysis and Design Methodology (SSADM) or Structured Analysis and Design Technique (SADT).
- 2) The Contractor shall produce all documents and drawings that will permit the Employer's Representative to check that the Works will comply with the Employer's requirements.
- 3) ^{A17}The Contractor shall coordinate the Works to ensure that all Subcontractors interact and coordinate their designs and construction methods with each other through the updated Program and Facility Information Modeling system (*see Section 01 31 00*) to ensure that the Works are fully coordinated, and fit for purpose.^{A17}

- b. ^{A19}**Safe and Reliable Equipment:** The Contractor shall use risk assessment methods to insure that design, construction methods, choices of equipments, suppliers and manufacturers are fully coordinated with Health an Safety Management (*see Section 01 35 23 Health and Safety Requirements*) in order to do the following: ^{A19}
 - 1) To ensure that the ^{A17}Works are ^{A17} safely built, with low risk for health and safety during the works, and
 - 2) ^{A17}To ensure that all the facility created is safe-operable, i.e. safe for environment, health and safety of users, Employer's Personnel and neighborhood. ^{A17}
- c. **Available Equipment:** The Contractor shall ^{A17}ensure ^{A17} that all provided materials, sensors, electrical and electronic devices, cables, and supports comply with the Employer's requirements, especially according to protection level, conditions of use, mounting procedures,
- d. **Easy to Maintain Equipment:** The Contractor shall insure all tools needed for maintenance of the process control systems shall be provided:
 - 1) ^{A16}Documentation according to Section 01 31 00 (*Project Management and Coordination*), Section 01 40 00 (*Quality Requirements*), and Section 01 78 23 (*Operations Data*) ^{A16}
 - 2) ^{A16}Tools for maintenance according to Section 01 93 00 (*Maintenance Services*) ^{A16}
 - 3) ^{A16}Schedules for preventive maintenance, according to Section 01 78 23 (*Operations Data*) ^{A16}.
 - 4) Maintenance staff training according to Section 01 79 00 (*Demonstration and Training*).
 - ^{A9}5) Consider anti-obsolescence as the highest priority.
 - 6) Software-based diagnostics for PCSs shall be in accordance with Section 40 96 45 (*Process Control Software*) and its related Sections. ^{A9}
- 3. **Security Systems:** Shall be designed in accordance with the guidelines of NFPA 730 and shall meet all applicable requirements of NFPA 731 and USACE UFC 4-020-02FA / TM 5-853-2, and USACE UFC 4-020-04FA / TM 5-853-4.
- 4. **WiFi Wireless Communications Systems:** Shall be designed in accordance with the requirements of BICSI WDRM and the U.S. Health Insurance Portability and Accountability Act (HIPAA).

- ^{A16}5. Infrastructure: All CCSS infrastructure, including direct current equipment and ducts, shall be designed as required for eight RGs per lock, regardless of the initial number of RGs. ^{A16}

C. **Equipment Location Layout:**

1. The PCS shall include redundant control stations located in the control room of the locks. Each control station left side shall handle operation HMIs, while the right side shall handle maintenance and fire-fighting HMIs.
2. The redundant master PLC arrangement shall be installed in equipment racks located at the equipment room below the control room. The computers and servers that service the control stations shall also be installed in equipment racks in the equipment room. Other CCVS, fire-fighting, PCS equipment, and other related hardware shall be installed in adjacent racks.
3. Each electrical room, which houses the power switchboards and motor control centers, shall include I/O concentrators, which report I/O to the master PLCs in the equipment room.
4. Each machinery room shall include a NEMA 4X touch screen operator interface that provides locally the operation and maintenance functions for each and all equipment in the machinery rooms.
5. In the case of valves, at each location of the actuator, a NEMA 4X, weatherproof controls box shall be connected to the nearest I/O concentrator for local maintenance operation of the valves.

D. ^{A9}**Process Control Requirements:**

1. **Communication Loss with an Electrical or Machinery Room:** if a loss of communication occurs between the master PLCs and any of the machinery rooms, after an adjustable timeout, all the related machinery shall operate to safe shutdown position. In the case of valves, this position is closed. In the case of gates, this position is stopped. In all other machinery, i.e. fire fighting and electrical distribution, the PCS shall act according to the last operator command.
2. **Interlocks:** Interlocks shall be based on the machinery indication information. Such machinery information shall be of the “positive safety” type so that in case it is false or not available, the interlock shall assume an “Open” condition for gates and valves.
3. **Machinery Position Indication:** Machinery position indication used by the locks operator shall primarily be actual sensed gate position or valve body position by means of an analog absolute type position transducer. Measuring machine actuator position or other indirect machine position indications shall be a secondary source of information. Using the last operator command issued to infer position shall not be acceptable.

- ^{A9}4. **PCS Total Cost of Ownership (TCO) Performance:** PCS design shall minimize TCO.
5. **PCS Manufacturer:** Shall have the following (with time units referenced to the date of Submission of the Tender):
- a. PLC manufacturer shall have a minimum of 20 years of experience producing PLCs.
 - b. PLC manufacturer shall have provided technical support and replacement parts for their top three PLC platforms for at least 15 years per platform generation.
 - c. On going service of 24 hours a day, 7 days a week technical support for PLC hardware and software via call center, chat center and/or help desk for at least five years.
 - d. Technical support for at least five years from regional representative based in Colombia, Costa Rica, and/or Panama.
 - e. Technical support from local representative for at least one year.
 - f. ^{A16}Parts Maintenance Agreement Management (PMA) in accordance with Section 01 93 00 (*Maintenance Services*).^{A16}

E. **Pedestrian and Vehicular Traffic Control:**

1. The locks ^{A17}operators ^{A17} shall have remote monitoring and control of pedestrian and vehicular traffic control equipment through the operations HMI. Maintenance information shall be available through the machinery diagnostics station HMI.
2. CCVS video shall be provided to the locks operator to confirm the gates and the approaches to the gates are clear of traffic, before operating the gates.

F. **Public Address (PA) Systems:** PA systems shall be provided as specified on Section 27 51 16 (*Public Address Systems*).

1. Automated emergency evacuation voice announcements and lock operator voice announcements.
2. Lockage automated warnings, such as ship approaching lock, hot ship, ^{A5}and other warnings foreseen for^{A5} the future.
3. Plant personnel dial-up PAS access.

G. **Risk Assessment:**

1. ^{A10}The Contractor shall carry out risk assessment studies of every process control system, considering each device and facility.^{A10}

2. The requirements of Section 01 40 00 (*Quality Requirements*), as well as IEC 61508 and IEC 62061 (or equivalent) shall be applied.
 3. These studies shall be coordinated with the health and safety manager according to the interface requirements of Subparagraph 1.03 D.3.
- H. **System Performance:** Shall be as specified in the particular Sections of the CCSS specifications listed in Tables 01 81 26-1 through -6 of Paragraph 1.01 of this Section of the specifications.
- I. ^{A17}**Installation Design Packages (IDPs):**
1. Each IDP shall be a set of Contractor information on proposed design and installation details about specific system(s), so that the Employer can evaluate the completeness of the work plan. IDPs shall include, but not be limited to, the following:
 - a) **Indication of All Equipment/Device Locations in Proposed Floor Plans:**
 - 1) Suggested location of all equipment, components, and their quantity for each place of installation.
 - 2) Recommended arrangement of all system components for each place of installation and their cabling routes.
 - 3) List of power requirements and the location of feeding sources for all equipment being installed.
 - b. **Design Diagram Indicating All Devices, Communication Wiring, and Power Connections:**
 - 1) **System Cable/Signal Diagram:** In block diagram format, shows all interconnecting cables between units.
 - 2) **System Power Distribution Diagram:** The system power/signal flow diagram shows all AC and DC power distribution in the same manner as the system cable/signal flow diagram described.
 - 3) **Interconnecting Wiring Diagram:** Shows the termination of cables at or in each of the system units.
 - c. **Typical Equipment/Device Mounting Details for Each System.**^{A17}

1.05 SUBMITTALS:

A. ^{A17}General:

1. Notwithstanding the general requirements with respect to submittals, the Contractor shall provide the ^{A17} ^{A11} design and construction documentation specified below.
2. Coordination meetings, design conferences, and interface management shall include the required combination of Employer’s Personnel, including the Employer Representative, engineers, operators, and technicians, as well as Contractor’s Personnel, including the applicable Subcontractors.

B. Possible Deviations from Items Proposed in Tender:

1. The Contractor may submit newer technology and model numbers that comply with or exceed the Employer’s Requirements at no extra cost to the Employer.
2. Such deviations shall not supersede the requirements of Subparagraph 1.03 R. (*Obsolescence Protection*).
3. The Contractor shall not change the proposed PLC platform ^{A11} ^{A17} after receiving the Letter of Acceptance, unless the brand name becomes unavailable. ^{A17}

C. ^{A19}Design Data: Within 119 days after the Commencement Date the Contractor shall submit to the Employer’s Representative for his review, five (5) sets of communications, control, safety and security systems design data. This design shall include but shall not be limited to: ^{A19}

1. Resubmission of the design provided with the proposal suitably amended to incorporate all variations, changes and modifications resulting from the Tender process.
2. This design submittal shall consist of a “top down” approach to the overall communications, control, safety, and security systems including the HMI interfaces to demonstrate to the Employer’s Representative and the Employer’s operations and maintenance organization that the Contractor shall design, manufacture, install and commission a system that shall be “fit for purpose” and provide the level of operability required by the Employer.
3. Provide an analysis of the design that shall include a written explanation of the system design and equipment selection. It shall contain a summary of the criteria applied to each system, including codes, references, safety, ergonomics, corrosion protection, fault tolerance, redundancy and common fault mode mitigation. Summary shall briefly justify the criteria used.
4. Include the relevant Sections of the Quality Control Plan and other quality procedures to demonstrate its procedure for identifying and resolving non conformances, interface design and construction issues, and the process of

providing the systems assurance requirements detailed in Section 01 40 00 (*Quality Requirements*).

D. Intermediate and Final Design Data:

1. ^{A16}The Contractor shall submit intermediate and final designs for review in accordance with the Accepted Baseline Programme, in sufficient detail for review by the Employer's Representative for all Sections listed in Tables 01 81 26-1 through -6 to determine whether Contractor can proceed with procurement and construction of these systems. ^{A16} ^{A19}Between design submittals, there shall be continuous review and dialogue required between the Employer and the Contractor during the design period for the Works. ^{A19}
2. The Employer envisions that the Contractor's progressive design submissions for the communications, control, safety and security systems shall be tied to events controlled by other engineering disciplines. Before these events occur, the Contractor shall arrange a design conference to ensure that the integration and interface design issues are fully incorporated and agreed to by the various parties.
3. ^{A16}Each of these events shall mark the end of a design ^{A16} ^{A17}phase and shall make the design pertinent to that phase. The following design phases shall continue to be reviewed while maintaining end product compliance requirements. If two or more events occur together, the design phases shall be merged.
4. The design submission for each design phase shall include the complete design description to enable a general evaluation of the design, including methods of protection specified in Paragraph 1.03. The design submission shall be finalized up to the current design phase and in progress for the remaining phases. ^{A17}
5. Design conferences shall be linked to events (instead of time) as specified below. ^{A11} (Deleted text) ^{A11}

a. For Communications, Power Sources, Safety, and Security Systems:

- 1) **Design ^{A17}Phase 1:** This phase ends with the event of the finalization of the civil works design related to outside plant, cable pathways and lock complex layout. At this point, all cabling details and termination equipment shall be clearly defined.
- 2) **Design ^{A17}Phase 2:** This phase ends with the event of review for procurement of the electronic and information system hardware and software. At this phase, ^{A17} ^{A16}all system details shall be clearly defined. ^{A16}

b. For PCs:

- 1) **Design ^{A17}Phase 1:** This phase ends with the event of the finalization of the civil works design related to outside plant, cable pathways and lock complex layout. At this point, all

cabling details and termination equipment shall be clearly defined.

- 2) **Design Phase 2:** This phase ends with the event of the finalization of the locks operating machinery and equipment design. At this phase, all machinery and equipment I/O such as, protection devices, terminal blocks, solenoids, relays, switches, sensors and other instrumentation details shall be clearly defined.
- 3) **Design Phase 3:** This phase ends with the event of review for procurement of the PCS controllers for local machinery or equipment. At this phase, all local controller and supporting device details for machinery or equipment shall be clearly defined, including selection and configuration of I/O concentrator or slave PLC.
- 4) **Design Phase 4:** This phase ends with the event of the finalization of the locks main control building civil design, including control and equipment rooms. At this phase, all centralized controls for machinery or equipment details shall be clearly defined, including selection and configuration of master PLC and / or HMI. Scope includes definition of all development software, modeling and simulation software, diagnostic software, and all other software as required.
- 5) **Design Phase 5:** This phase ends with the event of review for procurement of the electronic and information system hardware and software. At this phase, ^{A17}^{A16}all system details shall be clearly defined. ^{A16}

6. The Contractor shall submit all drawings and sketches.
7. The Contractor shall submit all documentation and reference materials.
8. The Contractor shall submit all quality, interface and systems assurance checks.

E. **Documentation:** ^{A17}Notwithstanding ^{A17} the requirements for drawing submissions contained in Section 01 33 00 (*Submittal Procedures*) the Contractor shall provide the following:

1. **Computer Files:** The Contractor shall furnish the following computer files in CD-ROM, DVD-ROM, ^{A5}Blu-ray DVD-ROM, ^{A5} or better:
 - b. Drawings in AutoCAD (*.dwg) formatted files.
 - c. Cable lists in Microsoft Office formatted files.
2. **Descriptive Literature:** Shall be in accordance with the particular Sections and Section 01 33 00 (*Submittal Procedures*).

3. **Drawings:** Shall be in accordance with the particular Sections and Section 01 31 00 (*Project Management and Coordination*).^{A10} Drawings shall include radiation patterns, as applicable to antennas and loudspeakers.^{A10}
4. ^{A17}**Design Drawings of Electronic and Associated Electrical Work for Review:**^{A17}
 - a. Drawings shall be provided for system review and shall include installation details, outline and dimensional data, point-to-point wiring diagrams, sections, views, general and one line elementary diagrams to indicate functions of equipment components, and equipment layout.
 - b. Wiring connections and interconnection drawings shall show the function and designation of each terminal or group of terminals, and each shall be referenced to its corresponding terminal on other drawings.
 - c. The drawings shall show markings, color coding, identifiers, control equipment component operation sequences, control unit configuration, and any other details required to demonstrate that the system has been coordinated and shall properly function as a whole.
 - d. Where wires and cables for the control systems share cable routing with other communications, safety and security systems, such as common cable trays and trunking, the Contractors installation and as built drawings shall clearly identify to which system the cables belong, and for what type of service they are being provided. This identification may take the form of frequently marking each group of cables with color cable wraps or the like. Where a number of conduits also form part of a common cable route these shall similarly be identified on the drawings and in the installation.
 - e. ^{A17}During design review, the Employer reserves the right to request modifying the original configuration in design drawings at no extra cost. This shall be done as deemed necessary and in accordance with acceptable practices of the manufacturer, and may include relocating and redistributing modules in different shelves to avoid concentration of any function or service in a few shelves, or to improve availability or redundancy.^{A17}
5. ^{A16}**As-Built Drawings:** Shall be provided in accordance with Sub-Clause 5.6 of the Conditions of Contract and Section 01 33 00 (*Submittal Procedures*) and 01 77 00 (*Taking-Over Procedures*) of the^{A16} ^{A17}Employer's Requirements.^{A17}
6. **Interface and Integration Management System:**
 - a. The Contractor shall include details on coordination with other systems as specified in Section 01 40 00 (*Quality Requirements*), and in the "Coordination and Interoperability" requirements clause of this Section of the specification.

- b. The Contractor shall develop and maintain an interface and integration management system throughout the life of the project (see Paragraph 1.05 F.).^{A16} The Contractor shall submit within 91 days of the Commencement Date the following:^{A16}
 - d. An interface management plan, which shall detail how the Contractor shall manage all physical interfaces between the various designers, manufacturers, constructors and third parties to ensure that the Contractor achieves a “fully coordinated” and “fit for purpose” Canal transportation system.
 - e. An integration management plan which shall detail how all of the electrical and mechanical support systems shall be integrated to ensure that they enable the completed Panama Canal third locks system to provide the Employer with a fully functional Canal transportation system that meets the operational objectives of the Employer.
 - f. This plan shall be regularly updated, and include designers, manufacturers, constructors, and newly involved in the project as soon as they are known. All such participants shall be represented in design conferences (ref. Paragraph 1.05).
 - g. It shall be the responsibility of the Contractor to ensure coordination with the systems and sub-systems of the disciplines listed in Tables 01 81 26-1 through -5 above is achieved and a fully integrated communications, controls, and security system is delivered to the Employer, which is fully compliant with overall requirements of the Contract.
 - h.^{A9} All security systems described in Division 28 shall be compatible with existing OPP systems and compliant with current OPP policies.^{A9}
7. **Monthly Design Review Report:** In accordance with Section 01 40 00 (*Quality Requirements*) the Contractor shall submit a Monthly Project Progress Report, for the communications, control safety and security systems design. The report, as a minimum, shall contain the following:
- a. A submission schedule for all proposed submissions indicating submissions made during the month, submissions to be made in the next month and status of previous submissions.
 - b. A list of ongoing design submissions with an indication of the progress and level of completion
 - c. A list of responsible designers for the outstanding design^{A17} work.^{A17}
 - d. A list and commentary of outstanding information or design decisions which are affecting design progress.
 - e. An “S Curve” reporting of overall design progress

- ^{A16}f. A substitute log which lists all potential substitutes and which includes comparative costs, as well as technical and commercial information needed by the Employer to evaluate whether there is a sizeable economic benefit.^{A16}
8. **Systems Integration Personnel:** The Contractor shall submit the curriculum vitae of the lead or senior integration design manager, and the integration commissioning manager to the Employer's Representative for review, prior to the commencement of the design and test and commissioning phases of the Works.
9. **Test Documentation:** ^{A17}Notwithstanding ^{A17} the requirements to submit routine factory and field test results and reports, the Contractor shall submit final field integration test (FFIT) documentation to the Employer's Representative in accordance with the requirements of Section 01 33 00 (*Submittal Procedures*).
- a. All test reports shall be prepared by the system manufacturer's qualified representative and shall include, but not be limited, to the following:
- 1) A complete list of equipment installed and wired, including manufacturer's name and model numbers,
 - 2) Indication that all equipment is installed and functions in accordance with these specifications, and,
 - 3) A complete set of "as built" drawings, including cable routing and cable wiring diagrams, which shall be color-coded with complete terminal or tag numbers included.
- b. Both parties shall review each step in the tests and sign off after successful completion.
- c. Both parties shall report and sign off specific failures, if any. After the Contractor has corrected all discrepancies, both parties shall retest with sign offs as appropriate.
10. **Test Reports:** Shall include but not be limited to the following:
- a. Reports from independent laboratory verifying compliance for the model numbers proposed (only for Sections where this is required).
 - b. FIT reports.
 - c. FFIT reports
11. **Training to be Provided Outside of Panama:**
- a. The Employer's preference is to have all training provided in Panama. Should the Contractor consider that for specific training courses this is

not advisable or wishes to deviate from this requirement, he shall submit a report to the Employer’s Representative for review.

- b. This report shall include all technical and commercial clarification that shall be needed by the Employer to justify any change in the current training requirements.

^{A11}F. **Miscellaneous:** The Contractor shall furnish all relevant information required for the applicable radio frequency assignment requests. ^{A11}

G. ^{A17}**Business Continuity Plans (BCPs):** Shall describe the details on how the Employer will partially or completely resume interrupted critical functions within a predetermined time after a Disaster or disruption.

H. **Disaster Prevention Plans (DPPs):** Shall describe the details on preventing disasters by determining possible causes, implementing proactive measures against them, fighting not to fail, and minimizing downtime.

I. **Disaster Recovery Plans (DRPs):** DRPs shall cover the data, hardware, and software critical for a business to restart operations in the event of a disaster. All DRPs shall contain the following:

1. Objectives.
2. Definitions.
3. ^{A19}Line of succession in the Employer. ^{A19}
4. Roles and responsibilities.
5. Notifications and escalations.
6. Damage evaluation.
7. Scenarios, each with probability of occurrence, impact, severity, criteria for invoking plan, message to users, action plan for recovery (critical, non-critical, and return to normal operations).
8. Reports.
9. Testing and validation.
10. Review and follow up. ^{A17}

1.06 QUALITY ASSURANCE:

A. **General:** Quality requirements shall be in accordance with Section 01 40 00 (*Quality Requirements*) and Test Procedures shall be as required for FIT and FFIT.

B. **Certifications:**

1. Certifications of compliance with the required standards for the model numbers offered.

2. Contractor and Subcontractor personnel qualifications shall include a certification by the respective manufacturers for design and installation of the offered equipment.
- C. **Factory Inspection Tests (FIT):** ^{A20}In addition to the requirements of Section 01 40 00 (*Quality Requirements*), subparagraph 1.10 H., the following applies to CCSS related Sections that require FIT. ^{A20}
1. **General:** A FIT shall be a complete test of all furnished system features and functions. This shall include, but not be limited to, the application programs, data-bases, displays, hardware, historical/trend data, software, system security, and date/time stamp compliance.
 2. ^{A16}**Review of the FIT:** During the execution of the Works, the Employer's Representative may request changes to the proposed FIT procedures to ensure a complete representative functional test of all furnished system features and functions are provided. ^{A16} Upon such notification from the Employer's Representative, the Contractor shall update the FIT procedures and resubmit them for review by the Employer's Representative.
 3. **Arranging FIT Schedule:** ^{A20}The Contractor and manufacturer(s) shall arrange the FIT and inspection schedule at the manufacturer's (or manufacturers') premises to be as near as possible to the dates of installation and maintenance training at the manufacturer's plant (if applicable) and shipping of the system. ^{A20}
 4. ^{A16}**Notification of FIT:** The Contractor shall notify the Employer at least 42 days before the specified equipment is ready for test. ^{A16} The Employer representatives shall witness the FIT and examine the system and the parts to ascertain the materials completeness, proper workmanship, and conformance with the specifications. During the FIT test period the Contractor and / manufacturer shall do the following:
 - a. Make available all necessary temporary wiring; test equipment, and devices required for the FIT and input/output point simulations.
 - b. Test spare parts, if any, on a rotation basis.
 - c. Simulate all the conditions necessary to test all possible software error messages.
 5. **Function Tests:** The tests shall be complete and representative of all functions provided whether specified or not. As a minimum, shall include backup, data base, dynamic system exerciser, hardware, initialization/restart, software, surge withstand capability, system, and temperature tests.
 6. **Backup Tests:** Proper manual and automatic changeover tests on all systems that have dual processors, redundant circuits or power sources from the on line to the backup shall be rigorously checked out with all system elements active.

7. **Data Base and Display Tests:**

- a. All applicable video display and report pages and a 100% sampling for each type of point in the database shall be verified.
- b. Should any bugs or data base errors be found during the FFIT, the Employer reserves the right to check all the data base (point by point) as deemed necessary by the Employer's Representative.

8. **Dynamic System Exerciser:** This test shall include running the system for no less than 16 hours (overnight) to verify that the hardware works as an integrated system, scanning all equipment in the normal operating manner under quiescent conditions.

9. **FIT Witnessing:**

- a. The Employer reserves the right to send representatives to the following, as deemed necessary by the Employer's Representative:
 - 1) Inspect any or all equipment before and during the FIT, and
 - 2) Witness any factory quality control and acceptance tests from the Contractor and any applicable Subcontractor.
- b. The Employer's Representative may decide to send a consultant or not to send any representative to the FIT and factory inspection.
- c. Should the Employer decide to send witnesses to the FIT, the parties shall also meet the following:
 - 1) The authorized representatives of each party shall review each step in the tests, and sign them off after successful completion. They shall identify and sign any specific failures in writing. After correction of these discrepancies, if any, they shall retests with sign offs as appropriate.
 - 2) The Employer shall be responsible for the travel and living expenses of its representatives while they are on the scheduled factory visits.
 - 3) The Contractor shall furnish a copy of the most up to date revision of reviewed FIT procedures to each of the Employer representatives.
 - 4) In addition, the Contractor shall conduct tours for the Employer representatives of the factory (or factories) and working offices so they may become familiar with the design, manufacturing, installation, maintenance, programming, reprogramming, service, and administration of the proposed items.

10. **Hardware Tests:**
 - a. Hardware diagnostic tests shall be run first to assure that each piece of equipment is testable and in proper working order.
 - b. All applicable devices shall also be checked out as completely as possible on a stand alone basis, using a suitable test set or device.
11. **Initialization/Restart Tests:** The ability of the system devices to automatically initialize and restart after a power failure or other anomaly shall be checked out.
12. **Software Tests:**
 - a. After hardware and dynamic system exerciser tests have been successfully completed, every specified functional requirement of the system, as well as the applicable manufacturer software modules shall be verified, using predefined simulations as necessary.
 - b. Correct operation for each type of feature and function shall be verified. However, should many bugs be found during the FIT, the Employer reserves the right to check all features and functions as deemed necessary by the Employer's Representative.
 - c. All possible major error and help messages shall be tested.
13. **User Acceptance Test Phase (or Beta):** ^{A20}It shall consist of the validation performed on the complete system in a controlled, production-like environment.^{A20}
14. **Surge Withstand Capability (SWC) Tests:** These shall be conducted as necessary to assure that inputs and outputs of the system meet the requirements of IEEE C37.90.1.
15. **System Tests:**
 - a. ^{A20}Levels of activity corresponding to on-line, real-time operation shall be simulated, and HMI responsiveness to operator requests shall be evaluated to test the entire system as an integrated unit.^{A20}
 - b. System tests shall include, but not be limited to, the following as applicable:
 - 1) Application program tests,
 - 2) Communication system capacity and CPU loading tests under different likely scenarios,
 - 3) Data base generation and editing tests,
 - 4) Data link tests,

- 5) Display building tests,
- 6) Input/output point operation tests,
- 7) System security compliance, and
- 8) ^{A20}Use of diagnostics modem or equivalent device.^{A20}

16. **Temperature Tests:** Shall be run as required to verify manufacturer published data.
17. **Calendar Date Tests:** Shall be performed as required to demonstrate compliance with the requirements of date / time stamp contained in this specification.
18. **Other Tests:** All applicable unspecified but furnished system features shall be tested or simulated, as feasible.

D. Factory Quality Control Tests (FQCT):

1. FQCT shall meet the MFQP requirements of Section 01 40 00 (*Quality Requirements*), Subparagraph 1.09 H.4.
2. The manufacturer(s) shall perform the standard quality control tests for all furnished items. The items shall have successfully passed the manufacturer's quality control (QC) tests.
3. ^{A20}The factory test equipment and methods shall conform to the applicable requirements of ANSI, EIA, IEEE, ISO, FCC, NEMA, NFPA, and UL standards.^{A20}
4. ^{A19}All printed circuit boards shall have successfully passed a suitable long burn in period, prior to conducting any FIT or FFIT inspections and tests.^{A19}
5. For all applicable digital devices, the manufacturer shall perform static and dynamic software quality assurance (SQA) tests.
6. The manufacturer shall run SQA tests to determine whether all input data produces correct and meaningful results.
7. Tests shall monitor program activity and possible "hot spots" in order to determine if software performance optimization is required.
8. ^{A20}Unless otherwise recommended by the Contractor and reviewed by the Employer Representative, all SQA tests shall meet the applicable requirements of IEEE 754, 1008, and 12207.0.^{A20}

- E. ^{A17}Tests on Completion:** The following applies to all related Sections that require tests on completion called Final Field Inspection Tests (FFIT):^{A17}

1. ^{A16}After preliminary (pre-functional) testing, the Contractor shall perform FFIT, including system activation, testing, and performance verification in accordance with Sections 01 40 00 (*Quality Requirements*) and 01 91 00 (*Commissioning and Testing*), as well as all tests conducted during FIT. ^{A16}
 2. Dynamic system exerciser shall be run again to verify that the hardware works as an integrated system.
 3. Hardware diagnostic tests shall also be run again to assure that each piece of equipment has survived shipment and installation without damage.
 4. Testing shall further demonstrate all device and equipment functions, as well as calendar date and time compliance. ^{A16}Field tests shall be made before issuance of the Taking-Over Certificate for the whole of the Works, provided that the following conditions are met: ^{A16}
 - a. The Contractor installation supervisor(s) shall verify the correctness of the entire installation,
 - b. The Employer's Representative is satisfied that the Contractor has fulfilled all Contract requirements, and
 - c. The system is complete, fully functional, stable, and ready for normal operation.
 5. The Contractor shall furnish materials, equipment, instruments, and trained personnel required for the tests. Fourteen (14) days before the tests, the Contractor shall provide a list of all the test equipment he proposes to use during the tests and shall show proof of recent calibration (not older than 12 months).
 6. The systems shall be demonstrated to operate in accordance with the requirements of these specifications and the manufacturer's specifications. ^{A16}Should there be any parts of FFIT procedures that fail, the Contractor shall correct the causes of failure and repeat the corresponding procedures to demonstrate the above requirements. ^{A16} ^{A17}Refer to Sub-Clause 9.2 of the Conditions of Contract for possible retries. ^{A17}
 7. Service personnel shall be an engineer or technician qualified and experienced in the inspection, testing, installation, and maintenance of the system. Such personnel shall conduct and perform final field inspection tests in the presence of the Employer's Representative or his authorized representative(s), as well as personnel from the Employer. The duration for ^{A9}FFIT^{A9} shall be as long as required.
- F. **Training Services:** The following shall apply whenever training services are specified in the particular Sections.

1. **Course Details:**
 - a. The Contractor shall furnish training course schedule(s) and outline(s) for the review by the Employer's Representative.
 - b. During the design process the Contractor shall revise the schedules and outlines and include complete details on the contents and duration of each applicable course.
 - c. Courses by the manufacturer or one of its authorized training partners shall include, but not be limited to:
 - 1) Theory of operation
 - 2) Recommended maintenance practices
 - 3) The use of any specialized maintenance and diagnostics tools and test equipment.
 - 4) Installation and troubleshooting block diagrams
2. ^{A16}**Documentation:** The Contractor shall provide adequate, non-returnable manuals to each one of the Employer trainees, in accordance with Section 01 78 23 (*Operations Data*). ^{A16}
 - a. The Contractor shall include for all training materials to be supplied to each student for each training course. The Contractor shall also provide two sets of soft copies of each training course to the Employer for the Employer's Training Department to conduct future training courses.
 - b. Unless otherwise specified, the Contractor shall assume that approximately 10 members of the Employer's staff, consisting of future training instructors and engineering evaluation staff, shall attend each training course. It shall be the responsibility of the engineering evaluation staff to evaluate the future training courses conducted by the Employer's instructors.
 - c. A third party may be subcontracted for training purposes only if the Employer is not required to sign a separate contract. In addition the third-party shall be have full knowledge of the course(s) and provide qualified instructors.
3. **Instructor(s) Qualifications:** The instructors shall be competent engineers or technicians certified, experienced, expert, and trained in the specified training services. Instructors shall be fluent in spoken and written English or Spanish.
4. **Language:** The course manuals shall be written in English. All course sessions shall be conducted in English or Spanish.
5. **Location:**

- a. ^{A17}Training ^{A17}courses shall, as far as is practical, be conducted in Panama at locations to be determined by the Employer's Representative.
- b. ^{A17}Should ^{A17}training courses be conducted in the manufacturer's plant(s) or training center(s), these shall be conducted in a laboratory environment and include hands-on experience and practice.

G. Warranty:

1. ^{A17}**General:** Warranty beyond Defects Notification Period ^{A17} ^{A16}shall be in accordance with Section 01 78 23 (*Operations Data*) ^{A16}.
2. **Date Stamp Defects:** Should any defect related to date stamp malfunction be found at any time during the first ten (10) years after issuance of ^{A17}Taking-Over Certificate, ^{A17} the Contractor or manufacturer shall promptly make available the corresponding hardware upgrades, labor, materials, and software patches at no extra cost to the Employer.

^{A10}H. **Test Equipment:** Shall be as recommended by system manufacturers and shall be within their respective certified calibration periods. ^{A10}

^{A17}I. **Tests After Completion:**

1. The Employer has the right to repeat FFIT procedures partly or completely in accordance with Sub-Clause 12.1 of the Conditions of Contract.
2. Consequences of failure are set out in Sub-Clause 12.4 of the Conditions of Contract.

J. Technical Support Levels: Shall be as follows:

1. **Level 1 Technical Support:** Technical support by trained Employer personnel, performed locally.
2. **Level 2 Technical Support:** Technical support by trained personnel from the corresponding manufacturer's Partner, performed locally.
3. **Level 3 Technical Support:** Technical support by trained manufacturer personnel, performed locally or remotely. ^{A17}

END OF SECTION

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