



# **DESIGN STANDARDS MANUAL**

## **FOR**

### **WATER, WASTEWATER, AND RECLAIMED WATER SYSTEMS**

**Produced by**

**EPWU Core Committee on Design Standards**

**August 25, 2008**

**Second Edition March 1, 2016**

**El Paso Water Utilities  
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## FORWARD

This Design Standards Manual (DSM) provides guidelines for the design of various water, wastewater, and reclaimed water facilities and related appurtenances within the City of El Paso and its Extraterritorial Jurisdiction (ETJ). It is intended for Consulting Engineers, Construction Contractors, Developers, and design personnel involved in planning, construction, and delivery of Utility public works infrastructure. Design concepts and specific technical data are presented herein but are not intended to supercede sound engineering judgment. Design standards shall be carefully applied and complement current City Code and legal requirements of other applicable governing jurisdictions.

This DSM and its provisions are effective August 25, 2008. For projects already designed under previous standards and during this transition period, our Engineering Section Managers may grant variances on a project by project basis.

The DSM standards have been bound in a loose-leaf format to facilitate updates in requirements and technical standards when necessary. Updates will be authorized by the Vice-President of Operations and Technical Services or his assign. The Technical Services Division will maintain a list of registered holders of this Manual. It is pertinent that holders be registered to obtain future updates to the manual.

A complementary "Utility Standard Details" manual has been completed and its drawing details will be made available on the Utility's website shortly. Users of this DSM are encouraged to submit comments or recommend changes or additions to these standards for review and possible update by the core committee.

Special thanks go to reviewers and contributors of this manual:

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Design Standards Manual for Water,  
Wastewater, and Reclaimed Water Systems

First Edition

August 25, 2008

Second Edition

March 1, 2016

El Paso Water Utilities

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# Table of Contents

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## **PART 1 – GENERAL DESIGN STANDARDS AND GUIDELINES**

	<b>Page No.</b>
<b>CHAPTER 1 General Requirements .....</b>	<b>1</b>
1.1 Purpose and Use of Manual .....	1
1.2 Review and Acceptance Procedures .....	2
1.3 Safety .....	4
1.4 QA/QC Guidelines .....	4
1.5 Community Notification and Involvement .....	5
<b>CHAPTER 2 Design Development .....</b>	<b>6</b>
2.1 Pre-Design Planning Phase .....	6
2.2 Design and Bid Phase .....	6
2.3 Construction Phase .....	6
2.4 Project Deliverables .....	7
2.5 Schedules and Progress Monitoring .....	12
2.6 Value Engineering .....	13
<b>CHAPTER 3 Right-of-Way and Surveying Requirements .....</b>	<b>14</b>
3.1 General Right-of-Way Requirements .....	14
3.2 Survey Requirements .....	14
3.3 Survey Datums .....	15
3.4 Survey Map Deliverables .....	15
3.5 GIS Coordination .....	17
<b>CHAPTER 4 Utility Locations .....</b>	<b>18</b>
4.1 General .....	18
4.2 Locations .....	18
4.3 Alternate Locations for Extensions .....	19
4.4 Separation of Utility Mains .....	19
<b>CHAPTER 5 Coordination with Public Agencies and Other Utilities .....</b>	<b>20</b>
5.1 Agencies .....	20
5.2 Utilities .....	21
5.3 Commerce and Interstate Transportation .....	22
5.4 Other Entities .....	22
<b>CHAPTER 6 Environmental Permitting and Compliance .....</b>	<b>23</b>
6.1 Environmental Compliance .....	23
6.2 Archeological Coordination .....	23
6.3 Stormwater TPDES Requirements .....	24
6.4 Noise Control .....	26
6.5 Dust Control .....	26
6.6 Air Permits .....	26
<b>CHAPTER 7 Cost Estimating .....</b>	<b>27</b>
7.1 Introduction .....	27
7.2 Definition and Types of Cost Estimates .....	27
7.3 Basis of Cost Estimate .....	29
7.4 Cost Estimate Reports .....	29
7.5 Life Cycle Costs .....	30

# Table of Contents

	<u>Page No.</u>
<b>CHAPTER 8 Geotechnical .....</b>	<b>32</b>
8.1 Investigation Requirements .....	32
8.2 Investigation Criteria .....	32
8.3 Laboratory Testing .....	33
8.4 Site Restoration .....	33
8.5 Geotechnical Report .....	34
 <b>PART 2 – FACILITY DESIGN STANDARDS AND GUIDELINES</b>	
<b>CHAPTER 9 Facility Support Provisions .....</b>	<b>35</b>
9.1 General .....	35
9.2 Security/Safety .....	35
9.3 Project Signage .....	35
9.4 Traffic Control .....	36
9.5 Dewatering .....	36
9.6 Testing and Disinfection .....	37
<b>CHAPTER 10 Site Work .....</b>	<b>38</b>
10.1 Earthwork and Grading .....	38
10.2 Landscaping .....	38
10.3 Demolition .....	38
10.4 Fencing and Rock Walls .....	39
<b>CHAPTER 11 Trench Width, Bedding and Backfill .....</b>	<b>40</b>
11.1 General .....	40
11.2 Trench Width .....	40
11.3 Embedment Class Material .....	41
11.4 Compaction Requirements .....	41
11.5 Surface Restoration .....	41
<b>CHAPTER 12 Water Distribution / Transmission Systems .....</b>	<b>44</b>
12.1 General .....	44
12.2 Water Main Classification by Function and Size .....	44
12.3 Design Parameters .....	44
12.4 Pipe Material Type .....	47
12.5 Pipe Material Selection .....	56
12.6 Standard Cover .....	58
12.7 Fittings and Valves .....	58
12.8 Thrust Restraints .....	59
12.9 Fire Hydrants .....	60
12.10 Water Service Connections .....	61
12.11 Tapping Sleeves and Valves .....	62
<b>CHAPTER 13 Water Storage Facilities .....</b>	<b>63</b>
13.1 General .....	63
13.2 Codes and Standards .....	63
13.3 Site Design Guidelines .....	64
13.4 General Design Components .....	66
13.5 Steel Tanks .....	68
13.6 Reinforced Concrete Tanks .....	69
13.7 Instrumentation and Control Guidelines .....	70

# Table of Contents

	<u>Page No.</u>
<b>CHAPTER 14 Water Pumping Stations .....</b>	<b>73</b>
14.1 General .....	73
14.2 Codes and Standards .....	73
14.3 Hydraulics and Piping .....	74
14.4 Selection of Pumps .....	75
14.5 Pump Station / Equipment Layout .....	79
14.6 Pump Inlet Configuration and Piping Layout .....	80
14.7 Transient Surge Analysis and Surge Control .....	81
14.8 Valves .....	84
14.9 Station Support Systems .....	84
14.10 Instrumentation and Controls .....	85
14.11 Other Issues .....	85
<b>CHAPTER 15 Wastewater Collection Systems .....</b>	<b>86</b>
15.1 General .....	86
15.2 Sewer Main Classification by Function and Size .....	86
15.3 Basic Design Requirements .....	87
15.4 Design Parameters .....	88
15.5 Pipe Material Type .....	96
15.6 Pipe Material Selection .....	97
15.7 Manholes .....	98
15.8 Inverted Siphons .....	101
15.9 Sewer Service Connections .....	101
<b>CHAPTER 16 Wastewater Pumping Stations .....</b>	<b>102</b>
16.1 General .....	102
16.2 Codes and Standards .....	103
16.3 Design Features .....	103
16.4 Site Design and Layout .....	105
16.5 Force Main Lines .....	110
16.6 Station Classification .....	111
16.7 Other .....	112
<b>CHAPTER 17 Reclaimed Water Facilities .....</b>	<b>113</b>
17.1 General .....	113
17.2 Reclaimed Main Classification by Function and Size .....	113
17.3 Design Parameters .....	114
17.4 Pipe Material Type .....	115
17.5 Pipe Material Selection .....	116
17.6 Standard Cover .....	117
17.7 Fittings and Valves .....	117
17.8 Service Connections .....	118
17.9 Other .....	118
<b>CHAPTER 18 Trenchless Construction .....</b>	<b>121</b>
18.1 General .....	121
18.2 Trenchless Technologies Types .....	121
18.3 Selection of Renewal Method .....	123
18.4 Casings and Tunnel Liners .....	123

# Table of Contents

	<u>Page No.</u>
<b>CHAPTER 19 Corrosion Control of Piping and Storage Systems.....</b>	<b>125</b>
19.1 General .....	125
19.2 Standard Types of Protection .....	125
19.3 Standard Protection for Various Pipe Material .....	126
19.4 Joint Bonding .....	127
19.5 Standard Cathodic Protection Testing .....	127
19.6 Standard Protection for Storage Systems .....	128
<b>CHAPTER 20 Electrical Design Standards .....</b>	<b>130</b>
20.1 General .....	130
20.2 Definitions .....	130
20.3 Codes and Standards .....	131
20.4 Design Intent, Studies and Calculations .....	132
20.5 Safety .....	135
20.6 Drawings .....	136
20.7 Specifications .....	137
20.8 Document Sealing and Permitting .....	137
20.9 General Requirements .....	138
20.10 Electric Utility and Service .....	139
20.11 Grounding and Bonding .....	140
20.12 Lightning and Surge Protection .....	141
20.13 Power Distribution .....	143
20.14 Switchgear .....	144
20.15 Switchboards and Panelboards .....	144
20.16 Motor Control Centers .....	146
20.17 Motor Controllers .....	146
20.18 Motors .....	149
20.19 Transformers .....	150
20.20 Generators .....	151
20.21 Other equipment .....	154
20.22 Lighting .....	154
20.23 Raceways and Fittings .....	156
20.24 Conductors and Cables .....	157
20.25 Electrical Devices .....	158
20.26 Identification and Labels .....	159
20.27 Testing .....	160
20.28 O&M Manuals .....	161
20.29 Record Drawings .....	162
<b>CHAPTER 21 Telemetry / Control .....</b>	<b>164</b>
21.1 Purpose .....	164
21.2 Description of Telemetry/Control System .....	164
21.3 Design Requirements .....	166

## **PART 3 – APPENDICES**

<b>APPENDIX A</b>	List of References, Standards, and Codes .....	A-1
<b>APPENDIX B</b>	List of Abbreviations .....	B-1
<b>APPENDIX C</b>	Definitions and Terminology .....	C-1
<b>APPENDIX D</b>	EPWU Design and Plan Checklists .....	D-1

# Table of Contents

---

<b>APPENDIX E</b>	TCEQ Requirements and Checklists.....	E-1
<b>APPENDIX F</b>	Easement Policy.....	F-1
<b>APPENDIX G</b>	Recurring (Cyclic) Surge – Figures and Design Example .....	G-1
<b>APPENDIX H</b>	Working-Pressure Rating Example .....	H-1
<b>APPENDIX I</b>	Approved Materials Reference List .....	I-1



# Table of Tables

<b>Table 2-1</b>	Summary of Submittal Packages .....	7
<b>Table 4-1</b>	Pipeline Location within New Right-of-Ways .....	18
<b>Table 7-1</b>	Cost Estimate Types .....	28
<b>Table 11-1</b>	Description of Embedment Material Classifications .....	42
<b>Table 11-2</b>	Standard Bedding Class Schedule .....	43
<b>Table 12-1</b>	Required Fire Flows .....	45
<b>Table 12-2</b>	Allowable Maximum Occasional Surge Pressure Capacity .....	49
<b>Table 12-3</b>	Temperature Coefficients Ft .....	49
<b>Table 12-4</b>	Transmission and Distribution-pipe Pressure Rating .....	50
<b>Table 12-5</b>	Pressure Surges in 8-inch Water Main Due To 2 fps Flow Velocity Change .....	52
<b>Table 12-6</b>	Design Table for PVC Pipe – Pressure Surge vs. Dimension Ratio .....	53
<b>Table 12-7</b>	Water System Allowable Materials and Pipe Class .....	57
<b>Table 12-8</b>	Standard Cover for Water Mains .....	58
<b>Table 12-9</b>	Valve Spacing .....	59
<b>Table 15-1</b>	Acceptable Grades for Gravity Sanitary Sewer Lines .....	88
<b>Table 15-2</b>	Residential Population Density Factors .....	91
<b>Table 15-2A</b>	Retirement Community General Mixed Use Density Factors .....	91
<b>Table 15-2B</b>	General Mixed Use Density Factors .....	91
<b>Table 15-3</b>	Average Unit Flows .....	93
<b>Table 15-4</b>	Gravity Sewer System – Allowable Materials .....	97
<b>Table 15-5</b>	Manhole Type and Applications .....	100
<b>Table 15-6</b>	Maximum Manhole Spacing .....	100
<b>Table 16-1</b>	Pump Capacities for Minimum Force Main Velocities .....	111
<b>Table 17-1</b>	Reclaimed Water System Allowable Materials and Pipe Class .....	116

# Table of Figures

---

<b>Figure 1</b>	Above Ground Storage Tank Pressure Transducer Weatherproof Enclosure .....	71
<b>Figure 2</b>	Surge Anticipator Valve Cover .....	83
<b>Figure 3</b>	Standard One-Line Diagram.....	134

# CHAPTER 1

## GENERAL REQUIREMENTS

### 1.1 PURPOSE AND USE OF MANUAL

- A. The purpose of this Design Standards Manual is to establish uniformity and consistency in engineered water and wastewater facility designs. The information contained herein is to assist the Engineer in the planning and design of Utility infrastructure, and in the preparation of all construction plans and documents for the El Paso Water Utilities (EPWU). Deviations from these standards and guidelines shall only be under unusual circumstances, special conditions that may arise to job specific requirements, and shall require the approval of the Utility.
- B. The term “Utility”, where used in this manual, shall denote El Paso Water Utilities under the authority and direction of its President/CEO, under the recommendations of the EPWU Core Committee on Design Standards.
- C. The manual emphasizes contemporary and common design practices which have worked well for past Utility projects and emphasizes requirements and standards acceptable to EPWU.
- D. The manual is not intended to replace codes and/or regulatory requirements, nor supersede sound engineering judgment.
- E. The manual includes and is divided into the following three (3) parts:
  - Part 1 – General Guidelines and Requirements consisting of Chapters 1 through 8, provides general guidelines and requirements that are applicable to a range of design projects.
  - Part 2 – Facility Design Requirements consisting of Chapters 9 through 21, provides more specific design requirements for typical water, sewer, and reclaim water infrastructure, including water distribution and wastewater collection systems, pumping stations, storage facilities, corrosion control, and electrical standards. Treatment Plant process design, well production, and stormwater facilities are not covered in this manual.
  - Part 3 – Appendices
- F. CADD Details – “Utility Standard Details” are referenced in this manual relating to design standards. These drawing details are revised and updated periodically and are available in hardcopy individual sheets upon request; otherwise, the full set will be available on the Utility's website following the issuance date of this edition of the manual. For questions or requests, contact the Utility's Technical Services Division at 594-5526.
- G. The Utility has developed a Procedures Manual (available to contracted personnel) as a tool for use by Engineering and Administrative support personnel involved in the planning, design and construction management of infrastructure projects for the Utility. This manual is a procedural document that outlines the approach to be used in conducting business with respect to the execution and completion of a project. The Procedures Manual should be used conjunctively with this Design Standards Manual

during the design effort. Components of the manual can be viewed in the Utility's website:

[http://www.epwu.org/project\\_management/projectmgmt.html](http://www.epwu.org/project_management/projectmgmt.html)

- H. To ensure that these standards and guidelines remain current, reference to governing standards, rules and regulations, or any similar information, shall be to the most recent issue, addendum, or revision of the particular document referenced.
- I. The Engineer shall utilize in his designs the most current technological advances in the industry, standards, codes, and regulations. The most economical and beneficial alternative solutions which may differ from the guidelines and standards of this manual shall be considered. Alternative approaches and deviations from the requirements of this manual shall be reviewed and approved by the Utility prior to implementation.
- J. These standards and guidelines are not all inclusive. Errors and omissions in these standards and guidelines do not relieve the Engineer of the responsibility to adhere to sound engineering practice and applicable codes, standards and regulations.
- K. For some projects, a Scope of Work may be developed to define project specific tasks, guidelines, and criteria. In some instances, minimal conflicts between the Scope of Work and the Standards Manual may exist. The Engineer to the best of their ability shall immediately identify such inconsistencies to the Utility.

## **1.2 REVIEW AND ACCEPTANCE PROCEDURES**

- A. El Paso Water Utilities engineering and operations personnel bear the authority to review, modify, accept, or reject any design of facilities for which the Utility will ultimately take ownership into its water, wastewater, or reclaimed water systems. Concurrence from the Utility is required as to the location, materials and equipment, and standards for construction of Utility infrastructure, main extensions, and related improvements.
- B. Design drawings and associated documents shall be reviewed at designated intervals by the Project Team consisting of the design engineer, the utility's Project Engineer Manager, and other designated Operations or Engineering personnel knowledgeable and responsible for the maintenance and operation of the constructed product in each respective discipline. The Chief Technical Officer and the Chief Operations Officer will provide technical review oversight and feedback as appropriate. The Purchasing Contracts Manager is responsible for QA review and ensuring the integrity of the Utility's Standard Front-end documents. The review process and acceptance of project designs shall generally follow the procedures set in Chapter 2 of these standards.
- C. Acceptance of a project by the Utility, contingent upon meeting the following criteria:
  - 1. The design and construction drawings are:
    - Prepared using sound engineering practices
    - In compliance with EPWU design criteria
    - Signed and sealed by a licensed Texas professional engineer
    - Reviewed and approved by EPWU
    - Reviewed and approved by the Texas Commission on Environmental Quality (TCEQ), if applicable
  - 2. All land acquisition issues have been resolved.
  - 3. The project is in compliance with local, state, and federal regulations.

4. All applicable local, state, and federal permits and approvals are obtained prior to construction.
  5. The project is constructed in accordance with the sealed and approved construction drawings and specifications, good construction practices, and applicable local, state, and federal permits and approvals.
  6. The construction was observed by a qualified employee under the supervision of a licensed Texas professional engineer
  7. Record drawings are submitted and the project passes a final inspection by the Engineer and EPWU. Record drawings shall contain a designation denoting Record Drawings reflecting revisions to original design drawings. The Engineer may include a qualifier statement that select changes are not certified by the engineer of record and the seal makes no representation of the accuracy or validity of those changes made by others for which the engineer had no control of.
- D. Designs involving new subdivision development areas shall be reviewed by the Engineering Development Section Manager and the Engineering Division Manager. Acceptance of Subdivision utility designs prepared by external engineering firms shall be coordinated between senior level field personnel and the Engineering Development Section Manager.
- E. The Utility's review, approval, or recommended revisions to third party designs (private developments) shall be intended as limited approval for general conformance to Utility design practices, and not to encompass other approvals required from other jurisdictional agencies. Third party design firms shall bear the responsibility for obtaining final permit approval from governmental agencies and other affected parties, for utility designs made in conjunction with new or existing developments. In such cases, the Utility's concurrence shall not be construed to overstep or supersede such agency approvals.
- F. Variances in designs and review/acceptance procedures shall be brought to the attention of EPWU engineering management staff, for concurrence or alternate action prior to finalizing and execution of designs. Variances shall be documented in the Basis of Design Report, or other similar technical memorandum. The variance request should include the following:
1. Specific criteria or guideline for which variance is requested
  2. Reason for requesting the variance
  3. Explanation as to how the criteria/guideline will be satisfied, or why the criteria is not applicable
  4. Appropriate supporting information
- G. Approval from the Utility is required for the location, design, materials, and standards of construction regarding water, wastewater, and reclaimed water system extensions or upgrades.
- H. Title to all Utility facilities shall remain in the El Paso Water Utilities, City of El Paso, Texas, acting by and through its Public Service Board (PSB) upon completion of such facilities and upon acceptance and incorporation of such facilities into the operating system (extracted from the El Paso Water Utilities-Public Service Board Rules and

Regulations). Current EPWU-PSB Rules and Regulations may be found on EPWU's website at [www.epwu.org](http://www.epwu.org).

### **1.3 SAFETY**

Job safety throughout the project is of the utmost importance and an absolute requirement for each phase of the project. Projects shall be designed with the interest of safety in mind for the construction phase and for operations and maintenance personnel once beneficial occupancy is obtained by EPWU. It is the Utility's policy to follow all applicable codes and standards, including but not limited to the latest published editions of the International Building Code (IBC), the National Fire Protection Association (NFPA) Codes and Standards, Texas Administrative Codes and Regulations, National Electric Code (NEC), City of El Paso Municipal Code, and Occupational Safety and Health Administration (OSHA).

### **1.4 QA/QC GUIDELINES**

- A. All personnel involved in Utility infrastructure design shall exercise due diligence in ensuring quality work. A Quality Assurance program shall be established which emphasizes a team approach to quality control of design work product by each responsible discipline. It is crucial that qualified, experienced personnel directly design or otherwise supervise all work involved in the design development phase.
- B. Quality assurance shall be provided to the Project by meeting the following minimum criteria:
  - 1. Surveying and platting are accomplished under the direction of a Professional Land Surveyor.
  - 2. Recording documents are sealed, signed, and dated by a Professional Land Surveyor.
  - 3. Calculations are prepared by or under the direct supervision of a Professional Engineer trained and licensed in disciplines required by the project scope.
  - 4. Final design drawings are sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.
- C. Elements of the quality control program shall generally consist of the following to assure a complete and functional design project:
  - 1. Calculation checks during the design
  - 2. Use of checklists and review forms
  - 3. Review matrices of assigned responsibility
  - 4. Drawings and specifications checked for completeness, technical accuracy, code compliance, and compatibility between specifications and drawings
  - 5. Validation and verification of computer modeling results
  - 6. Inter- and intra-discipline reviews

7. Constructability of drawings and specifications
  8. Document control
  9. Appropriate allowance for review time in project schedule
- D. Design checklists shall be incorporated by the design team as a quality control measure. Example design checklists are found in Appendix D. The Procedures Manual (re: 1.1G) also includes a review checklist (PM Form 7800) for use in the preparation of bid documents, a copy of which is included in Appendix D.

## **1.5 COMMUNITY NOTIFICATION AND INVOLVEMENT**

EPWU is committed to early citizen notification and involvement. The goal of identifying neighborhood concerns has a high priority. Communication through printed notice, media relations, a public information contact phone number, and public presentations can be essential elements in the sequencing and scheduling of design plan approval and construction work.

Engineer shall coordinate with EPWU Project Engineering Manager to follow the project specific public outreach plan developed.

END OF CHAPTER

## CHAPTER 2

### DESIGN DEVELOPMENT

#### 2.1 PRE-DESIGN PLANNING PHASE

Prior to commencement of actual design of a project, a Preliminary Engineering Report may be required to outline general requirements for funding applications, feasibility of constructing the project, performing model or prototype programs to define project alternatives, and to lay out economic and environmental considerations requiring advance decision-making prior to commencing design of the project. Such pre-design reports (PER) may include:

- As Assessment of existing conditions
- A Determination of Future Requirements
- The Identification of Major Alternatives (including Facility Sites, Alignments, Configurations, Processes, Materials and Construction Methods)
- Benefit/Cost Analysis

#### 2.2 DESIGN AND BID PHASE

The Engineer's areas of responsibility from the design phase through the bid phase may be as follows depending on the defined scope of work (*specific deliverables and item lists for documents shown below are described in the Utility's Procedures Manual*):

- Prepare Basis of Design Report (BDR)
- Prepare Design Construction Documents
- Obtain Approval of Plan Checks
- Prepare Owner Procurement Documents
- Prepare Construction Cost Estimates
- Complete QA/QC Reviews
- Assist in Value Engineering Review
- Assist in Program Scheduling
- Prepare Permit Applications
- Provide Planning /Environmental Assistance
- Assist in Land Acquisition, Permits, and Right-of-Way
- Assist in Public Information Program
- Implement Equal Opportunity Compliance Program
- Request Deviations
- Manage Claims Avoidance
- Schedule and conduct Pre-Bid Conference
- Prepare and issue Addenda to Design Construction Documents as Required
- Attend Bid Opening, Evaluate Bids, and Submit Recommendation of Award.

#### 2.3 CONSTRUCTION PHASE

Construction Phase Services and responsibilities shall be defined no later than 95 percent design stage, and the scope of said services and responsibilities shall be negotiated prior to the Notice to Proceed issuance to the Contractor. These responsibilities are defined in the Procedures Manual for Administering and Managing Engineering and Construction Projects.



## 2.4 PROJECT DELIVERABLES

These Guidelines establish the Engineer's deliverable milestones, define the contents of each deliverable package and describe the reviews to be conducted by the Utility during preparation of construction drawings and specifications for the proposed facilities.

- A. Submittal Packages: A list of submittal packages and reviews conducted for each project is indicated in Table 2-1 below:

<b>TABLE 2-1 SUMMARY OF SUBMITTAL PACKAGES</b>		
<b>Submittal Package</b>	<b>Review Technique by Engineer</b>	<b>Review Technique by EPWU</b>
Basis of Design Report (BDR)	Intradisciplinary Progress Review	Intradisciplinary Progress Review
30% Design Complete	Intradisciplinary Progress Review	Operations & Maintenance Review; Intradisciplinary Progress Review
60% Design Complete	Intradisciplinary & Interdisciplinary Progress Review	Operations & Maintenance Review; Intradisciplinary Progress Review
95% Design Complete	Intradisciplinary & Interdisciplinary Progress Review; Peer Review	Biddability/Constructability Review; Operations & Maintenance Review; Intradisciplinary Progress Review
100% Design Complete	Final Review	Final Review

- B. Initial Project Scope: Design of facilities is based on the scope of work as defined and agreed to by the Utility.
- C. Deviations From Initial Scope of Work: Occasions may arise when the Engineer desires to deviate from the project scope of work. Procedures for addressing deviations are addressed in the Procedures Manual.
- D. Submittal Guidelines: The Engineer shall submit progress submittals or milestone deliverables as per contract agreement or as described in the Procedures Manual.

The following sections provide more specific information pertaining to each of the deliverables listed in Table 2-1.

### 2.4.1 Basis of Design Report:

- A. The Basis of Design Report (BDR) provides concise, definitive descriptions of the alternatives evaluated and the facilities recommended for detailed design. The BDR is typically distributed to Utility management, design staff, and operations and maintenance staff as a convenient guide for review, coordination, and reference. In addition, the BDR establishes a baseline document for discussion between disciplines. It typically includes the following:
- Presentation of design criteria

- Summary descriptions of major systems
- Preliminary Drawings
- Supporting Information
- Expanded Description of the recommended design
- Critical Processes
- Materials of Construction
- Key Design Features
- Volumes or Flow Rate Pressure Needs or Constraints
- Facility Arrangements
- Right-of-way Needs
- Outstanding Technical Issues Requiring Further Resolution
- Define requirements for ancillary facilities
- Establish space and support requirements
- Define architectural concepts
- Assessment of existing conditions
- Determination of future requirements
- Identification of major alternatives (including facility sites, alignments, configurations, processes, materials and construction methods)
- Preliminary Cost Estimates

B. The BDR serves the following specific purposes:

1. *Technical Guide for Conducting Final Design.* The BDR provides the basic outline of plans for each design discipline (process, civil, general mechanical systems, structural, electrical, instrumentation and control, and architectural). Because it presents preliminary information on all aspects of the design, it serves as a technical guide for completing the final design.
2. *Document for Review.* The draft BDR provides a document for formal in-house review by the Engineer and the Utility. Changes resulting from these reviews are incorporated into the final BDR which, upon approval by the Utility, becomes the basis for preparing the detailed design documents. The final BDR is used as a baseline for defining scope changes.

C. A BDR shall be prepared in substantial accordance with the following suggested Table of Contents format:

1. Executive Summary
2. Purpose and Scope of Work
3. Project Identification
4. Design Criteria in Various Disciplines
5. Field Investigations
6. Alternatives Analysis
7. Hydraulic Analysis
8. Right of Way and Property Acquisition
9. Summary and Recommendations

10. Construction Considerations/Other Issues
11. Preliminary Cost Estimate
12. Appendices

#### **2.4.2 30% Design Submittal Package**

The 30% design submittal package may include the following items:

1. Comments from BDR review incorporated
2. All reviewed calculations completed to date
3. Hydraulic calculations, complete and reviewed
4. Tentative list of construction contract drawings
5. Table of contents for specifications
6. List of Special Conditions
7. Process control strategies complete
8. Geotechnical Report
9. Cost Estimate at 30% completion level
10. Civil Drawings:
  - Existing utilities plotted; existing facility horizontal controls and elevations confirmed with current survey
  - Plan view on all plan and profile drawings with existing utilities, structures, and roadways
  - All major system structures located
  - Preliminary drawings including site layout, yard piping, and major grading elements
11. Architectural Drawings:
  - Preliminary architectural design completed and ready for approval. Show floor plans, exterior elevations, and roof plans of buildings.
12. Structural Drawings:
  - Layout for structural design established
  - The main structural system and detailed design approach for each structural component established
  - Layout plan drawings started

13. Mechanical Drawings:

- General arrangement layout of major equipment completed
- All major equipment, pipe sizes, work clearances, equipment spacing, and access shown
- System flow diagrams complete

14. Electrical Drawings:

- Preliminary single-line diagrams of major distribution systems and of motor control centers prepared
- Preliminary site layouts showing locations of switchgear and main motor control centers prepared
- Partial equipment control schematic diagrams started
- Preliminary Load Analysis

15. Preliminary Instrumentation and Process Diagrams (P&ID) depicting:

- General instrumentation and control philosophy
- Tentative primary and secondary control and monitoring devices (elements, transmitters)
- Tentative instrumentation (primary, secondary, panel and computers) shown but not tagged

### 2.4.3 60% Design Submittal Package

The design submittal package may include the following items and shall be completed at a 60% completion level:

1. Comments from all 30% design submittal reviews incorporated or exceptions taken or a written explanation as to why comments were not incorporated.
2. All calculations completed, reviewed, and bound
3. Complete list of construction contract drawings
4. Complete guide specifications set including drafts of Engineer's development sections
5. Initial Draft of Special Conditions
6. Process control strategies complete
7. Geotechnical report
8. Cost estimate
9. Preliminary construction schedules
10. Civil Drawings:
  - Cover sheet and legends complete
  - Grading Plans and demolition plans Plan and profile sheets
  - Sections and details
  - Traffic Control Plans partially complete (if required)

- Typical details
11. Landscape Drawings:
    - Planning plans partially complete
  12. Architectural Drawings:
    - Floor, roof and reflected ceiling plans
    - Elevations and sections
    - Door, window and finish schedule
  13. Structural Drawings:
    - Foundation plans
    - Other plans and sections and details
  14. Mechanical Drawings:
    - General arrangement drawings
    - Sections and details
    - Schedules
  15. Electrical Drawings:
    - Power block diagrams, single-line diagrams and motor control diagrams
    - Power and control layouts completely laid out, partially wired, if possible
    - Panel, duct-bank, pull box, and cable/conduit panel schedules
    - Electrical equipment elevations
    - Lighting plans completely laid out, partially wired, if possible
    - Grounding plans
    - Electrical details
  16. Instrumentation:
    - Process/Instrumentation Diagrams complete and tag numbers shown
    - Process control strategies essentially complete and tag numbers included
    - Panel layout drawings and details

#### **2.4.4 95% Design Submittal Package**

1. Comments from all 60% design submittal reviews incorporated and/or otherwise addressed
2. All calculations completed, reviewed and bound
3. Geotechnical Report update
4. Cost estimate at 95% completion level
5. All drawings in all disciplines complete
6. Storm Water Pollution Prevention plan complete

7. Easements secured
8. Coordinate agency permit approvals
9. Evidence that all requirements of the Procedures Manual are met
10. Final construction schedule
11. All specification sections essentially complete. No square brackets or "Notes to Specifiers" remain

Reference shall be made to the Utility's standard form PM7800 95% review checklist found in the Procedures manual and Appendix D of this Manual.

#### **2.4.5 Final Submittal**

The final submittal consists of reproducible copy (translucent bond) of all drawings and specification sections necessary for a complete construction bid package, as well as electronic AutoCad files and a PDF of all drawings. All of the Engineer's in-house review comments, all Utility review comments, and all outstanding issues have been addressed and/or resolved.

#### **2.4.6 Construction Documents**

- A. Construction Documents generated for the Project shall contain sufficient design details as required to complete the Project in accordance with standard industry practices and the EPWU Design Standards and Guidelines.
- B. Design documents should stand on their own without the need to refer to codes or standards to determine the installation required by the Contract Documents.
- C. Construction Documents shall consist of Conformed Documents ensuring that all addenda are being referenced and utilized during construction.
- D. Statements intended to make a contractor meet "applicable code requirements" shall not be used in the Contract Documents. No design or studies shall be required of the Contractor except for the following:
  1. Where necessary, unique hardware is to be furnished within engineered systems;
  2. Items related to Contractor's means and methods of construction (i.e. shoring, dewatering, blasting, etc.)

### **2.5 SCHEDULES AND PROGRESS MONITORING**

- A. Project Schedule must be prepared and updated monthly per the requirements of the Procedures Manual. The Project Schedule will be used to organize and monitor work activities, identify potential bottlenecks, and to assign work responsibilities.
- B. Any delays should be identified as soon as possible, including anticipated and unexpected delays.
- C. Resources should be properly allocated to meet the required schedule.

- D. Use of the Critical Path Method is encouraged where practical.

## **2.6 VALUE ENGINEERING**

- A. Value engineering (VE) studies (also termed Value Analysis or Value-enhanced Design) may be warranted for some Utility projects involving several complex alternative designs or major investments in equipment and materials. The VE study shall not substitute for nor be performed in lieu of a quality assurance/quality control (QA/QC) review (reference Chapter 1).
- B. The VE methodology shall be a function oriented, systematic team approach to balance performance and cost. It shall be used as a management tool to reduce program/acquisition costs, validate the design, and enhance the overall functionality, reliability, and quality of the project.
- C. VE studies shall generally follow the following five basic steps (or other approved variations): Information Phase, Speculation (Creative) Phase, Evaluation (Analysis) Phase, Development Phase, and Presentation Phase.
- D. VE studies shall be conducted by an independent, third party multi-disciplined team of designers, Engineers, and other stakeholders.
- E. Results and recommendations shall be documented in a VE study report. The report shall include cost savings, cost avoidance, project/program improvements, schedule improvements, and other qualitative improvements.
- F. The Engineer may consider that relevant VE proposals by third parties be incorporated into the Design documents, with the approval of the Utility.

In general, modification of the design documents may be incorporated into the construction contract through a change order, except that the VE change should generally result in a minimum of 10% of the value of the construction contract to warrant consideration.

END OF CHAPTER

## CHAPTER 3

### **RIGHT-OF-WAY AND SURVEYING REQUIREMENTS**

#### **3.1 GENERAL RIGHT-OF-WAY REQUIREMENTS**

- A. The Utility requires safe and quick access to all City and County water, wastewater and reclaimed water mains at all times in order to repair mains, install taps and perform preventative maintenance. Therefore, it is the intent of the El Paso Water Utilities to construct Utility Mains and related structures foremost within dedicated public rights-of-way when available, otherwise to obtain legal easements for such construction from private property owners or other entities.
- B. Prior to the construction of Utility Mains in public streets and/or public alleys, such streets and alleys shall be legally dedicated and their subgrades brought to within six (6) inches of the finished grade as approved by the City Engineer.
- C. Utility Mains shall not be constructed in easements except when the Utility specifically requests or authorizes such construction. Design and construction within an easement shall be in accordance with El Paso Water Utilities' "A Policy for Dedication of Easements for Water and Sanitary Sewer Services," as included in Appendix F.
- D. Upon request by the Utility, the Engineer shall provide descriptions of parcel easements or rights-of-way to the Utility for acquisition. Such acquisitions shall be made in accordance with acquisition policies administered by the Utility.

#### **3.2 SURVEY REQUIREMENTS**

- A. Easements and rights-of-way which are not property of the Utility shall be described and recorded through standard surveying methods.
- B. Surveys shall be performed in accordance with the State of Texas Professional Land Surveying Practices Act and General Rules of Procedures and Practices, latest revision.
- C. All field notes and right-of-way map(s) shall be imprinted or embossed with the seal of the responsible Registered Surveyor and shall be dated and signed by the Surveyor.
- D. For acquisition of new or additional rights-of-way:
  - 1. Tie all points of commencing (POCs) or points of beginning (POBs) for each parcel to the City survey monuments, if within 2,000 feet of the parcel. In the event any one parcel in the right-of-way is within 2,000 feet of a City monument, tie all parcels to the monument.
  - 2. Identify all monuments, corners, angle points of curvature (PC), points of intersection (PI), points of tangency (PT), and other points as either "found" or "set". Describe each point such as 3/4-inch iron rod, 3/4-inch iron pipe, concrete marker, disk etc.



3. Locate all improvements, buildings, fences, permanent signs, and other structures within the parcel or within 10 feet of the property line or proposed right-of-way that will influence the value of the parcel to be acquired.
  4. Set iron rods or permanent markers at the intersections of the proposed right-of-way and property lines of all parcels to be acquired.
- E. Set temporary bench marks within 200 feet of the beginning and end of the project and at intervals not to exceed 1,000 feet throughout the project.
- F. Record the center lines and angles of intersections of side streets with the main roadway centerline stationing.
- G. Record all topographic features within the public right-of-way, permanent right-of-way, any contiguous easements to the right-of-way, and any construction right-of-way of the project and on all intersecting streets for a distance of 20 feet beyond the intersection of the right-of-way lines. Identify all underground structures with size, depths, inlet type and depth, manholes, and junction boxes.
- H. Cross sections, where required, shall be taken at intervals of 100 feet.

### **3.3 SURVEY DATUMS**

Horizontal and vertical controls shall be referenced from points established by City of El Paso or Texas Department of Transportation (TXDOT) benchmarks and monuments. Datums assigned to these control points are: North American Datum 1983 (NAD83) for horizontal control and North American Vertical Datum 1988 (NAVD88) for vertical control. Where applicable, establish and include equation stationing or benchmarks in design plans.

### **3.4 SURVEY MAP DELIVERABLES**

- A. Parcel Strip Map – Where various parcels are to be considered in a project, such multiple parcels shall be submitted on a map at a scale (generally 1-inch = 100 feet) sufficient to differentiate the various easements and parcels. Format should be shown on 24-inch x 36-inch sheet as appropriate. Each parcel abutting the project shall be shown and shall indicate proposed and existing dimensioned rights-of-way, easements, ownership, and areas. The following criteria shall apply.
1. Format: 24-inch x 36-inch per Utility standards
  2. Scale: 1-inch = 100-feet
  3. Property addresses and occupants identified
  4. Property owners identified
  5. Existing easements and right-of-way identified
  6. New easements and right-of-way to be acquired identified
  7. Strip Maps shall be prepared with the direction of the Utility

- B. Parcel Exhibits - One exhibit per parcel is required. One exhibit per ownership may be submitted with approval from the Utility's Land Administrator and the Project Engineer Manager.
- C. Parcel Exhibit Maps – Parcel Exhibit Maps are to be prepared on individual sheets and are to include a legend indicating the type of acquisition. The plan shall show the parcel boundary dimensioned to section corners (non-subdivided lots), adjacent right-of-way centerline, any onsite improvements along with all existing and proposed easements and rights-of-way clearly identified and dimensioned. The identified or existing rights-of-way and easements shall include the appropriate county recording information. The following criteria shall apply:
1. Format: 8.5-inch x 11-inch per Utility Standards
  2. Title at lower right identifying the Utility's project, project number, tax parcel number (PID), and owner of the parcel.
  3. North arrow and scale
  4. Section ties
  5. Property addresses and occupants identified
  6. Property owners identified
  7. Existing easements and rights-of-way identified
  8. New easements and rights-of-way to be acquired identified
  9. Individual areas noted
  10. Parcels dimensioned and bearings
- D. Parcel Descriptions (Metes and Bounds) - The individual parcel descriptions for all new easements and/or right-of-ways shall be prepared under the direct supervision of a land surveyor registered in the State of Texas and be sealed by the same. All parcel descriptions shall be typed on separate 8.5-inch x 11-inch formats and shall be consistent with A.P.L.S. standards. Descriptions shall be typed in single space format and double-spaced between its various parts indicated as follows:

Legal Description

- Brief description stating location of parcel, portion of a subdivision, aliquot portion (i.e. the northwest ¼ section.....) of sectional breakdown, city, county, township and range.

Metes and Bounds

- Tie true point of beginning to an established section corner or permanent monument, identifying its character
- Corner to corner bearing and distance of property line
- Identify boundary lines of joiners, citing El Paso County Recorder's numbers and pages

#### Areas of Easement or Right-of-Way

- Stated to nearest square foot and acres to 4 decimal places

### **3.5 GIS COORDINATION**

All surveying for parcels, easements, and rights-of-way to be used for Utility infrastructure shall be compatible with the Utility's Geographical Information System (GIS) format for further data entry into its GIS database.

END OF CHAPTER

## CHAPTER 4

### UTILITY LOCATIONS

#### 4.1 GENERAL

- A. Extension of Utility mains shall originate at nearest adequate Utility Main and shall extend to and along property to be served. Extension must be consistent with system operation and efficiency, as determined by the Utility.
- B. The surrounding area adjacent to any Utility Main shall remain free of any structure unless prior provisions have been made for ready and easy access.
- C. The Engineer shall research and resolve all known conflicts of proposed utilities to the extent possible during design and prior to construction.
- D. For purposes of this chapter and in accordance with established City Subdivision Standards, a “**street**” is defined as the area or width between two generally parallel right-of-way lines, which includes the vehicular “**roadway**”, adjacent pedestrian sidewalks, and/or shoulder parkways or medians. The “**roadway**” is that area portion within the street right-of-way designated for vehicular traffic and generally bounded by curbing or header curb, and usually contains pavement.

#### 4.2 LOCATIONS

- A. New Utility Mains shall be designed in the locations indicated in Table 4-1 for the various street right-of-way widths indicated per Standard Details.

TABLE 4-1 PIPELINE LOCATION WITHIN NEW STREET RIGHTS-OF-WAY							
RIGHT-OF-WAY WIDTH	DISTANCE FROM CENTERLINE			RIGHT-OF-WAY WIDTH	DISTANCE FROM CENTERLINE		
	WATER	SEWER	RECLAIMED		WATER	SEWER	RECLAIMED
36 ft	9 ft	1 ft	6 ft	72 ft	10 ft	5 ft	10 ft
44 ft	8 ft	3 ft	8 ft	76 ft	10 ft	5 ft	10 ft
52 ft	8 ft	5 ft	10 ft	84 ft	20 ft	5 ft	10 ft
64 ft	10 ft	5 ft	10 ft	110 ft	25 ft	15 ft	20 ft

- B. In general utilities shall be located in relation to the centerline of the dedicated street as follows:
  - Water Lines shall be located on the north or east side of dedicated streets or alleys.
  - Wastewater Lines shall be located on the south and west sides of dedicated streets or alleys.
  - Reclaimed Lines shall be located on the south or west sides of dedicated streets or alleys.

- C. Centerline- Reference centerline shall be centerline of street right-of-way provided it coincides with the public roadway centerline. Where these centerlines do not coincide, then the reference shall be the public roadway centerline, thereby assuring the Utility mains are constructed within the public roadway.
- D. Dead – Ends/Cul-de-Sacs – per Utility Standard Details.
- E. Curved Right-of-Ways
- Water lines and wastewater forcemains shall be designed with a minimum horizontal radius of curvature of 250 feet. For lines 16-inch and larger, radius of curvature shall be in accordance with joint deflection specified by the engineer but not to exceed the pipe manufacturer's recommendation.
  - Wastewater gravity lines shall be designed with a minimum radius of curvature of 150 feet.
  - Reclaimed water lines shall be designed with a minimum horizontal as radius of curvature of 250 feet. For lines 16-inch and larger, radius of curvature shall be in accordance with joint deflection specified by the engineer but not to exceed the pipe manufacturer's recommendation.

Where curved rights-of-way are in excess, appropriate fittings and restrained joints shall be utilized.

#### **4.3. ALTERNATE LOCATIONS FOR EXTENSIONS**

- A. Where standard locations are unavailable, or if in the interest of operation, efficiency, or maintenance of the system, the Utility may designate another location.
- B. In existing rights-of-way where pavement replacement must be minimized, or where existing structures and utilities must be avoided, alternate locations may be selected, subject to Utility approval.

#### **4.4 SEPARATION OF UTILITY MAINS**

- A. Separation distance requirements are pursuant to Texas Commission on Environmental Quality (TCEQ) rules and regulations.
- B. Parallel lines shall be installed in separate trenches.

END OF CHAPTER

## CHAPTER 5

### **COORDINATION WITH PUBLIC AGENCIES AND OTHER UTILITIES**

#### **5.1 AGENCIES**

This Section identifies public agencies and other Utility companies for which coordination may be required during the course of the planning and design process. The coordination efforts include agency reviews and approvals to comply with specific agency requirements. The list of agencies is not all inclusive; therefore, appropriate coordination efforts should also be made with other relevant agencies not listed.

Where applicable, Utility designs may involve coordination with the requirements of outside entities such as the Texas Commission of Environmental Quality, the Environmental Protection Agency, certain grant-funding or loan agencies such as the Texas Water Development Board, and other public or private entities bound by Interlocal Agreements with the El Paso Water Utilities.

##### **5.1.1 City Engineering or Other City Departments**

- A. Continuous communication, both oral and written, is necessary
- B. Any cutting of a street, except for emergency work or small routine services, shall be authorized
- C. Repaving shall be done per current City Ordinance requirements

##### **5.1.2 County Road and Bridges**

- A. Continuous communication, oral and written
- B. Coordinate paving work and other County road structures

##### **5.1.3 Texas Department of Transportation**

- A. Work to be done in a Texas Department of Transportation (TXDOT) right-of-way requires a permit.
- B. All utilities placed and/or adjusted underneath existing highways shall be in accordance with the requirements specified in the TXDOT Right-of-Way Division – Utility Manual and the Utility Accommodation Policy.
- C. Traffic control design is to be in accordance with TXDOT's "Manual on Uniform Traffic Control Devices", and City of El Paso Traffic Division requirements.

##### **5.1.4 Texas Commission on Environmental Quality (TCEQ)**

- A. Coordination, review, and approval with the TCEQ is required on all water and wastewater infrastructure projects, as applicable.

- B. The Texas Pollutant Discharge Elimination System (TPDES) program requirements are directed and enforced by the TCEQ and administered by the City's Subdivision Development section.
- C. Other permit requirements including hazardous wastes and air pollution shall be coordinated through the TCEQ by environmental and engineering personnel.

#### **5.1.5 Irrigation Districts**

- A. A permit must be obtained from the El Paso County Water Improvement District #1 (EPCWID1) when Utility Mains cross irrigation ditches or drains.
- B. All installations shall be in accordance with the requirements specified by the agency.

#### **5.1.6 Bureau of Reclamation**

- A. A permit must be obtained from the Bureau of Reclamation when Utility Mains cross or exist within the Bureau of Reclamation right-of-ways.
- B. All installations shall be in accordance with the Bureau of Reclamation's Design Criteria as referenced in document manual entitled "The Reclamation Manual."

#### **5.1.7 International Boundary and Water Commission**

- A. A permit from the International Boundary and Water Commission must be obtained when Utility mains cross the Rio Grande River right-of-way, or property under IBWC jurisdiction.
- B. All installations shall be in accordance with the requirements specified by the agency.

#### **5.1.8 U. S. Corps of Engineers**

- A. Coordinate watershed or floodplain drainageway crossings or proposed structures within storage basins such as dams; a Section 404 Permit may be required whenever a project impacts waters of the United States.
- B. Design installations in accordance with requirements of the agency

### **5.2 THIRD PARTY UTILITIES AND UNDERGROUND LOCATING SERVICES**

- A. Other utility companies are intended to include electric, telephone, cable, fiber communications, gas, and oil pipeline companies.
- B. Any proposed work should show the location of the facilities of any of the above companies which are in the vicinity.
- C. Contact should be made with the proper representative of each of these companies to verify the location.
- D. The Engineer, as part of Design Package, shall direct Construction Contractor to contact DIGTESS prior to construction.

*NOTE: El Paso Water Utilities existing pipelines located beyond the City Limits, shall be tagged, bolded, or emphasized on the design drawings, at locations where such existing*

*facilities will be crossed by the proposed pipeline facility. It is possible that DIGTESS may not have records of utility structures outside the city nor on records provided to them by others.*

### **5.3 COMMERCE AND INTERSTATE TRANSPORTATION**

- A. Coordination with interstate commerce entities is intended to include railroad companies and Airport operations.
- B. A permit must be obtained from the appropriate governing office when mains cross railroad rights-of-way.
- C. All utilities placed and/or adjusted underneath existing railroad and other interstate transportation right-of-ways shall be in accordance with the requirements specified by the governing agency.

### **5.4 OTHER ENTITIES**

- A. When required, coordination with environmental entities shall be performed to secure the appropriate reviews, permits, and other project specific items. (see Chapter 6)
- B. All installations shall be in accordance with each entity's specified design criteria.

END OF CHAPTER



## CHAPTER 6

### **ENVIRONMENTAL PERMITTING AND COMPLIANCE**

#### **6.1 ENVIRONMENTAL COMPLIANCE**

- A. Compliance with appropriate federal, state, and local environmental rules, laws, regulations and permits is required. The Engineer shall coordinate with appropriate agencies and acquire the required permits to maintain environmental compliance. In addition, it is the responsibility of the Engineer to ensure that the project engineering design incorporates all requirements identified in environmental and permitting documents developed for the project.
- B. All projects must comply with current requirements from environmental agencies including the Texas Commission on Environmental Quality (TCEQ), U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (Corps), Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), and other applicable agencies.
- C. When modifying existing facilities, determine if existing features were part of previous permit conditions.
- D. In instances where permits are required during construction, the Contractor shall be required to acquire such permits. In special situations, where significant lead times are needed for acquiring permits that are required during construction, the Engineer shall acquire them.
- E. If permits are required for the collection and disposal of groundwater, then provisions shall be included in the permit application for the removal or treatment of contaminated groundwater if any is expected to be encountered.
- F. The disposal of contaminated soils may require specific classification for disposal at an appropriate facility. State health agencies may require the classification of expected contaminants so that appropriate safety plans may be developed to protect workers during any field investigations or construction.
- G. Careful Consideration and public/private clearance may be required when crossing arroyos or other protected cultural or environmental areas with utility infrastructure. Consult existing Green Space and Open Space City ordinances.

#### **6.2 ARCHEOLOGICAL COORDINATION**

- A. Notify EPWU if archeological sites are encountered.
- B. The National Environmental Policy Act (NEPA) states that Federal authorities, such as the Corps, Bureau of Land Management (BLM), Bureau of Reclamation (BuRec), International Water and Boundary Commission (IWBC), and Fort Bliss preserve important historic, cultural, and natural aspects of our national heritage. Coordination of Utility projects with Federal authorities will require compliance with NEPA regulations.

- C. The State authority is the Texas Historical Commission (THC). Utility coordination with THC will include archaeological permit numbers, determinations, investigations, and conditions assessments. This is mandatory when working with state departments, such as the Texas Department of Transportation (TXDOT) and other state agencies.
- D. The Utility shall take an active role when projects affect historic properties. Because the Utility is a political subdivision of the State of Texas, actions which affect archaeological and historic sites on its property are regulated by the Texas Antiquities Code.
- E. Compliance with the National Historic Preservation Act of 1966 requires the protection, rehabilitation, restoration, and reconstruction of any UTILITY structures, sites, buildings, and objects of significance in American history (50 years old or older).
- F. Utility lands which have a State Archaeological Landmark (SAL) designation may not be altered, damaged, destroyed, salvaged or excavated without a permit from the Antiquities Committee (committee). Removing the designation as a landmark may be determined by an evaluation from the committee to release the SAL from the previous provisions, if there is no longer an educational, historical, archaeological, or scientific value to warrant its classification as a landmark.
- G. Investigational phases for archeological compliance typically include the following:
  - 1. Reconnaissance – records research and visual field visit
  - 2. Pedestrian Survey – records research, shovel tests, and backhoe trenches
  - 3. National Register Testing – delineation and determination if site is eligible for National Register of Historic Places
  - 4. Mitigation – recover artifacts, archive, and record site data
- H. In some instances, permit stipulations may require that an Archaeological Monitor be present on site during construction activities. If an archaeological resource is uncovered during construction, Monitors will have the authority to temporarily stop or redirect ground disturbing activities away from the find. The potential significance of the resource will be coordinated with the THC or the applicable federal agency.

### **6.3 STORMWATER TPDES REQUIREMENTS**

- A. All projects involving construction grading, earthwork, or disturbance of existing land areas, must comply with local, state, and federal stormwater pollution regulations.
- B. The Texas Commission on Environmental Quality (TCEQ) directs and enforces requirements under the Texas Pollutant Discharge Elimination System (TPDES) program required to comply with federal stormwater regulations. TCEQ has relegated responsibility to the City of El Paso to review, administer, and ensure compliance with the TPDES requirements by the general public, and to provide permits thereof. Contact the City's Subdivision Development Division.
- C. TPDES Construction General Permit No. TXR 150000 allows operators to obtain permit coverage for stormwater conveyance from Small and Large Construction Activities. The permit specifies that a Storm Water Pollution Prevention Plan (SWP3) must be developed and implemented if storm water discharges will reach Waters of the United States.

- D. A SWP3 must be prepared in accordance with the General Permit requirements. The purpose of the SWP3 is to identify and address potential sources of pollution that are reasonably expected to affect the quality of stormwater discharges from the construction site. The SWP3 generally consists of the following items:
- Project Description
  - Site Map
  - Description of Best Management Practices
    - Erosion and Sediment Controls
    - Stabilization Practices
  - Structural Controls
  - Permanent Stormwater Controls
  - Other Controls
  - Compliance with State and Local plans
  - Maintenance of Controls
  - Inspection of Control
- E. Permitting requirements are dependent on the acreage of disturbed area. Construction activities are categorized as follows:
1. Small Construction Activity - has a land disturbance equal to or greater than one (1) acre and less than five (5) acres.
  2. Large Construction Activity - includes a land disturbance equal to or greater than five (5) acres, or part of a larger common plan of development.
  3. Construction Activity Less Than 1 Acres – permit is not required, however, City municipal code still applies.
- F. A project categorized as a small construction activity may apply for a permit waiver under the following circumstances:
1. Low Rainfall Erosivity – rainfall erosivity factor for entire construction period is less than 5; waiver certification is sent to TCEQ and City; no SWP3 is required.
  2. Low Potential for Erosion – construction activity will occur during a period of low potential for erosion (per Appendix A of General Permit); a Construction Site Notice must be posted at the construction site and a copy provided to the City; no SWP3 is required.
- If neither of the above waiver conditions is met, a permit is required and the following items must be provided:
- Construction Site Notice is posted at the project site and a copy is provided to the City.
  - SWP3 must be prepared by a registered engineer and a copy provided to the City.
  - City Permit Application must be completed.
- G. Permitting compliance for large construction activities requires the following items:
- SWP3 – prepared by a registered engineer and a copy must be provided to the City.
  - Notice of Intent (NOI) – must be submitted to the TCEQ along with the appropriate fees; a signed copy must be provided to the City and must also be posted at the project site.

- City Permit Application must be completed.
- Notice of Termination (NOT) – to be submitted to TCEQ and City upon completion of project and achieving final stabilization.

#### **6.4 NOISE CONTROL**

- A. Compliance with all applicable local ordinances and regulations regarding noise control must be followed.
- B. All operations shall be conducted so that they do not disturb the residents in the vicinity of the work.
- C. Noise control measures should be considered and implemented in order to avoid noise disturbances. Examples of types of measures include:
  1. Normally scheduled construction activities should be limited to daytime hours, 7 a.m. to 6 p.m., and should not be performed on Saturdays, Sundays, or legal holidays unless approved by the Utility.
  2. Construction equipment must be equipped with manufacturer's standard noise control devices (i.e., mufflers, acoustical lagging, and/or engine enclosures).
  3. Contractors shall be required to coordinate and obtain City approval for routing heavy trucks and machinery to avoid noise-sensitive areas and the use of public rights-of-way for construction traffic.

#### **6.5 DUST CONTROL**

- A. Compliance with local and state regulations related to air pollution and dust control is required for all projects. Where available, EPWU encourages the use of reclaimed water or non-potable approved waters for use in dust control. The use of potable water for dust control should be mitigated where possible.
- B. Appropriate measures should be taken to minimize the impacts of dust on the environment during construction of project facilities. Examples of types of measures include:
  1. Wetting down bare soils.
  2. Providing stabilized construction entrances and staging areas.
  3. Replace ground cover in disturbed areas as quickly as possible.
  4. Suspend all excavating and grading operations during excessive wind conditions.
  5. Provide properly operating combustion emission control devices on construction vehicles and equipment.

#### **6.6 AIR PERMITS**

Air permits may be required from the TCEQ or City/County for the installation or replacement of engines, boilers, flares and other air handling equipment. It is the responsibility of the Engineer to determine and obtain required permits and to coordinate with the Utility as well as ensure the project engineering design incorporates all permit requirements.

END OF CHAPTER

# CHAPTER 7

## COST ESTIMATING

### 7.1 INTRODUCTION

- A. This chapter provides a systematic approach to the preparation of major construction cost estimates in order to achieve uniformity in the development of the estimates, and to facilitate review by various project participants. The Engineer should utilize best estimating practices of the engineering and construction industries in preparing cost estimates. Alternative cost estimating systems and variations in methods may be used provided they meet the general intent and requirements of this chapter. The cost estimate level of detail will be determined by the Project Engineer Manager on a per project basis.
- B. Cost estimates prepared under contract with the Utility are strictly confidential and distribution is prohibited beyond that specified in the Engineer's contracted scope of work. Estimates are submitted to the Utility as "Engineer's Opinion of Probable Cost".
- C. Preparation of construction cost estimates shall take into account the current climate of the construction industry in the City of El Paso to avoid overly conservative estimates.
- D. The Engineer may use the manual methods described in this chapter, or otherwise, a computerized cost estimating software to generate cost estimates. The system must clearly identify the various cost categories, types, codes, standard calculations, and defaults.

### 7.2 DEFINITION AND TYPES OF COST ESTIMATES

- A. The definitions and categories of cost estimates provided herein are referenced from the Association for the Advancement of Cost Engineering (AACE – see also [www.aacei.org](http://www.aacei.org)). The cost estimate should include an assessment of the difficulties inherent in the construction work. This includes such factors as labor conditions, construction equipment, construction supervision, material costs, and equipment installation costs. All reasonable costs expected to be incurred are also included.

The Engineer provides construction cost estimates for review by the Utility with each design submittal as defined below:

- 30% Design Complete: Type C Estimate
- 60% Design Complete: Type B Estimate
- 95% Design Complete: Type A Estimate
- 100% Design Complete: Type A Estimate

Refer to Table 7-1 below and following discussion of each estimate type.

TABLE 7-1 COST ESTIMATE TYPES				
TYPE OF ESTIMATE	CLASS OF ESTIMATE	DESIGN LEVEL	EXPECTED ACCURACY	MAXIMUM CONTINGENCY
30% Submittal Estimate (Budget level cost estimate)	C	30%	+30% to –15%	30%
60% Submittal Estimate (Management directed and corrected scope of work)	B	60%	+20% to –10%	20%
95% and 100% Submittal Estimate (Definitive Estimate)	A	95% and 100%	+10% to –10%	10%

Note: Class of Estimate A, B, and C is in accordance with Association for the Advancement of Cost Engineering (AACE).

B. Class “C” Cost Estimate:

A Class C cost estimate is developed at or near the completion of preliminary design and is referred to as the Budget Level cost estimate. It is the first construction budget developed from project specific design criteria and is submitted with the 30% design. The framework of this estimate is based on quantities and unit price models developed from the design criteria, site layout, soils reports, and the Basis of Design Report. The expected accuracy of the estimate is +30% to –15% of the actual cost of construction.

C. Class “B” Cost Estimate:

A Class B cost estimate is an extension of the Class C cost estimate. It is the interim budget cost estimate developed to conform to the latest project-specific design criteria and is submitted with the 60% design. The framework of this estimate is based on quantities and unit price models further refined or revised assumptions from the design criteria, site layout, soils reports, and the Basis of Design Report. The expected accuracy of the estimate is +20% to –10% of the actual cost of construction.

D. Class “A” Cost Estimate:

A Class A cost estimate is the definitive estimate of the final Engineer’s Estimate. This estimate is usually independent of the earlier budget level estimates and serves as a final check on the expected construction cost of the project. This level of cost estimate is submitted with the 95% and the 100% design. The estimate is intended to serve as the final project cost plan and as a comparison to the interim budget level cost estimate and for the Analysis of Construction Bids. This estimate is most sensitive to actual bidding climate and site conditions. The expected accuracy of the estimate is +10% to –10% of the actual cost of construction. The 100% cost estimate must have any contingency factored into bid items and cannot be shown as a separate line item.

E. For each cost estimate prepared, the Engineer should identify any deviation from the previous cost estimate and explain the differences between the estimates. The variance in cost (over or under) from the previous estimate is identified at the cost item level and is

later included in the summary level cost estimate. The Engineer shall participate in cost estimate review meetings with the Utility to reconcile cost estimates. Where estimates at 100% completion level vary by 15% or more from the previous 95% level, or revised a second time at 100% level prior to bid, a justification for the revision shall be provided to the Utility.

### 7.3 BASIS OF COST ESTIMATE

- A. The basis of the construction cost estimate is documented using lists of drawings and specifications, quantities, equipment lists, qualifications, assumptions, inclusions, exclusions, a brief narrative of the cost estimate variance for the current design completion, and the construction approach used in developing the cost estimate.
- B. The Engineer should provide a quantity takeoff with each applicable cost estimate and define the unit cost (pricing) data used to calculate/extend each line item. For pricing, the Engineer may use industry cost databases or estimates on unit costs developed specifically for the project. The Engineer should clearly define the cost sources on which the pricing is based, including indirect costs and direct costs for labor, material, equipment, subcontractors and suppliers. Escalation costs should be shown as a separate line item. The amount of escalation used may be determined by taking the *Engineering News Record (ENR)* construction cost index (CCI) for El Paso at the time the cost estimate is prepared and escalating it to the estimated midpoint of construction. Cost allowances and cost contingencies are shown separately with definitions of the items included in these allowances and contingencies.
- C. All major material and equipment costs should be identified and sufficient supporting price quotations from manufacturers and/or suppliers provided. Minor equipment costs may be documented by written telephone quotations. All backup information shall be indexed and sorted.
- D. All Owner-furnished equipment or materials and all labor costs associated with Utility system, should be excluded from the construction cost estimates submitted by the Engineer unless otherwise directed by the Utility. However, installation costs for owner-furnished items, to be incurred by the Construction Contractor are included in the cost estimate.
- E. Cost estimates should be broken down using the bid form as developed for the project.

### 7.4 COST ESTIMATE REPORTS

- A. Cost estimate reports with detailed breakdowns should be maintained in project files and, upon request by the Project Engineer Manager, be made available to the Utility. Such reports should be prepared summarizing the total cost, quantities of materials, labor man-hours, and unit costs for materials and labor. The cost estimate should be formatted to allow for detailed and summary presentation of the project costs. A cost breakdown is recommended to facilitate review, comment, and reconciliation of cost estimates with other participants.
- B. Other costs items should be allocated as a percentage of total cost components. These costs appear as separate line items in the cost estimate summary, and may include such items as follows:
  - Federal/State Unemployment Insurance

- Social Security and Medicare Tax
  - Field Supervision
  - Main Office Expense
  - Tools/Minor Equipment Expense
  - Contingency
  - Other Taxes
  - Profit
  - Economic Adjustment
- C. When appropriate, the following reports may be developed and kept on file as support documentation with each cost estimate:
- Summary Cost Estimate Report sorted by Work Task
  - Summary Cost Estimate Report sorted by CSI Division Number
  - Detailed Cost Estimate Report sorted by CSI Section Number
  - Worksheets Report sorted by CSI Section Number
  - Worksheet Report sorted by Work Task
- D. For construction bidding purposes, the Engineer shall submit to the Utility, 95% and 100% level estimates (Engineer's Opinion of Probable Cost) formatted to the bid item description and numbering sequence shown in the contract bid proposal. Cost estimate reports showing the bid item cost breakdowns or detail schedule of values for individual or group bid items shall be submitted if required, along with the bid item cost estimate to the Utility.
- E. Source documentation in developing the cost estimate may include R.S. Means cost databases for labor, materials and equipment, quotations from vendors and suppliers, in-house utility historical unit cost rates from completed projects, details and sketches used in quantity take offs, and contractor's equipment cost guide or blue book published by Dataquest. Material prices should reflect current market conditions.

## 7.5 LIFE CYCLE COSTS

- A. A life cycle cost analysis shall be performed to quantify capital and operating expenditure decisions and justifications. The intent of the life cycle cost analysis shall be to provide the Utility with a realistic expectation of the anticipated costs associated with the new project and to compare project design and/or material/equipment alternatives.
- B. Life cycle cost analysis shall consider the total cost of ownership over the life of the system. This analysis shall enable the engineer to choose a system that is least costly over the entire life of the system. It shall determine and include all the applicable costs to include but not limited to:
- Start-up costs and initial capital costs
  - Operational costs, including labor, chemicals, power and other costs applicable for the lifetime of the project
  - Maintenance costs, including parts, labor, and other related maintenance costs
  - Rehabilitation and refurbishment costs. These refurbishments may be repeated during the project life. The frequency of the refurbishments shall be based on the expected life of the equipment.
  - Decommissioning, recycling, and demolition costs at the end of the project life
  - Compliance costs
  - Other annual costs



- C. Recurring costs shall be converted to present worth values (PW) costs using the following formula:

$$PW = \text{Annual cost multiplied by } [(1+i)^n - 1] / [i (1+i)^n]$$

where:

n = number of years

i = interest rate, a number calculated from the cost of money and average inflation rate

- D. Consult EPWU's finance department for the interest rate to be used. If not available, the United States Environmental Protection Agency (EPA) publishes a discount rate for cost-effectiveness analysis that may be used. In accordance with EPA guidelines for cost effectiveness, only those costs incurred during a 20-year planning period should be considered in the evaluation of alternatives, although the facilities are expected to last much longer.
- E. The Engineer shall use actual EPWU operating costs where available from the Operations and Maintenance Division. The Engineer shall determine and take into account the expected project life duration and the expected life of the project elements.

END OF CHAPTER

# CHAPTER 8

## GEOTECHNICAL

### 8.1 INVESTIGATION REQUIREMENTS

- A. Geotechnical evaluations and recommendations shall be conducted by a qualified geotechnical professional who is an Engineer or Geologist with professional registration in Texas.
- B. A preliminary or reconnaissance investigation is required to better define the extent of the geotechnical history of the project. The investigation shall generally consist of a data review, visual inspection, and site surface examination.
- C. A geotechnical investigation by borings is required to identify subsurface features that will affect final design and construction of the project. This investigation may include soil borings, test pits, ground water measurements, and laboratory analysis of soil samples.
- D. Soil and water samples collected from borings and/or piezometers in areas that have the potential of being contaminated should be checked for volatile organics and hydrocarbons. The Engineer is responsible for adhering to all pertinent federal, state, and local regulations and laws.

### 8.2 INVESTIGATION CRITERIA

This section provides minimum requirements for frequency and depth of borings for those projects requiring a geotechnical field investigation. The Engineer shall determine the need and extent of geotechnical work based on the nature of the proposed design and construction.

- A. Water, Wastewater, and Reclaimed Water Mains
  - 1. Soil borings shall be made at a spacing of 500 to 750 feet, with additional borings at closer spacing to better define areas of inconsistent stratigraphy.
  - 2. Soil borings shall be made at an offset distance of no more than 20 feet from the centerline alignment.
  - 3. Boreholes should generally extend 5 to 10 feet below the pipe invert or proposed structures. Boring depths should be increased if unusual soil conditions are encountered.
  - 4. Boreholes at bridge crossings should be coordinated with the geotechnical engineer depending on the nature of proposed construction and geophysical site conditions.
  - 5. Soil boring logs should be maintained with the following minimum information:
    - Boring number, location, elevation
    - Drilling contractor, drilling method, and equipment used
    - Water level, date and time measured
    - Sampling data (top and bottom of sample interval, length of sample recovered in split-spoon, penetration number, etc.)

- Soil description and classification
- Comments

**B. Storage Facilities**

1. The geotechnical engineer shall establish a boring program in consultation with the Utility and a structural engineer.
2. In addition to the soil boring requirements specified in 8.2 A-5, at least one boring must be made within 20-feet of the proposed center of the storage facility. Additional borings around the periphery of the storage facility should be spaced a maximum of 50-feet apart.
3. Borehole depths shall extend a minimum 15-feet below the lowest footing or foundation of the structure it supports, or as determined by the structural engineer.

**C. Pumping Stations & Building Structures**

1. The geotechnical engineer shall establish a boring program in consultation with the Utility and a structural engineer.
2. In addition to the soil boring requirements specified in 8.2 A-5, at least one boring must be made within 20-feet of the proposed center of the pumping station or building. Additional borings around the periphery of such structures should be spaced a maximum of 50-feet apart.
3. Borehole depths shall extend a minimum 15-feet below the lowest footing or foundation of the structure it supports, or as determined by the structural engineer.

### **8.3 LABORATORY TESTING**

- A. The laboratory testing program should be prescribed by the geotechnical professional and reviewed and approved by the Engineer.
- B. Laboratory tests shall be relevant to the engineering analyses and recommendations for the project, and shall be conducted on representative soil samples.
- C. Relevant minimum soil parameters to be provided in the laboratory testing may include strength data, classification test results, moisture content, Atterberg limits, dry density, and shear strength.
- D. Laboratory tests should be conducted in accordance with the corresponding ASTM standards.
- E. Certain types of investigations will require additional laboratory analysis. These additional investigations may include select fill evaluation, slope stability/failure investigations, foundation analysis, pavement analysis, and others as needed.

### **8.4 SITE RESTORATION**

- A. Boreholes along the developed right-of-way shall be cleaned by removing cuttings and mud and other debris. Ruts or pits in the ground shall be filled to original conditions and elevations.

- B. Backfilling of boreholes or sealing of piezometers should be conducted with non-shrink grout, using tremie method.
- C. Backfilling with natural soils is acceptable if materials are not contaminated and methods are in agreement with regulations regarding groundwater protection.
- D. Restoration of boreholes through pavement shall be restored with the same or equivalent materials as the existing pavement.

## **8.5 GEOTECHNICAL REPORT**

- A. A geotechnical report shall be prepared in substantial accordance with the following suggested Table of Contents format:
  - 1. Executive Summary
  - 2. Purpose and Scope of Work
  - 3. Site Exploration
  - 4. Field Work
  - 5. Laboratory Testing
  - 6. Subsurface Conditions
  - 7. Engineering Analysis
  - 8. Summary and Recommendations
  - 9. Construction Considerations
  - 10. Appendices (to include boring logs and site map)
- B. When necessary, a geotechnical report for large open excavations or trench safety systems shall be provided for specified projects. The report shall satisfy statutory requirements for contracting for trench safety construction. Design and construction bid documents shall require that the Contractor provide a trench excavation safety plan indicating the type of shoring and excavation safety equipment to be used, sealed by a geotechnical engineer or other qualified Professional Engineer.

END OF CHAPTER

## CHAPTER 9

### FACILITY SUPPORT PROVISIONS

#### 9.1 GENERAL

Guidelines on facility support structures and other appurtenances are provided in this chapter. These requirements are intended to include security/safety, signage, traffic control, dewatering, and testing and disinfection.

Engineer shall obtain approval from the Utility for exceptions or deviations from these requirements. Exceptions or deviations may be granted on a project by project basis only.

#### 9.2 SECURITY / SAFETY

- A. EPWU facilities shall be designed with proper security measures to ensure the safety and protection of the facility, workers, and other resources.
- B. Minimum security measures shall be defined by EPWU for their facilities and may include:
  - 1. Site fencing with barbed or serpentine wire at the top or higher wall without barbed wire based on EPWU direction. All perimeter wall systems shall be in accordance with TCEQ requirements while considering current EPWU site aesthetics.
  - 2. Security cameras and surveillance monitoring
  - 3. Intrusion alarms
  - 4. On-site security guard facility
  - 5. Site lighting
  - 6. Locked buildings and electronic access, where applicable
- C. More site specific security measures may be required and must be coordinated and approved by the Utility.

#### 9.3 PROJECT SIGNAGE

- A. EPWU facilities shall be provided with standard signage. Project signage must be provided at all EPWU facilities that include pumping stations, storage facilities, well production sites, treatment plants, lift stations, etc. Relevant information to be displayed on the sign includes:
  - 1. Owner name (EPWU)
  - 2. Facility name
  - 3. Facility address

4. Safety warnings or other no trespassing warnings
5. Emergency phone numbers

Refer to the Utility's Standard Detail for example of standard sign requirements.

- B. Project signage shall be placed at appropriate locations, generally within 10-feet from the site security fencing, where it is visible from the exterior perimeter of the facility.

#### **9.4 TRAFFIC CONTROL**

- A. It is the Engineer's responsibility to include project-specific provisions in the contract documents for traffic control and temporary access to minimize disruption to traffic and the community.
- B. Traffic control requirements for the protection of traffic in public or private streets and other traveled ways, shall provide for the placement and maintenance of all necessary barricades, traffic cones, warning signs, lights and flaggers, detours, and other safety devices.
- C. Temporary crossings shall be provided to allow continuous, unobstructed, safe, and adequate access for pedestrians and vehicles to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals.
- D. Construction activity shall not interfere unnecessarily with the work of utility companies or other agencies. Work should be coordinated to minimize disruption of normal activity in the area of construction.
- E. Access to residential driveways shall be provided to the property line except when necessary construction precludes access for a reasonable period of time. Interruption of access will be allowed only after appropriate notification to the property or business owner. Notification to business owners and residents shall be provided at least 14 days in advance of work being started in a specific area.
- F. Traffic control design shall be in accordance with City of El Paso Traffic Division Standards or Texas Department of Transportation's (TXDOT) Manual on Uniform Traffic Control Devices.

#### **9.5 DEWATERING**

- A. Dewatering activities may be required to facilitate construction of underground utilities in shallow groundwater conditions.
- B. Prior to commencing dewatering activities, coordination with the appropriate regulating agency, such as the El Paso County Water Improvement District #1 (EPCWID1), is required to secure necessary permits and comply with local and state regulations.
- C. A dewatering plan specification shall be prepared for the Utility and for a subsequent permit request, to document the amount of water to be handled, discharge locations (vicinity map), special disposal procedures, and other pertinent information as required by the EPCWID1 or other jurisdictions.

- D. Expected groundwater control systems that may be appropriate include pumping systems, wells, well points, or sump pump systems. Plan shall consider governing agency discharge and water quality requirements as part of plan and ultimate approvals.
- E. Care should be taken to ensure that dewatering activities minimize the effect on adjacent improvements.
- F. Control of surface runoff is required to minimize the effect on the existing project.

## **9.6 TESTING AND DISINFECTION**

- A. The Engineer shall include provisions in the Contract Documents for testing and disinfection of constructed facilities. Pressure testing, leak testing, and disinfection of constructed facilities shall be performed during the construction phase and prior to acceptance of the facility by the Utility.
- B. Testing and disinfection shall comply with appropriate codes and standards established by local, state, and federal regulations. Where appropriate, references and guidelines provided by the American Water Works Association and other technical organizations shall be followed.
- C. Pressure testing shall include, but not be limited to, utility mains, valves, fittings, joints, and process equipment.
- D. Leak testing shall include air or water testing on sewer mains, manholes, wet well structures, and storage reservoirs.
- E. Disinfection shall include, but not be limited to, utility mains and storage facilities.
- F. EPWU will perform sewer line testing of gravity lines.

END OF CHAPTER

## CHAPTER 10

### SITE WORK

#### 10.1 EARTHWORK AND GRADING

- A. For construction projects, site grading and earthwork shall be performed in conformance with applicable local, state, and federal regulations and permitting requirements. Refer to section 6.3 for stormwater TPDES requirements.
- B. Site grading shall be designed to ensure adequate site drainage and proper functioning of the facility. No adverse impacts shall be created to upstream, downstream or adjacent properties or to public right-of-way, property and/or facilities.
- C. Earthwork activities must comply with applicable trench safety requirements.
- D. Projects shall be designed to minimize impacts to existing trees, shrubs, vegetation, and existing structures. Trees in proximity to the work shall be boxed or otherwise protected against injury.
- E. Upon completion of construction, land resources within the project boundaries shall be restored to the original project condition or better, so that the earthwork activities do not detract from the appearance of the project or drainage patterns.

#### 10.2 LANDSCAPING

- A. Constructed project facilities shall be designed with appropriate landscaping, in accordance with local ordinances, that is low maintenance, native vegetation, and drought tolerant.
- B. Plant selection and irrigation design is of utmost importance in creating a low maintenance project. A list of appropriate plant selection can be obtained from the EPWU Water Conservation Department.
- C. Site conditions such as overall size, soil type, existing vegetation, adjacent vegetation, water availability, remote or urban location, surrounding features, and geographic elevation need to be considered when designing project landscaping.
- D. Where required, landscaping shall comply with requirements from the Texas Pollutant Discharge Elimination System (TPDES) program to ensure erosion and sediment control.

#### 10.3 DEMOLITION

- A. Site demolition activities shall comply with all applicable local, state, and federal regulations and permitting requirements.
- B. Unless otherwise specified, the demolition work shall include the removal, wholly or in part, and satisfactory disposal or abandonment of such items included, but not limited to, buildings, structures, mechanical/electrical equipment, fences, pavement, pipelines, manholes, and other appurtenances.



- C. The Utility will provide a list of salvageable material that shall be removed, without unnecessary damage, in sections or pieces which may be readily transported and delivered to EPWU designated facilities.
- D. Cavities or depressions left by structure removal shall be filled to the level of the surrounding ground and compacted in accordance with appropriate construction specifications.
- E. Proper management and disposal techniques must be followed for the demolition and disposal of asbestos containing materials and PCB containing materials, in compliance with applicable local, state, and federal regulations.

#### **10.4 FENCING AND ROCK WALLS**

- A. Fencing and rock walls shall be designed in accordance with local ordinances and EPWU Standard Details.
- B. The design shall be aesthetically pleasing and conforming to neighboring surroundings. Each site is project specific and shall be coordinated with EPWU PEM to determine wall requirements.

END OF CHAPTER

## CHAPTER 11

### TRENCH WIDTH, BEDDING, AND BACKFILL

#### 11.1 GENERAL

- A. Trench width, bedding, and backfill shall be designed to accommodate the utility line, in conformance with the project specifications.
- B. Trenching shall conform to the applicable requirements of the agency with jurisdiction in the area that construction occurs.
- C. The trench length shall not exceed the limits indicated in the project specifications.
- D. For trenches exceeding 5 feet in depth or trenches in unstable soil for any depth, an adequate safety system shall be designed. The safety system shall meet the requirements of applicable local and state construction safety orders and federal requirements.
- E. Trench requirements for special cases may differ from these standards and must be approved by the Utility.
- F. Any new utility line shall be marked by installing the appropriate marking tape in the trench. The marking tape shall consist of a 5.0 mil inert polyethylene plastic material. The burial depth shall generally be 18-inches below final grade for shallow excavations. For deeper excavations (greater than 5' of cover), a second tape shall be placed 2-feet above the top of pipe.

#### 11.2 TRENCH WIDTHS

- A. The trench should be as wide as necessary for proper installation of the pipe and backfilling, and should provide adequate room to meet safety requirements for workers. A minimum clearance of 12 inches horizontally on both sides of the pipe shall be provided.
- B. The Engineer shall determine the appropriate trench width by considering the pipe size, mitigation of pavement replacement, depth of cover, type of material to be removed, the space required for installation of the pipe and operation of equipment, and general construction practices.
  - a. Engineer shall review current City of El Paso Ordinance regarding pavement replacement requirements. Engineer shall also coordinate with EPWU regarding proposed pavement replacement plans.
- C. Trench width shall be provided as noted on the project specifications and the standard details.
- D. The pipe zone shall be considered to include the full width of the excavated trench from the bottom of the trench to a point at least 12-inches above the top outside surface of the barrel of the pipe. The minimum depth of bedding material beneath the pipe should be

selected based upon the expected unevenness of the trench bottom and the diameter of the pipe.

- E. Particular attention shall be given to the area of the pipe zone from the flow line to the centerline of the pipe to ensure that firm support is obtained to prevent any lateral movement of the pipe during final backfill of the pipe zone.
- F. Shoring, bracing, or sheeting shall be used, when advisable. Safety precautions and devices shall be utilized to the fullest extent.

### **11.3 EMBEDMENT CLASS MATERIAL**

- A. Trench bedding and backfill shall be in accordance with the project specifications and standard details.
- B. Table 11-1 provides a general guide description of embedment material classifications. Size of material may be superseded by specific Utility detail standards.
- C. Table 11-2 provides the standard bedding class schedule.

### **11.4 COMPACTION REQUIREMENTS**

- A. Compaction requirements shall be in accordance with the project specifications and standard details.
- B. Generally, compaction of backfill material shall be done in layers not to exceed 8 inches and compacted by approved mechanical equipment until the required density is obtained. The backfill material shall be moistened or aerated as necessary to obtain optimum moisture.
- C. Compaction shall occur from as close to the pipe as possible to as close to the trench shield as possible.
- D. Vibratory rollers may not be used as compaction equipment in city streets.
- E. Compaction activities shall be performed so as to minimize impacts to adjacent pipelines and structures.

### **11.5 SURFACE RESTORATION**

- A. Surface restoration will be required to match or exceed existing conditions according to the requirements of each agency with jurisdiction in the project area.
  - a. Engineer shall review City of El Paso pavement replacement Ordinance and consider means which protect or limit excessive pavement replacement. Surface restoration cost implications shall be considered in design.
- B. Existing street driveways, curbs, sidewalks, and all other miscellaneous structures damaged or removed by construction activities shall be restored to original or better than original condition. All restorations shall be completed promptly to minimize inconvenience to pedestrians, businesses, and residents.

- a. Engineer shall do due diligence to review existing ROW conditions, (ie striping, traffic loops , etc)

<b>TABLE 11-1 DESCRIPTION OF EMBEDMENT MATERIAL CLASSIFICATIONS</b>		
<b>SOIL CLASS</b>	<b>SOIL TYPE</b>	<b>DESCRIPTION OF MATERIAL CLASSIFICATION</b>
<b>CLASS I SOILS *</b>	--	Manufactured angular, granular material, ¼ to 1 ½ inches (6 to 40 mm) size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells.
<b>CLASS II SOILS **</b>	GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
	SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
<b>CLASS III SOILS ***</b>	GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
	GC	Clayey gravels, gravel-sandy-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
	SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
	SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
<b>CLASS IV SOILS</b>	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit of 50% or less. 50% or more passes No. 200 sieve.
	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
	CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
<b>CLASS V SOILS</b>	OL	Organic silts and organic silty clays of low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
	OH	Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
	PT	Peat, mulch, and other highly organic soils.

\* Soils defined as Class I materials are defined in ASTM D2321.

\*\* In accordance with ASTM D2487, less than 5% pass No. 200 sieve.

\*\*\* In accordance with ASTM D2487, more than 12% pass No. 200 sieve. Soils with 5% to 12% pass No. 200 sieve fall in borderline classification, e.g., GP-GC.

**TABLE 11-2  
STANDARD BEDDING CLASS SCHEDULE<sup>1</sup>**

<b>CLASS</b>	<b>MATERIAL CLASS</b>	<b>BEDDING SECTION</b>	<b>PIPE TYPE<sup>3</sup></b>	<b>DEPTH COVER</b>	<b>SOIL CONDITION</b>
<b>A</b>	Native > 12% passing No. 200 sieve	Shaped Trench	Rigid	3 ft – 12 ft	Dry
<b>B</b>	Native > 12% passing No. 200 sieve	6-inch Bed Min + (O.D./6)-inch but not < 4-inch	Rigid	3 ft – 18 ft	Dry & Wet <sup>2</sup>
<b>C</b>	Soil-Cement Slurry	(O.D./6)-inch but not < 4-inch Ext. to Springline	Rigid	3ft - 18 ft	Wet
<b>E1</b>	Class I ASTM D-2321	4-inch to 6-inch Bed – Ext. to Top of Pipe Zone	Rigid & Flexible	> 3 ft	Dry
<b>E2</b>	Class II ASTM D-2487	4-inch to 6-inch Bed – Ext. to Top of Pipe Zone	Flexible	> 3 ft	Dry
<b>E3</b>	Class III ASTM D-2487	4-inch to 6-inch Bed – Ext. to Top of Pipe Zone	Flexible	> 3 ft	Dry
<b>F</b>	Class I	4-inch to 6-inch Bed – Geotech. Fabric Bottom of Bed to Top of Pipe Zone	Flexible	> 3 ft	Wet
<b>G</b>	Class II ASTM D-2487	4-inch Bed – Ext. to Top of Pipe Zone	Flex Pressure Pipe	As specified	Dry & Wet <sup>2</sup>

<sup>1</sup> Refer to Drawing Details for correlation to this table

<sup>2</sup> Under special conditions, where trench bottom is unstable, gravel may be added to embedment material

<sup>3</sup> Pipe type shall be classified according to the following, as designated by the Utility:

**Rigid (Semi-Rigid) Pipe** shall denote steel (STL), steel cylinder concrete pipe (SCCP), ductile iron pipe (DIP), v

**Flexible Pipe** shall denote polyvinyl chloride (PVC) gravity sewer pipe, high density polyethylene (HDPE), fiberglass pipe and , polypropylene pipe.

**Flexible Pressure Pipe** shall denote polyvinyl chloride (PVC) water, reclaimed or force main pipe in accordance with AWWA Standards.

END OF CHAPTER

# CHAPTER 12

## WATER DISTRIBUTION/TRANSMISSION SYSTEMS

### 12.1 GENERAL

- A. This chapter provides guidance and minimum design criteria for the modification and construction of water distribution systems.
- B. Water mains are defined as a closed pressure pipe designed to be leak proof and convey potable water suitable for public use to the general population as well as for firefighting uses.
- C. Engineer shall obtain approval from the Utility for exceptions or deviations from these requirements. Exceptions or deviations may be granted on a project by project basis only.
- D. The Engineer shall develop Contract Drawings to meet the needs of the Project. The Contract Drawings must conform to the requirements as noted in Chapter 2.
- E. The design of water distribution systems shall adhere to the requirements of the Texas Commission on Environmental Quality (TCEQ). A summary of TCEQ requirements and design/construction checklists are provided in Appendix E.

### 12.2 WATER MAIN CLASSIFICATION BY FUNCTION AND SIZE

Pipe size shall mean the actual or the nominal inside diameter of the pipe. Generally, the basic classifications of water lines by function and approved standard sizes are:

- A. Transmission Lines  
20-inches in diameter and larger. Standard pipe sizes shall be 20, 24, 30, 36, 42, 48, 54, and 60-inch.
- B. Distribution Lines  
6-inches to 16-inches in diameter. Standard pipe sizes shall be 6, 8, 12, and 16-inch.
- C. Service Lines  
3/4-inch to 10-inches in diameter. Fire line services and specially metered areas may require 6-inch or larger diameter based on required demand of customer facilities.
- D. Non-Potable Water Systems  
Under special design circumstances, non-potable waterline facilities such as well flow lines, plant effluent, or reclaimed mains (see Chapter 17) may be required. Design of non-potable water line facilities shall comply with the applicable standard guidelines established for transmission or distribution lines, described herein.

### 12.3 DESIGN PARAMETERS

The design and selection of water mains comprising the distribution system for the City of El Paso shall be based on the following internal and external parameters.

### 12.3.1 Design Flow Capacity of the Main

- A. In designing the flow capacity of a main, the following water demand rates shall be determined, either from previous data or based on predicted demands:

Average Daily Demand is the average of the total amount of water used per day in a one-year period.

Maximum Daily Demand is the maximum total amount of water used during any 24-hour interval in a three-year period. This rate shall exclude any unusual and excessive water use during this time period that would affect the final value.

Maximum Hourly Demand is the maximum amount of water used during any 60-minute period, on any day, in a three-year period.

- B. Water Transmission and Distribution Mains shall be sufficient in capacity to supply the larger of either the Maximum Hourly Demand or the Maximum Daily Demand **plus** the required minimum rates of flow for fire protection for the required duration of time. These Fire Flow Rates are based on the minimum rates established by the Texas Commission on Fire Protection and are indicated in Table 12-1.

TABLE 12-1 REQUIRED FIRE FLOWS		
AREA	RATE	DURATION
Heavy Commercial	3000 gpm	3 Hours
Light Commercial	1500 gpm	2 Hours
Dense Residential	1000 gpm	2 Hours
Scattered Residential	1000 gpm	1 Hour
Mixed Use	1500 gpm	2 Hours

The distribution system shall be designed to maintain a minimum pressure of 20 psi at all points in the system under combined fire flow and normal consumption conditions.

### 12.3.2 State Regulations

- A. The system shall be designed to maintain a minimum pressure of 35 psi at all points within the distribution network at flow rates of at least 1.5 gallons per minute per connection.
- B. A connection shall be a single family residential unit or each commercial or industrial establishment to which potable water is supplied from the system. When sufficient data is unavailable to accurately determine the number of connections being served or to be served, the population served divided by three will be used as the number of connections for calculating system capacity requirements.

### 12.3.3 Hydraulic Flow (Limiting) Factors

- A. Maximum rate of head loss due to friction in a distribution or transmission main shall be 5-7 feet per thousand feet.
- B. Velocity in Transmission Mains shall not exceed 4-5 feet per second.
- C. Velocity in Distribution Mains shall not exceed 5-7 feet per second.

#### 12.3.4 Anticipated Pressure Conditions

- A. In providing material suitable for the anticipated pressure conditions, the following distinctions shall be made:
  - Working Pressure (WP) shall denote the maximum anticipated sustained operating pressure of the water system.
  - Surge Pressure (Ps) shall be the maximum pressure increase greater than working pressure that is anticipated in the system as a result of change in the velocity of the water column when valves are operated or when pumps are started or stopped.
  - Pressure Class (PC) shall denote the pipe's designated design capacity (psi) to resist working pressure and shall provide for an anticipated pressure rise above the maximum working pressure caused by surge.
  - Pressure Rating (PR) shall denote the pipe's designated design capacity (psi) that corresponds to its recommended safe maximum operating pressure. There is no allowance for pressure surges above this maximum sustained operating pressure in the pressure rating designation.
- B. Selection of the appropriate pressure class or pressure rating shall be based on the anticipated total system pressure which shall be defined as the sum of the working pressure plus surge pressure.
- C. Selection of Pressure Class or Pressure Rating for a pipe to be used in a particular area shall be based upon the area's anticipated normal operating pressures and anticipated surge pressure as determined by system analysis or field data, and shall be in accordance with the following Working Pressure Zones, as defined by the Utility:
  - **ZONE 1** is assigned to a distribution network area where the combination of working pressure and normal anticipated surges is equal to or less than 100 psi.
  - **ZONE 2** is assigned to a distribution network area where the combination of working pressure and normal anticipated surges is **greater** than 100 psi. Distribution system piping connected directly to pumping facilities and subjected to pump discharge pressures in excess of 100 psi due to working pressure alone or in combination with anticipated surges, shall be treated as a zone 2 piping system. Refer to Section 12.4.1 G-6.

Refer to Table 12-7 for information regarding appropriate Pressure Class, Pressure Rating and Pipe Material Selection.

#### 12.3.5 External Load Factors

- A. Pipe strength must be sufficient to resist external forces including standard backfill, the weight exerted by traffic, and other anticipated external forces.
- B. Embedment of a pipe is significant in determining external load-carrying capacity. Pipe embedment shall provide uniform longitudinal support under pipe and shall ensure that external loads will not deflect nor cause pipe settlement beyond allowable limits.



### 12.3.6 Grid Network

The development of the grid network shall be based on the size and shapes of tract, including right-of-ways, in subdivisions. Generally, the following criteria shall be implemented:

- A. Minimum pipe diameter within the network is 6-inch at a maximum spacing of 600 feet,. When this distance is exceeded, 8-inch pipe shall be used.
- B. In right-of-ways 90 feet and larger, the minimum line size shall generally be 12-inch,. These shall be arranged into interlocking loops so that the maximum spacing is the shortest of either of the following: 3000 feet or the length that would, by fluid friction, render the line incapable of producing the flows and pressures set out herein for the type of area to be served.
- C. In 70-foot right-of-ways, the minimum line size shall be 12-inch,. These distributions' mains shall be arranged within the larger loop, no more than a few blocks apart, and shall provide normal supply and fire fighting capabilities.
- D. In right-of-ways 60-feet and smaller, the lines' sizes shall generally be 6 and 8-inch. These lines shall form a grid over the area to be served and shall supply water to service lines and fire hydrants.

### 12.3.7 Separation Distances

Separation distances of Utility mains shall be in accordance with Chapter 4 and the Utility Standard Details.

## 12.4 ALLOWABLE PIPE MATERIAL TYPES

The following section provides general information on the type of pipe materials acceptable within the El Paso distribution system. Additional information regarding these material types is included in Section 12.5. Information regarding corrosion control of the various pipe materials is addressed in Chapter 19.

### 12.4.1 Poly Vinyl Chloride (PVC) Pressure Pipe

- A. PVC pipe shall generally be used for Distribution Lines unless special conditions or other prohibitions as set forth in this Chapter require another material. All PVC shall conform to AWWA Standards C-900 and C-905. Outer diameters shall be comparable to cast iron pipe or fittings. Pipe shall be fabricated with color as specified by EPWU (blue – water, purple – reclaimed, green – sewer).
- B. Designation of PVC **C-900** shall be according to “**pressure class**” for pipe diameters 4” to 12”.  
  
Designation of PVC **C-905** shall be according to “**pressure rating**” for pipe diameters 14” to “48”.
- C. The design selection of **pressure class** or **pressure rating** of PVC pipe shall be made according to the criteria established in this Chapter and Table 12-7 below.
- D. **Pressure Class C-900 Considerations**
  - 1. Minimum pressure class of C-900 pipe should be equal to or greater than the system working pressure (WP).

2. Pressure Class is calculated based on the following ISO equation:

$$PC = [ 2 / (DR - 1) ] \times HDB \times DF$$

Where:

PC = Pressure class, psi  
DR = Dimension Ratio =  $D_o/t$   
 $D_o$  = Average Outside Diameter, in.  
 $t$  = Minimum pipe wall thickness, in.  
HDB = Hydrostatic design basis, 4,000 psi  
DF = 0.5; design factor or inverse of safety factor; includes consideration of degree of safety and the variables, including **limited** surge effects in the end application

- a. In accordance with revisions to AWWA C900-07 Standard effective, the concept of a built-in surge allowance using a 2.5 safety factor has been eliminated and replaced by, and reflected in, the design factor  $DF = 0.5$  of the ISO equation above (corresponding to a safety factor of 2), which accounts for two types of surge effects: occasional surge pressure and recurring surge pressure, as described below. These changes are intended to allow the designer to analyze surge conditions specific to their project (refer to 12.4.1 F on surge evaluation below):
- b. **Occasional** (emergency or transient) **surge pressure** (Pos) is normally of high magnitude and severity, caused by emergency pump and valve operations. The distribution system should be designed to withstand positive and negative pressures caused by such emergency operations.

For most normal distribution networks where occasional surge pressures are anticipated by the Design Engineer, the selected pressure class will be deemed to accommodate these surges PROVIDED that the sum of the maximum anticipated working pressure PLUS the maximum anticipated occasional surge pressure ( $WP + Pos$ ) collectively termed "**Occasional Surge Pressure Capacity**", does not exceed 1.60 times the pipe's pressure class times the temperature coefficient  $F_t$  (collectively termed "**Short-term Pressure Rating**"):

$$WP + Pos < 1.60 \times PC \times F_t$$

Based on this requirement, Table 12-2 below provides designers with the allowable maximum occasional surge pressure capacity and allowable sudden changes in water velocity for pipe operating at 73° F (23° C) at working pressures expressed as percent of nominal pressure class (PC). NOTE: The surge pressure tolerances in this table apply only to pipe and not to system components, which may have lesser tolerances. The design should consider possible system reactions and their potential effect on system components.

A pipe may sometimes be subjected to net negative internal pressure because of the individual or combined effect of internal negative transients and external forces (such as water table). When this situation exists, refer to the supplier for information on the hydraulic collapse resistance of the pipeline.

**Table 12-2 Allowable Maximum Occasional Surge Pressure Capacity**

DR	Pressure Class (PC)	Occasional Surge Pressure Capacity	Corresponding Sudden Changes in Velocity With WP = % of PC			
			100%	80%	60%	40%
25	165	264	6.7	9.0	11.2	13.5
18	235	376	8.1	10.8	13.5	16.2
14	305	488	9.2	12.3	15.4	18.5

- c. **Recurring** (cyclic) **surge pressure** (Prs) occurs frequently and is inherent to the design and operation of the system such as normal pump startup or shutdown, and normal valve opening or closure. Recurring surge pressure, although generally of low amplitude, may develop high-frequency, high-amplitude surge conditions, and may occur millions of times in a piping system's lifetime. Where recurring surge pressures are anticipated, the selected pressure class will be deemed to accommodate these surges provided that the sum of the maximum anticipated working pressure PLUS the maximum anticipated cyclic surge pressure (WP + Prs) collectively termed "**Recurring Pressure Capacity**", does not exceed the pipe's pressure class times the temperature coefficient:

$$WP + Prs < PC \times Ft$$

- d. A design example utilizing recurring and occasional surge pressures is presented in Appendix G of this manual as a reference.
3. The pressure class selected and as shown in Table 12-7, shall apply to a sustained operating temperature of the pipe wall of 73.4° F (23° C) or less. Where the pipe wall temperature exceeds this value, the pipe's pressure class shall be reduced by the appropriate temperature-compensating multiplier (Ft) per the following table:

**Table 12-3 – Temperature Coefficients Ft**

Pipe Temperature		Pressure Rating Reduction Coefficient Ft
°F	(°C )	
73.4	(23)	1.00
80	(27)	0.88
90	(32)	0.75
100	(38)	0.62
110	(43)	0.50
120	(49)	0.40
130	(54)	0.30
140	(60)	0.22

However, a short-term rise in service temperature above 73° F (23° C) as for example, a few weeks during the summer, does not require use of temperature coefficients for pipeline design.

4. The maximum anticipated working pressure cannot exceed the pipe's pressure class times the temperature coefficient (Ft):

$$WP < PC \times Ft$$

#### E. Pressure Rating C-905 Considerations

1. Pipe pressure ratings shall be based on a safety factor of 2.0 when calculated using the following equation:

$$PR = [2 / (DR - 1)] \times [HDB / F]$$

Where:

PR = pressure rating (psi) – Note: For sustained pipe temperatures above 73° F (23° C), adjust the values per Table 12-3

DR = Dimension Ratio (Do/t)

HDB = hydrostatic design basis, 4000 psi

F = 2.0 safety factor

**Table 12-4 – Transmission and Distribution - Pipe Pressure Rating**

Dimension Ratio (DR)	Pressure Rating (PR) psi
51	80
41	100
32.5	125
26	160
25	165
21	200
18	235
14	305

2. **Working Pressure Rating (WPR)** shall be a variable rating dependent on specific pipeline design conditions. Working pressure rating shall be calculated using the following equation and shall depend upon (1) the safety factor selected and (2) anticipated pressure surges:

$$WPR = [2PR / F] - Ps$$

Where:

WPR = Working-pressure Rating (psi)

PR = Pressure Rating (as defined in 12.4.1 E above)

F = Safety Factor, normally 2.0 for transmission pipe – other applications may warrant the use of a safety factor other than 2.0

Ps = Surge Pressure allowance (psi) as analyzed by computer or calculated for anticipated operating conditions

NOTE: In the WPR equation, when the safety factor is 2.0 and no surges are calculated or anticipated, the WPR is simply the pressure rating of the pipe (PR). It is pointed out that while the pressure class and pressure ratings are the similar for the same DR, the pressure class accounts for limited surges and smaller pipe diameters, while the pressure rating accounts for no surge, larger transmission pipe diameters, and may therefore require a different class or DR designation when introducing surge values, depending on the magnitude of the working pressure component.

A Working-Pressure Rating Example is presented in the AWWA C900 Appendix as a reference.

#### F. Surges - Evaluation and Application

In determining whether or not a particular PVC pipe design selection merits a full scale surge analysis or evaluation, the following should be considered:

1. High surges caused by abrupt changes in water flow velocities of high magnitude will result in high surge pressures which can be detrimental to a piping system. Under most normal circumstances, flow velocities in municipal water mains rarely exceed 2.0 feet per second (fps). Such systems are designed to provide large-volume water distribution through piping grid systems at relatively low pressures (generally under 80 psi). These low operating pressures normally prevent high flow velocities, even under fire flow conditions. In common practice and during peak demand periods, maximum flow velocity in PVC and other material piping systems is limited to 5 fps (refer to other criteria for various pipe diameters Section 12.3.3). Where higher flow velocities are anticipated, these maximum flow velocities must be defined and a determination of the corresponding anticipated surge pressures should follow. This will provide criteria for pipe material selection by pressure class or rating, which will accommodate worst case total system pressures as discussed in Sections 12.4.1 D and E above. In addition to proper material selection, design precautions should be implemented through surge suppression devices, anti-surge control valves, safety valves, variable speed drives, surge tanks, etc.
2. As a convenience for the benefit of users of this manual, the following surge equations are provided. Computerized programs may also be substituted in determining surge magnitudes. Maximum surge pressure (Ps) is the result of rapid closing of a valve, sudden starting or stopping pumps, reservoir wave action, entrapped air, or other mechanisms creating liquid column separation. The **maximum surge pressure** (Ps) is related to the maximum rate of change of the flow, and the rate of travel of the pressure wave is related to the speed of sound in the fluid (modified by the piping material).

**Step One: Determine the wave velocity ( a ) from the following equation:**

$$\begin{aligned} \text{For any pipe material:} \quad a &= \frac{4600}{\sqrt{1 + \frac{kd}{Et}}} \\ \text{For PVC:} \quad a &= \frac{4600}{\sqrt{1 + \frac{k}{E} (DR-2)}} \end{aligned}$$

Where:

$a$  = wave velocity (fps)  
 $k$  = fluid bulk modulus (300,000 psi for water)  
 $d$  = pipe ID (inches)  
 $E$  = modulus of elasticity of pipe (400,000 psi for PVC)  
 $t$  = wall thickness (inches)  
 $DR$  = pipe OD/ $t$

**Step Two: Determine the maximum pressure surge ( $P_s$ ) from the equation:**

$$P_s = \frac{aV}{2.31 g}$$

Where:

$P_s$  = pressure surge (psi)  
 $a$  = wave velocity (fps)  
 $V$  = maximum velocity change (fps)  
 $g$  = acceleration of gravity (32.2 ft/sec<sup>2</sup>)

**Table 12-5 – Pressure Surges in 8 inch Water Main  
(In Response to 2 fps Instantaneous Flow Velocity Change)**

Pipe Product	Pressure Surge (psi)
Class 350 DI Pipe	106.1
Press Class 235 PVC (DR 18)	34.8

**Table 12-6 - Design Table for PVC Pipe – Pressure Surge vs Dimension Ratio  
(In Response to 1 fps Instantaneous Flow Velocity Change)**

Dimension Ratio	Pressure Surge (psi)
14	19.8
18	17.4
25	14.7

Table 12-6 surge values can be multiplied by an anticipated change in flow velocity when calculating occasional or recurring surge pressures as defined in 12.4.1 D and in calculating the surge component of the Working Pressure Rating described in 12.4.1 E. A design example utilizing recurring and occasional surge pressures is presented in Appendix the AWWA manual as a reference.

**G. Prohibitions in Use of PVC**

Except under special or unforeseen circumstances and/or approval by the Utility, PVC pipe shall not be the selected material for trench installation when the following conditions are known to be present:

1. Depth of cover conditions:
  - a. When the depth of cover exceeds 10 feet. This limitation is driven more by access issues during repair activities, safety, and traffic hazards due to deep pit exposures during line breaks, and not by overburden weight.
  - b. When the depth of cover is less than 4 feet.
2. When cement flowable fill is expected to be used around the open-trench pipe zone. This limitation attempts to reduce or eliminate on-field placement activities which inadvertently may force shifting of pipe joints, creating undesirable deflections which must be held to nearly zero, and where it is critical that pipe joints remain concentric to each other.
3. When soil conditions indicate the presence of hard rock conditions in the trench excavation requiring blasting or difficult loosening or fragmenting of the trench bedding material. Engineer shall verify subsurface conditions in suspect hard terrain areas using standard geotechnical methods. Under unforeseen circumstances or changed site conditions where PVC pipe has been approved for installation, where jagged rock projects vertically and horizontally into the pipe bedding zone or from the trench side walls, overexcavation of the pipe embedment zone and a suitable imported sand or class I or II soil material, free of large angular rock, shall be placed around the pipe zone, not less than 12" in compacted width all around. No on-site material excavated having over 25% angular fragmented rock greater than 2 inches by volume shall be used for backfill. Instead, a suitable class I or II imported material shall be used. Ductile Iron pipe shall be the preferred option under the above rock conditions.

4. Where the working pressure alone or in combination with a surge component, exceeds a Zone 1 service area designation (refer to 12.3.4 C), except that under these circumstances, only DR 14 PVC pipe shall be allowed provided that calculations are submitted to the Utility indicating that the anticipated maximum operating (working) pressure with anticipated surges will not exceed the pressure rating corresponding to DR 14 pipe.
5. On intermediate pressure zone developments or service areas, where pressure reducing valves are utilized to separate the high pressure service area from the intermediate (or lower) pressure service area. Under this condition, the intermediate service area shall be deemed to potentially become transformed into a Zone 2 (>100 psi) working pressure system. As such, PVC pipe may be allowed upon approval by the Utility's engineering office provided that:
  - a. the intermediate zone development or subsequent connecting developments are equipped with at least one pressure relief valve station at the lower extremities of one or more connecting development zones, and;
  - b. the intermediate zone is designed with either PVC Pressure Class or Pressure Rating 305 (DR 14) pipe in accordance with Table 12-7 or other alternate pipe material, meeting or exceeding a pressure class rated for the anticipated maximum working pressure plus calculated surge pressure, otherwise a 100 psi surge allowance.
6. On the discharge main of a booster supply pump station, including distribution system piping connected directly to pumping facilities, subjected to pump discharge pressures in excess of 100 psi due to working pressure alone or in combination with anticipated surges. The discharge main and connecting lines shall be treated as a zone 2 piping system, up to an elevation rise where the combined working pressure and surge is reduced back to under 100 psi (Zone1). **PVC shall not be approved or selected as discharge piping for booster pump stations up to the following distance:**
  - a. Where the discharge line is used as supply transmission to elevated storage, up to any distance where calculations or hydraulic analysis indicates that the anticipated maximum operating pressure alone or in combination with a calculated or anticipated surge pressure exceeds a Zone 1 pressure (100 psi) limit.
  - b. Where the line is connected to the distribution system network at various points, and a hydraulic network analysis indicates that the anticipated maximum operating pressure alone or in combination with a calculated or anticipated surge pressure exceeds a Zone 1 pressure (100 psi) limit.
  - c. Where the discharge line is 16-inches or larger in diameter at any distance.

Where extenuating circumstances require the use of PVC, and where anticipated total system pressures are within a Zone 1 limit, special approval may be granted to use PVC on portions of the pump station discharge system. As such, only DR 14 pipe shall be installed per Table 12-7.



#### H. Over Homing

Construction specifications shall include language in the PVC installation section requiring the contractor to monitor, control, and eliminate installation practices involving “over homing” each joint of pipe, spigot to bell, as the pipe laying progresses. The recommended practice (AWWA M23) is to use hand or bar with block methods of pushing one joint into another. Construction machinery should be used only at the direction of the manufacturer. A circumferential reference mark is placed on the pipe’s spigot end by the manufacturer to indicate the correct depth of spigot penetration into the pipe’s gasket joint. All pipe shall have dual insertion marks on the spigot indicating proper penetration when the joint is assembled and only one mark remains visible. The sockets and/or spigot configurations for the fittings and couplings shall be compatible to the pipe. Socket configuration shall prevent improper installation of gasket and shall ensure that the gasket remains in place during joining operations. If undue resistance to insertion of the pipe end is encountered, or if the reference mark does not position properly, disassemble the joint and check the position of the gasket. If the gasket is twisted or pushed out of its seat (“fishmouthed”), inspect components, repair or replace damaged items, clean the components, and repeat the assembly steps. Ensure that pipe lengths are in concentric alignment. If gasket is not out of position, verify proper location of the reference mark. Relocate the reference mark if it is out of position. Few fittings allow as much spigot insertion length as do pipe bells and couplings.

#### 12.4.2 Steel Cylinder Concrete Pipe (SCCP)

Shall generally be used for Transmission Lines and shall conform to AWWA Standards C-303. Concrete pressure pipe shall be bar-wrapped steel cylinder type.

#### 12.4.3 Steel Pipe (STL)

Shall generally be used for Transmission Lines and shall conform to AWWA Standard C-200 with cement mortar lining (AWWA C-205), and polyurethane coating (AWWA C-222). At the owner's discretion, selection of steel pipe as an alternate material for use in a project shall be based upon a life cycle cost analysis with regards to other pipe materials. Wrap shall be of color as specified by EPWU (blue – water, purple – reclaimed, green – sewer).

#### 12.4.4 Ductile Iron (DIP)

Shall generally be used for Transmission Lines, unless special conditions require that it be used for Distribution Lines. DIP shall be accordance with AWWA C-151/A21.51 and cement mortar lined in accordance with AWWA C-104/A21.4. The manufacturer shall provide a standard asphaltic coating in accordance with AWWA C-151. Polyethylene wrap shall be used on DIP 30-inches and smaller. The polyethylene wrap be applied in accordance with AWWA C-105/A21.5 except a minimum thickness of 30 mils shall be used. Wrap shall be of color as specified by EPWU (blue – water, purple – reclaimed, green – sewer).

Designation of DIP shall be by pressure class of the pipe. Pressure class shall be for the rated working pressure plus a surge allowance of 100 psi in accordance with AWWA C-151/A21.51.

#### 12.4.5 Cast Iron Pipe (CIP)

Cast iron pipe is not acceptable.

#### 12.4.6 High Density Polyethylene Pipe (HDPE)

HDPE is not allowed for potable water applications. HDPE pipe is flexible pipe manufactured in the United States that shall conform to ASTM Standard F-894. Pipe sizes for HDPE shall be for diameters 36-inch and smaller. Use of HDPE pipe shall be under special circumstances such as for concentrate disposal plant effluent operations or under other extreme constrained conditions as approved by the Utility.

## **12.5 PIPE MATERIAL SELECTION**

### **12.5.1 Water System Allowable Material and Pipe Class**

- A. Water mains shall be designed and constructed to satisfy the requirements established in Table 12-7 for the various diameters, material type, and pressure class shown.
- B. Projects designed to replace existing pipelines with the same pipe material shall be in accordance with the standards and schedule set herein. All materials shall be approved materials as specified previously.

TABLE 12-7 WATER SYSTEM ALLOWABLE MATERIALS AND PIPE CLASS							
PIPE DIAMETER (in)	MATERIAL	AWWA STANDARD	ZONE <sup>1</sup>	Minimum PC <sup>2</sup> (psi)	Minimum PR <sup>2</sup> (psi)	DR	STD LENGTH (ft)**
6, 8, 12	PVC	C-900	1	235		18	20
			2	305		14	20
	DIP	C-151/A21.51	1 & 2	350		NA	18
16	PVC	C-905	1		235	18	20
			2		305	14	20
	DIP	C-151/A21.51	1 & 2	****		NA	18
20 - 36	DIP	C-151/A21.51	1 & 2	****		NA	18
	STEEL	C-200	1 & 2	***		NA	45
	SCCP	C-303	1 & 2	***		NA	32
42, 48, 54, 60	DIP	C-151/A21.51	1 & 2	****		NA	20
	STEEL	C-200	1 & 2	***		NA	45
	SCCP	C-303	1 & 2	***		NA	32
DR – Dimension Ratio – determined by dividing the average OD of the pipe by its minimum wall thickness							
<sup>1</sup> Zones 1 & 2 defined in Section 12.3.4							
<sup>2</sup> PC (Pressure Class) and PR (Pressure Rating) defined in Section 12.3.4							
* HDPE pipe size designated as nominal outside diameter							
** Engineer shall evaluate maximum joint length specifications in relation to shipping, handling and installation to mitigate potential damage to the pipe.							
*** Shall depend upon specific project requirements and shall be determined by the pipe manufacturer and Engineer							
**** Pressure Class to be determined in accordance with Section 12.4.4 (AWWA C151/A21.51)							

#### 12.5.4 Well Flow Lines (Collector Lines)

Well lines shall be designed in accordance with potable water requirements unless otherwise approved by EPWU and as determined by the Engineer on a case by case basis.

## 12.6 STANDARD COVER

Standard cover shall generally be as indicated in Table 12-6 and in accordance with Utility Standard Details. Engineer shall consider potential for future development and/or roadway improvements when establishing depths of cover.

TABLE 12-8 STANDARD COVER FOR WATER MAINS			
CONDITION		DIAMETER = 6-Inch and 8-Inch	DIAMETER = 12-Inch and LARGER
A	NORMAL LINE INSTALLATION, STREET AND DRAINAGE PROJECTS, WATER LINE RELOCATION	Minimum cover shall be 4-ft from <u>top of pipe</u> to finished grade	Minimum cover shall be 5-ft from <u>top of pipe</u> to finished grade
B	NEW SUBDIVISIONS OR NON-PAVED AREAS	Minimum cover shall be 6-ft from <u>top of pipe</u> to proposed finished grade	Minimum cover shall be 7-ft from <u>top of pipe</u> to proposed finished grade

## 12.7 FITTINGS AND VALVES

### 12.7.1 Fittings

Fittings shall be used for change in line direction or size and branch connections. All fittings shall conform to applicable ASTM, ANSI, and AWWA Standards for the type of pipe material utilized. Utility Standard Details are provided in the Appendix.

### 12.7.2 Valve Types

#### A. Gate Valves

Shall be in compliance with AWWA Standards C-500 or C-509. Gate valves shall be used on water mains whose diameter is less than 16-inch. They shall be used to isolate pipe sections for pressure testing, emergency cutoffs, and to provide "blow off" at low dips in the line.

#### B. Butterfly Valves

Shall be in compliance with AWWA Standard C-504. Butterfly valves shall be used on water mains 16-inch diameter and larger. They shall be used to isolate pipe sections for pressure testing and emergency cutoffs. Butterfly valves shall be positioned for horizontal operation. Sixteen (16) inch operator valves shall have a standard valve extension, pipe spool and bonnet box. Valves larger than 16-inch shall have a typical manhole in accordance with Utility Standard Details. Upon request by the Utility, manholes shall be provided for 16-inch butterfly valves. Butterfly valves may not be allowed by TxDOT within their ROW.

#### C. Air Relief Valves

Air relief valves shall generally be installed at the high points in a line, or where a long line changes slope. These valves can be positive air release or a combination air vacuum valve as required.

- D. Check Valves  
Check valves shall be used on discharge side of pumps or other locations where the potential for backflow exists. Valve type selection shall be based on hydraulic considerations or on a case by case basis.
- E. Miscellaneous Control Valves:
- Surge Valves  
Shall be used in locations where engineering analysis indicates a high probability of high pressures generated by water hammer. A typical location of surge valves is in the vicinity of a pumped source of supply.
- Pressure Reducing Valves  
Shall be used between high and low or intermediate pressure zone where a constant downstream pressure must be maintained.
- Pressure Relief Valves  
Shall be used to relieve high pressures on the low elevation end of a pressure zone that borders a lower or intermediate zone.
- F. Blow-off Valves  
Blow-off valve assembly shall be used at low points of a long stretch of pipeline, preferably in systems 16-inch and larger.

### 12.7.3 Valve Bonnet Box

A valve bonnet box shall surround and provide access to the valve stem of each buried valve, and shall conform to Utility Standard Details.

### 12.7.4 Valve Spacing and Location

- A. Valves on water mains shall be placed at a maximum distance of 500-feet.

**Table 12-9 – Valve Spacing**

Pipeline Size (Diameter)	Maximum Spacing Distance
Less than 20"	500'
20" and greater	1000'

- B. The number of valves at an intersection is one less than the streets coming into an intersection. Valves shall be aligned with the property line of the street.
- C. One isolation valve shall be placed on each side of major canals, railroads, utility corridors, TxDOT right-of-way, etc.
- D. A shut-off valve shall be provided on every hydrant lateral.

## 12.8 THRUST RESTRAINTS

### 12.8.1 Concrete Thrust Blocks

- A. Concrete Thrust Blocks shall be provided, as necessary, to reduce movement of pipe or appurtenances in response to thrust. Thrust blocks shall be used as secondary thrust support conjunctively with mechanical joint restraints. Thrust blocks shall NOT be used in soft or unstable trench wall soil conditions without supplemental joint restraint fittings. Thrust blocking is required at each hydrant, valve, bend, tee, and at reducers or fittings where changes in pipe diameter or direction occur.
- B. Anchor straps or steel rods embedded to concrete thrust blocks shall be provided in accordance with Utility Standard Details, and sized adequately to resist stresses imposed by internal forces.
- C. Thrust blocks shall be installed in accordance with Utility Standard Details. Unusual loading conditions may require special thrust block design. Design shall depend upon soil type, maximum system pressure, pipe or appurtenance size and type.

### **12.8.2 Mechanical Joint Restraints**

The preferred method of restraining pipe sections at bends, tees, or other changes in direction shall be through mechanical joint restraints. The Engineer shall design, or make provisions in the design documents, for adequate pipe joint restraint design to resist anticipated thrust forces for pressure pipe applications. The distance to be restrained from a bend or fitting shall be computed utilizing proven pipe manufacturers software tools, or manual methods using industry thrust restraint design methods.

## **12.9 FIRE HYDRANTS**

### **12.9.1 General Information**

- A. All hydrants shall conform to AWWA Standard C-502 and the standards established by the City of El Paso Fire Department.
- B. Public fire hydrants shall only be installed along open dedicated streets, or at other approved locations with existing structures.
- C. All hydrants shall include Davidson type Anti-terrorism Valve assemblies.

### **12.9.2 Hydrant Size**

The standard size for a hydrant is 5-¼ inch. It shall be connected to the main by a 6-inch line with a separate gate valve. Refer to the Utility Standard Details.

### **12.9.3 Hydrant Location**

- A. The maximum distance of a hydrant from the face of the curb shall be 2 feet, in accordance with Utility Standard Details.
- B. Fire hydrants shall not be installed within 9 feet vertically or horizontally of any sanitary sewer line regardless of construction.
- C. The preferred location of fire hydrants is at street intersections. However, due to spacing requirements, fire hydrants may be placed at the approximate midpoint of two intersections. This location shall coincide with the property line common to adjoining lots.

#### 12.9.4 Hydrant Spacing

- A. Hydrants shall be spaced according to regulations specified by the City of El Paso Fire Department. Standard maximum spacing of fire hydrants shall be:
- 800 feet for single-family residential
  - 500 feet for multi-family residential
  - 500 feet for commercial/industrial

Other factors, such as level of risk and street layout, adjacent land use (current), should be considered when determining the spacing of hydrants.

#### 12.10 WATER SERVICE CONNECTIONS

- A. Water meters shall generally be designed in accordance with AWWA M-6 and AWWA M-22.
- B. Typical service line installations shall be in accordance with Utility Standard Details.
- C. Water Meters

1. The Utility will not place meters or services on the outside of the curb line on any existing street or newly constructed streets unless the outside grading (property side of curb) is within four (4) inches of the finished grade for a distance of ten (10) feet from the property side of the curb. If a curb does not exist then the meters shall be placed flush with the existing roadway surface.
2. For vacant lots, the Utility shall make a determination on whether or not provide a service extension to that property.
3. New water meters, unless otherwise specified, will be furnished and installed by the Utility. All other materials including meter boxes shall be furnished and installed by the Contractor.
4. Meter Location  
When a location for a water meter box outside the property line is not practical, the water meter box shall be located on the customer's premises near the point where the service pipe crosses the property line. There shall be one meter per service line.

Water meters shall not be located in parking lots or driveways and shall be accessible at all times.

5. Meter Size  
Sizing of a meter shall depend upon anticipated required flow rates, pressure at the service connection, and friction losses. Selection of meter size requires approval from the Utility.

The typical sizing of water meters, based on flow demands, shall be:

- Domestic meters =  $\frac{3}{4}$ , 1, and 1- $\frac{1}{2}$  inch
- Yard meters for sprinkler systems, swimming pools, etc. = 2 and 3 inch
- Fire lines = 4 inch meters

6. Construction Meters  
Refer to the Utility Standard Details for information on the following:

- Fire hydrant assembly
  - Standpipe assembly
7. Backflow Prevention Assembly  
All commercial meters shall have a backflow prevention assembly, per TCEQ's Cross Connection Control Program. Engineer shall also refer to the current EPWU Rules and Regulations for backflow preventer requirements as defined by user type.
- D. The separation of between a water service lateral and a sanitary sewer service lateral from the property line to the water distribution main and the sanitary sewer collection main shall be 5-feet minimum of undisturbed or compacted earth.

#### **12.11 TAPPING SLEEVES AND VALVES**

- A. Taps shall be separated by a minimum distance of 18 inches on the longitudinal axis of the pipe. Multiple taps on a single joint shall be approved by EPWU on a case-by-case basis and in accordance with existing pipe manufacturer recommendations.
- B. Tapping assemblies shall be made in accordance with industry standards and shall take into account pipe size, condition, material, wall thickness, etc. Tapping of EPWU pipelines 24" or greater shall be performed by an approved representative of the existing pipe manufacturer.
- C. Tapping of EPWU pipelines 24" or greater shall be done by existing pipe manufacturer.

END OF CHAPTER



# CHAPTER 13

## WATER STORAGE FACILITIES

### 13.1 GENERAL

- A. The term storage as used in these guidelines refers to potable water (and in special cases reclaimed water), which is held in reservoirs or tanks and which is available for delivery to the water system as either a normal or emergency function. The design of storage facilities shall include consideration of:
- Peak demands
  - Emergency storage
  - Interzone pumping
- B. This chapter provides guidance for the design of storage facilities, including steel tanks, reinforced concrete storage tanks and circular pre-stressed concrete tanks. (ground and elevated).
- C. The Engineer shall develop Contract Drawings to meet the needs of the Project. The Contract Drawings must conform to the requirements as noted in Chapter 2.
- D. The Engineer shall prepare all supporting information required to assist the Utility in obtaining permits for the Project.
- E. The design of water storage facilities shall adhere to the requirements of the Texas Commission on Environmental Quality (TCEQ), TAC Rule §290 Subchapter D Rules and Regulations for Public Water Systems, specifically §290.43 Water Storage.

### 13.2 CODES AND STANDARDS

The Engineer is responsible for applying the latest applicable standards and codes to the design of the storage facilities. The following are minimum standards, codes, and references for the design of storage facilities:

- Standards for Welded Steel Tanks for Water Storage, ANSI/AWWA D100
- Standards for Composite Elevated Tanks for Water Storage, ANSI/AWWA D107
- Standards for Wire-Wound, Circular, Prestressed Concrete Water Tanks, ANSI/AWWA D110
- AWWA Standard for Automatically Controlled Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks, ANSI AWWA D104
- AWWA Standard for Coating Steel Water Storage Tanks, ANSI/AWWA D102 and ANSI/NSF Standard 61
- International Building Code (IBC) of the International Code Council, as adopted by the City of El Paso Municipal Code
- Standards of the Occupational Safety and Health Administration (OSHA)
- Structural Welding Code – Steel, ANSI/AWS – D1.1
- American Concrete Institute (ACI 318) and commentary (ACI 318R)
- Environmental Engineering Concrete Structures (ACI 350R)
- Rectangular Concrete Tanks, PCA
- Moments and Reactions for Rectangular Plates, U.S. Bureau of Reclamation

- Concrete Manual, 8th edition, U.S. Bureau of Reclamation
- CRSI – Handbook, Concrete Reinforcing Steel Institute
- Formulas for Stress and Strains, Roark and Young
- Federal Aviation Administration requirements

### 13.3 SITE DESIGN GUIDELINES

- A. The Engineer shall ensure that the designated site has sufficient area, is located at the proper elevation, and has adequate drainage.
- B. The Engineer shall evaluate the following issues when situating the storage facility on the site:
  - Access and parking
  - Flood protection
  - Grading and drainage
  - Yard piping
  - Land ownership and zoning
  - Setbacks from residential areas
  - Landscaping and irrigation
  - Overflow piping
  - Security requirements
  - Subdrain system
  - Site lighting
  - Site utilities
  - Geotechnical conditions
  - Aesthetics
  - Conveyance of overflow offsite
  - Tank shadow castings
  - Space provisions for future telecommunication tower(s)-(case by case basis)
  - Space provisions for future storage facility expansion and pumping facilities, if required
  - FAA Obstruction Determination for elevated storage tanks
- C. Construction drawings for storage facility site improvements must include the following information:
  - Project location map and vicinity map.
  - Survey controls identifying the site by map number, lot number or other identifier linked to the most recent legal title document, and other control features including benchmarks. Survey control must be in accordance with the requirements in Chapter 3. All surveys shall be prepared by Texas Registered RPLS.
  - Site plan, showing the proposed civil works at the site, the existing site topography, and the site boundary.
  - Site address for emergency and utility services.
- D. Access and Parking

Adequate right-of-way must be provided for vehicular access, parking, and turnaround, and for the supply pipeline and drain. A 20-foot minimum width strip area must be provided around the perimeter of the storage tank and on the driveway to the street or the access area.

E. Flood Protection

The floor elevation of buildings at the storage facility must be at least 2 feet above the 100-year flood elevation as determined by the Federal Emergency Management Agency.

F. Grading and Drainage

The grading and drainage plan must be developed in accordance with the requirements of the latest edition of the IBC and the City of El Paso Municipal Code. Recommendations of the site geotechnical report shall be incorporated in the grading design. Overall grading for the site should allow for future modifications or facility expansion at the site.

The site shall be graded with a slope away from the tank in all directions. The storage facility shall be positioned and the site developed to ensure a uniform soil bearing conditions. The footing and floor shall be placed on either native material or structural fill, and the storage facility may not be situated with a portion on native material and a portion on fill, unless approved by the Utility. Over excavation of the site may be required to provide placement of the storage facility on similar materials.

G. Yard Piping

Yard piping must be either steel, ductile iron or concrete steel cylinder pipe. Exposed piping at storage facilities must be steel or ductile iron pipe. Yard piping shall be provided with cathodic protection measures, per Chapter 19.

Unless otherwise approved by the Utility, mainline valves shall be of the same diameter as the pipeline. External ground-level valves shall be protected by bollards.

H. Setbacks

Adequate setbacks from property lines must be provided to conform to local ordinances and codes. The distances between structures are determined by access requirements, piping requirements, site ponding, and future expansion plans. Sufficient setback shall also be provided to allow for fill, cut, or fill transition to existing contour elevations at property lines. Engineer shall also consider tank shadow casting impacts to developed areas. Ideal site size for elevated tanks is 5 acres to accommodate site improvements and future expansion potential; however, may be less if required due to site specific issues.

I. Landscaping and Irrigation

The landscape development of storage facility sites is kept to a minimum and should be low maintenance. Landscape shall be designed in accordance with City of El Paso Municipal Code.

J. Security Fencing

Storage facility sites shall be completely enclosed by a perimeter wall in conformance with TAC §290.38-Definitions. Fencing shall be rockwall/wrought-iron unless an alternate design is required or approved by the Utility. All perimeter walls shall be in accordance with TAC Chapter 290 security requirements for potable water storage facilities. The security fence shall generally be placed 12-inches to the inside of the Utility's property line. Additional security requirements are provided in Chapter 9.

K. Site Lighting

Storage facility site lighting requirements shall be coordinated with the Utility Operations and Maintenance personnel. Outdoor lighting provided shall be selected to reduce glare over the surrounding area and shall be vandal-resistant. Site lighting requirements shall comply with City of El Paso Municipal Code.

L. Project Signage

Project signage identifying the water storage facility shall be provided, in accordance with the guidelines in Chapter 9.

M. Utilities

Develop Site Utilities: Develop design loads, identify and arrange utility services (including electrical, gas, etc), submit request for service and coordinate service installation as needed.

### 13.4 GENERAL DESIGN COMPONENTS

The design of operational components of storage tanks shall be in accordance with AWWA D-100, AWWA D-107 or ACI guidelines, as may be applicable. The design of operational components of composite elevated storage tanks shall be in accordance with AWWA D107.

A. Storage Facility Hydraulics and Piping

1. Inlet and Outlet:

Inlet and outlet piping shall be designed to maximize water circulation inside the tank. As a general rule, separate inlet and outlet pipes are required on all tanks, unless approved by the Utility. Provision of a diffuser on the inlet is desirable to disperse inflow to the tank and promote circulation. For elevated tanks, the piping shall be stainless steel and configured to promote circulation up the water stored. Consideration of tank circulation shall be evaluated on a case by case basis. A safety grill shall be provided to prevent a person from falling down the inlet/outlet piping. Elevated tank piping shall consider capability for obtaining multiple sample points at various tank levels. Sample taps, shall be coordinated with Utility Operations and Maintenance personnel, as to quantity and locations on the tank. Elevated storage tanks shall include sample tap(s) and sample pipe routed to grade.

Altitude valves, if required, may be of the two way type on tanks of 2 million gallons or less, and provided with a bypass valve around the altitude valve. The altitude valve shall be designed with a sensing line and flow control valve. A motor operated valve and gate valve shall be designed to isolate the inlet line. Alternately, motor operated valves (MOV) shall generally be used to control supply into and out of the storage facility. Motor operated valve shall be monitored through the station SCADA system for H-O-A (hand-off-automatic) switch position, and valve position using position switches. Valve shall be capable of being actuated open or closed through SCADA system.

Sample taps, shall be coordinated with Utility Operations and Maintenance personnel, as to quantity and locations on the tank. Elevated storage tanks shall include sample tap(s) and sample pipe routed to grade. Provided separate and independent taps at base of tank for level transmitter required below.

2. Drain:

A drain pipe shall be designed at the bottom of the tank, and the floor of the tank shall be designed with a downward slope towards the drain. The drain line may be discharged to a drainage basin or structure to which the overflow pipe drains. Drain lines shall be not less than 6 inches diameter and shall be equipped with standard gate valve assembly. A removable silt stop, if required, shall be at least 6 inches high, and the fitting or piping connection shall be flush with the floor when the stop is removed.

3. Overflow:

An internal overflow pipe shall be sized to discharge the maximum fill rate of the tank. Discharge from the overflow pipe shall be directed away from the tank foundation towards a drainage basin or structure. A catch trough shall be connected to the overflow pipe inside the storage tank.

4. Drainage Basin:

A drainage basin or structure shall be designed to receive the site storm water drainage and tank overflow. Basin sizing requirements for storm water drainage shall comply with City of El Paso Municipal Code requirements. For tank overflow, a general guideline on design capacity is to provide storage to contain overflow for a period of 30 minutes to one hour.

For storage tanks monitored through SCADA, including an inlet motor operated valve and overflow detection device. Design capacity is to provide a minimum storage capacity to contain overflow for a period of 20 minutes.

B. Access

A minimum of three access manways shall be provided. The minimum diameter shall be 36-inches and shall be provided at the bottom shell course of steel tanks. A 36-inch diameter access hatch shall be provided in the roof and shall be provided with a suitable hinged cover and a hasp for locking. For concrete tanks, at least two 36-inch by 36-inch rectangular manways with hinged covers shall be provided. The design of the manway and the reinforcement around the opening must conform to the requirements of ANSI/API Standard 650 (for steel tanks) or ACI 318 (for concrete tanks).

For elevated tanks, a roof opening shall be provided with a minimum size of 30-inches. Openings shall be provided with a hinged cover and hasp for locking. An additional opening near the tank center shall be provided. Additional openings may be required to provide ventilation during painting or interior tank circulation systems.

Tank ladders, inside ladders, and roof ladders shall be provided and designed in accordance with AWWA D-100 and OSHA requirements. Inside tank ladders shall be fiberglass. For ground storage tanks, the outside ladder is to extend 16-feet above ground level to 4 feet above top of tank landing. The ladder is to be entirely caged in expanded metal, and the bottom of the cage shall have a locking hatch.

C. Vent

One tank vent shall be provided at the center of the tank roof. The vent shall be an Omega shroud and no vendor supplied "or equal" shall be permitted. Vents shall be sized for the maximum inflow or discharge rate to prevent pressure buildup inside the tank. An insect screen shall be provided in the vent.

D. In Tank Mixing – DBP removal

Provisions and need for in-tank mixing system for water quality and disinfection by product (DBP) treatment shall be evaluated. Tank access, hatch dimensions, and provisions for power and control shall be coordinated with the equipment manufacturer.

### **13.5 STEEL TANKS**

This guideline governs the design of elevated or ground storage tanks that are circular in shape, with welded steel plate walls, floors, and roofs.

#### **13.5.1 Structural Guidelines**

- A. The tank roof shall be structural-steel-supported, steel-cone roof, with minimum 1:12 slope and as required by TCEQ. A knuckle with a 2-foot minimum radius shall be provided at the roof and wall junction.
- B. The roof plate construction shall be in accordance with the standard practice of ANSI/AWWA D100 and AWWA D107, by continuous fillet weld at the topside only, provided that a maximum overlap of roof plates does not exceed 6-inches. Full penetration welds shall be used to join the roof knuckle together. The roof plate shall not be connected to the support members.
- C. The roof supports shall be hot-rolled structural shapes with a minimum thickness of 3/16-inch.
- D. Bolts inside the reservoir shall be Type 316 stainless steel.
- E. The tank wall design shall be in accordance with ANSI/AWWA D100 and AWWA D107 standards.
- F. The tank bottom shall be lap welded continuously from the top of the plate with a minimum thickness of 5/16-inch. The bottom plate shall be extended a minimum of 1-inch beyond the exterior of the tank wall. The joint between the tank wall and the bottom plate shall be continuously welded from inside and outside of the tank wall.
- G. The Geotechnical Engineer shall provide recommendations for the foundation design of the storage tank. The reinforced steel and concrete ring foundation may be designed by the tank manufacturer's structural engineer.
- H. Elevated Storage Tanks shall be designed and constructed in accordance with the standard practice of ANSI/AWWA D107, including structural requirements of the IBC Code, ASCE 7 and ACI 318.

Structural design for elevated tanks shall include: Geotechnical investigation, including seismic evaluation, groundwater, wind loading, and live and dead loads of the structure, and shall include recommendations for foundation design: mat type or deep (pier) type, based on the evaluation. Cut and structural backfill requirements shall be identified to assure uniform soil bearing of the structure.

### **13.5.2 Protective Coatings**

All parts of steel shall be painted in accordance with the requirements of ANSI/AWWA D-102 and ANSI/NSF Standard 61, and in accordance with SSPC/NACE standards. Both the interior and exterior surfaces of the tank shall be painted with a protective coating.

### **13.5.3 Cathodic Protection**

- A. Cathodic protection is required to safeguard against corrosion of the submerged surfaces.
- B. The water chemistry, coating, and the change of water level in the tank are some of the factors that determine the design, installation, and power requirements for cathodic protection.
- C. The cathodic protection system shall conform to the requirements of ANSI/AWWA D-104, Automatically Controlled Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks. Impressed current cathodic protection systems shall generally not be energized for new coating for a period of one year.
- D. Refer to Chapter 19 for additional information regarding corrosion protection for storage facilities.

## **13.6 REINFORCED CONCRETE STORAGE TANKS**

Reinforced concrete tanks shall be designed only under special cases and as required by the Utility. This guideline governs the design of buried or partially buried cast-in-place, reinforced concrete tanks.

### **13.6.1 Structural Guidelines**

- A. As required by structural design and to meet minimum code requirements, reinforcing shall run continuously through roof construction joints.
- B. Construction joints shall be provided in the roofs of reinforced concrete reservoirs in accordance with the ACI 350R. Roof joints shall be aligned with wall joints.
- C. The effect of relative rigidity shall be considered when the concrete reservoir roof is rigidly connected to the tank walls. The effect of daily temperature fluctuation on exposed concrete roof slabs is a consideration for partially buried reservoirs.
- D. Expansion, contraction, and construction joints shall be provided in accordance with ACI 350R to allow flexibility and to adequately tolerate differential movements and shrinkage stress. All types of joints in reinforced concrete reservoirs shall be provided with waterstops, where water tightness is required. In addition, all reservoir floor joints shall be provided with sealant.
- E. The Geotechnical Engineer shall provide the foundation design for the storage tank. For buried or partially buried tanks, the geotechnical engineer should evaluate and provide soil lateral loading information for use in design. The floor slab shall be provided with construction (contraction) joints detailed and spaced to allow movement at these joints and to adequately tolerate differential settlement and shrinkage stresses. All floor slab joints shall have a sealant groove and shall be provided with waterstop.

### 13.6.2 Underdrain System

An underdrain system shall be provided that consists of a grid of drainpipes beneath the floor and around the perimeter of the reservoir structure, together with an underdrain vault. The purpose of the underdrain system is to reduce the uplift forces that occur when the reservoir is drained and to detect excessive leakage from the reservoir. Leakage of the tank shall be monitored at the underdrain vault and through a level switch alarm. Engineer will specify the leak test and the acceptable leakage rate.

## 13.7 INSTRUMENTATION AND CONTROL GUIDELINES

Instrumentation and control systems at storage facilities shall consist of level monitoring, and intrusion alarm systems. Other instrumentation and control systems may be required by Operations' personnel on a case by case basis.

### A. Telemetry/Control and Communications

Chapter 21 describes telemetry/control and communications requirements for supervisory control data acquisition (SCADA) referred to as remote terminal units (RTUs) or station control panels. A programmable logic controller (PLC), inherent to the RTU, shall interface between the site instruments and the radio transceiver. The storage facility RTU is polled by the Central Control System, which is programmed in accordance with the storage facility control philosophy, as defined in the Contract Documents unless specified otherwise. This control strategy should be prepared by the Engineer in coordination with the Utility's Instrumentation and Control Group.

### B. Level Monitoring

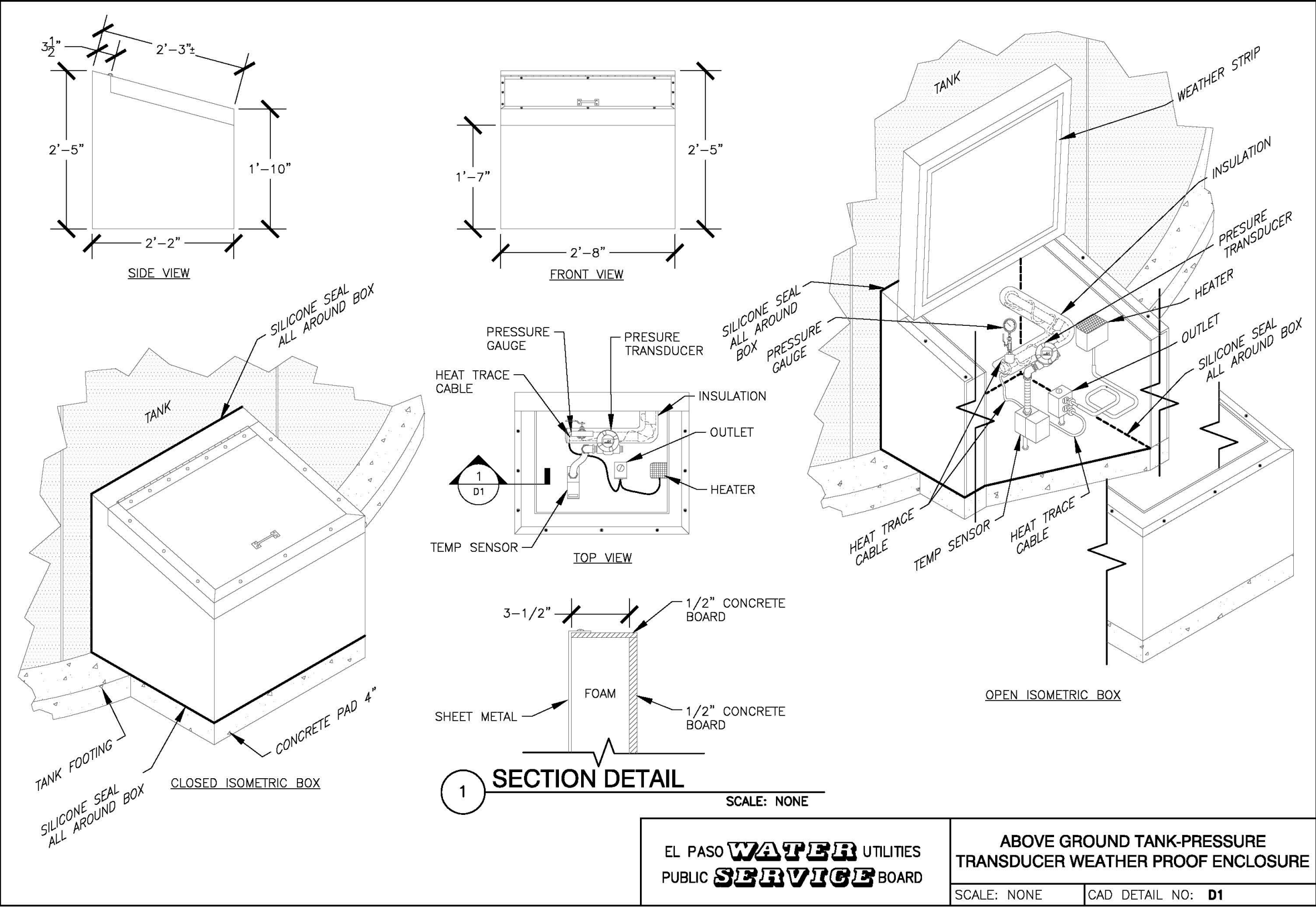
The storage facility level sensor shall be a loop powered ultrasonic or radar level transmitter that produces a 4-20 mA signal proportional to the measured height of the water in the storage facility. The transmitter shall be sourced and signal sensed by the facility's RTU. The transducer shall be mounted on a 150lb ANSI flange at the top of the storage facility. A process meter and enclosure are to be mounted 4.5-feet above finished ground. The process meter with integral digital level readout shall indicate the tank level in feet and inches.

A pressure transmitter shall be provided as a back up to the level transmitter. The pressure transmitter shall be a loop powered device with local indicator connected at the base of the tank. The pressure transmitter and the level transmitter shall be connected to the PLC. Dual cell storage facilities shall be provided with level instrumentation in each cell. A hot box with heat trace, heater, and temperature sensor shall be provided to protect lines and equipment. Provide separate tank tap for instrumentation separate from sampling tap. Tap location shall be coordinated with tank sampling taps, valves, and ports that will be located outside the box.

A detail of an above ground storage tank pressure transducer weather proof enclosure may be seen below in Figure 1.



Figure 1 - Above Ground Storage Tank - Pressure Transducer Weather Proof Enclosure



If required and approved by the Utility, a local level indication shall be provided with a target and gauge board assembly on the exterior wall of the tank. An internal float riding on two bottom anchored guide cables shall actuate the vertical moving pointer. All components in contact with water must be Type 316 stainless steel.

C. Site Intrusion Alarm

The storage facility site shall be provided with intrusion switches on ladder hatches, tank hatches, maintenance access openings, and electrical room doors. Intrusion switches shall be connected to the PLC.

END OF CHAPTER

# CHAPTER 14

## WATER PUMPING STATIONS

### 14.1 GENERAL

- A. This chapter addresses guidelines for the design of potable and reclaimed water pumping stations. Guidelines for the design of pump stations for wastewater are covered under Chapter 16.
- B. Specific design and equipment requirements for the project shall be developed by the Engineer in conjunction with the review and approval by the Utility.
- C. Special pumping station requirements, if required by the Utility, are typically for pumping station designs with high lift or high flow pumps, special environmental concerns, or other special design requirements as determined by the Utility.
- D. The Engineer shall submit a written verification of special pumping station criteria to be incorporated into the design of the pumping station. The Engineer shall also reference and discuss any criteria in this listing to which it takes exception and does not recommend implementing.
- E. The Engineer shall develop Contract Drawings to meet the needs of the Project. The Contract Drawings must conform to the requirements as noted in Chapter 2.
- F. The design of water pumping stations shall adhere to the requirements of the Texas Commission on Environmental Quality (TCEQ). TCEQ design requirements and checklists can be found at [www.sos.state.tx.us/tac/](http://www.sos.state.tx.us/tac/).

### 14.2 CODES AND STANDARDS

- A. Codes and Standards to be used in the design of pumping stations shall include but not limited to the following:

AASHTO	American Association of State Highway & Transportation Officials
ABMA	American Bearing Manufacturer's Association
ACI	American Concrete Institute
AGMA	American Gear Manufacturer's Association
ANSI	American National Standards Institute
ASHREA	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
HI	Hydraulics Institute Standards
ISA	Instrument Society of America
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
TCEQ	Texas Commission on Environmental Quality
IBC	International Building Code
IFC	International Fire Code

IFGC	International Fuel Gas Code
UL	Underwriters Laboratory, Inc.
IMC	International Mechanical Code
IPC	International Plumbing Code

- B. The Engineer shall also observe all applicable local codes and requirements adopted by local permitting agencies. The current version of these documents effective at the time of receipt of Notice to Proceed with the design phase shall be used as reference for design purposes.

### **14.3 HYDRAULICS AND PIPING**

#### **14.3.1 Station Hydraulics**

- A. The aggregate total firm pumping capacity of pump station facilities for a particular service pressure zone shall equal the sum of the following:
1. The maximum daily demands of that zone, plus
  2. The maximum daily demands of upper dependent zones, plus
  3. An emergency reserve allowance equal to 10 percent of the sum of 1 and 2.

Phased implementation of the pumping station shall be coordinated in conjunction with the demands of development.

- B. Pump stations shall be designed for a “rated capacity” equal to the total firm capacity (i.e., capacity available with the largest pump out of service) plus backup capacity equal to or greater than the pump out of service.
- C. The Engineer shall refer to data, if available, furnished by the Utility for information on system hydraulics, design capacity, system head curves, net positive suction head (NPSH), pump operating curves, piping configuration, transient surge analyses and control. The Engineer shall review this information and prepare hydraulic calculations to reflect the following :
1. System head curves
  2. Pump operating curves
  3. Available NPSH
  4. Piping configurations
  5. Pump controls
  6. Transient surge analyses

Record drawings shall contain as-built pump make, model, and system and test pump curves with final head, flow and horsepower data.

- D. A figure shall be provided showing both the system head curve and pump operating curves as described in paragraph 14.5.5 of this chapter. Where variable frequency drives (VFDs) are used, pump-operating curves must also indicate pump operation at specified speeds, such as 95 and 90 percent RPM.

### 14.3.2 Piping Materials

- A. All pumping station suction and discharge piping above ground shall be ductile iron (DI) or engineered shop fabricated steel. Avoid the use of pipe threads on ductile iron pipe flanges. The Engineer shall include in the Contract Documents a schedule of piping materials for all exposed and buried piping over 2-inches in diameter to be utilized on the Project within the limits of the pumping station.
- B. A piping schedule presenting materials, pressure rating, and test requirements shall be prepared for Utility review and approval.

### 14.3.3 Flow Velocities

Flow velocities shall be designed in accordance with manufacturer's recommendations. Generally, intake velocities shall be limited to 3.5 feet per second at the mouth of the suction bell and 5-feet per second in the intake piping, unless lower values are recommended by the pump manufacturer. The velocity of discharge piping shall not exceed 8-feet per second. Pipe discharge manifold and pipe transmission piping from the pump station shall be sized accordingly to maintain a maximum velocity of 5-feet per second.

## 14.4 SELECTION OF PUMPS

### 14.4.1 General

- A. Vertical turbine can type pumps shall be used wherever possible. However, the use of horizontal split case pumps may be used in special cases if approved by the Utility.
- B. The Engineer shall present a comparative evaluation of cost, operability, and construction issues for the pump configurations considered. This analysis shall include general arrangement drawings and cost estimates for the pumping station with the various configurations. Based on the analysis and the Engineer's recommendation on pump configuration, the Utility will select the configuration to use before proceeding with the final design of the pumping station.
- C. Standard nominal voltage used for pump stations shall be 480/277V, 3-phase, 4-wire.

### 14.4.2 Vertical Turbine Pumps

- A. Engineer shall include the following features of pump construction. Engineer shall consider material of construction recommendations in relation to durability, cost, etc specific to site-specific issues.
  - 1. Type: Vertical canned turbine
  - 2. Barrel or Can: Heavy duty steel epoxy coated for mounting in concrete encasement, designed to support the unit without vibration at any operating speed. The pump manufacturer provides barrel or can. Engineer should evaluate and define when pump cans should be seamless construction and include appropriate design requirements and details.
  - 3. Bowls: Cast iron, porcelain enamel lined capable of withstanding hydrostatic pressures equal to twice the head at rated capacity of 1.5 times the shut-off-head

4. Impellers: Impeller selection should consider water quality and potential degradation of impeller materials. Cast bronze, enclosed type, balanced to operate within acceptable field of vibration limits. Carbon steel or stainless steel may be allowed as dictated by specific conditions and as approved by the Utility.
  5. Shaft: Stainless Steel, either Type 316 or 416 and meet or exceed AWWA A101 requirements
  6. Shaft Couplings: Type 316L
  7. Bowl Wear Rings: Alloy 836 or 410 SS
  8. Seals: Mechanical with flushing water. Seal selection should consider water quality type (ie non-potable water applications and seal requirements).
  9. Bearings: Bronze, rubber, or other approved materials
- B. The pump motor coupling must allow for adjustment of the pump impeller at the upper end of the motor.
  - C. The vertical turbine pump discharge head, sole plate, column, and cans are to be provided by the pump manufacturer as a package.
  - D. A typical pumping station general arrangement drawing for the vertical turbine-pumping configuration is provided in the Utility Standard Details.

#### 14.4.3 Horizontal Split Case Pumps

The Utility maintains and operates horizontal split case pumps; however, these pumps are generally not used for new facilities and shall be used only upon approval by the Utility.

- A. The Engineer shall include the following features of pump construction. Engineer shall consider material of construction recommendations in relation to durability, cost, etc specific to site-specific issues:
  1. Type: Horizontal split case
  2. Casing: Close grained cast-iron tested to 150% of maximum head
  3. Impeller: Enclosed double suction, bronze, statically and dynamically balanced and keyed to shaft
  4. Wearing Rings: Renewable, type 316 stainless steel
  5. Shaft: Type 316 stainless steel, machined and polished, designed for maximum deflection
  6. Shaft Sleeve: Type 316 stainless steel
  7. Stuffing Box Bushings: Bronze or rubber. Other materials may be considered on a case-by-case basis and are subject to EPWU approval.
  8. Bearings: Heavy duty, grease lubricated ball type, and double row thrust bearings, Minimum L-10 bearing life

9.     Seals: mechanical with flushing water
  10.    Shaft Couplings: Heavy duty flexible with OSHA safety guard
  11.    Base: Heavy cast iron, or steel base, with integral rim or pan and drain
- B.     A typical pumping station general arrangement drawing for the horizontal pumping configuration is provided in the Utility Standard Details.

#### 14.4.4 Pump Operating and System Head Curves

The Engineer shall perform the hydraulic calculations of the system and prepare a system head curve in combination with selected pump operating curves showing all pumps running and the hydraulic operating conditions for each single operating pump and/or pumps if they differ in capacity and size. The system head curve shall be indicated with both Hazen-Williams coefficients of 110 and 140 to determine friction loss. Thus, curves shall represent both maximum and minimum pressures to be experienced by the pumping system. In addition, system curves shall graphically reflect the effects of minimum, maximum and design static head conditions. The acceptable design operating envelope limits shall be submitted to the Utility for approval.

#### 14.4.5 Net Positive Suction Head (NPSH)

- A.      $NPSH_A$  (NPSH available) versus  $NPSH_R$  (NPSH required) has a profound effect on pump selection and/or installation design. The Engineer shall select pumps with proper consideration of the NPSH throughout the pump operating range so as to avoid pump cavitation. The  $NPSH_A$  must always exceed the  $NPSH_R$  under any combination of circumstances. Calculations shall be submitted to the Utility for review and approval.
- B.     Refer to the Hydraulic Institute Standards for specific guidelines and criteria. In the absence of other criteria, make sure the  $NPSH_A$  is at least 1.35 times  $NPSH_R$  and also never less than 5 feet more than  $NPSH_R$ .

#### 14.4.6 Pump Drives

- A.     The most common drive preferred on Utility pump stations is the variable speed drive. Constant speed electric motor drives are acceptable for special conditions. Variable speed pumps are to be considered where flow or head requirements vary, especially where the variances would require additional pumps or extensive flow throttling to cover the full operating range. Inverter Duty (NEMA Premium Efficiency) motors shall be used for all pumps for continuous duty variable speed applications. NEMA Premium efficiency motors should be used for all pumps for continuous duty, constant speed applications. NEMA Premium efficiency motors are normally not cost effective for sump pumps or other intermittent duty pumps. The Engineer shall refer to Chapter 20 Electrical Design Standards for other applicable design guidelines. Cross the line starters may be used up to 40 horsepower. Soft-start or VFD drives shall be specified for 50 hp and above.

- B.     Electric Motors

The Engineer shall require that pump motors be furnished with the following characteristics:

- NEMA Premium efficiency motors
- Max. rotational speed: 1800 rpm

- Starts/Hr:
  - 10 up to 20 hp
  - 5 for 25-75 hp
  - 4 for 100-200 hp
  - Above 250-consult manufacturer
- Suitable for continuous operation.
- Nameplate horsepower that exceeds the maximum required by the pump under all operating conditions. For best efficiency, the motors specified should operate in a range within 90% to 100% of its rated power (avoid over sizing motors since efficiency and power factor drops in motors running below load rating).
- Provide a 1.15 service factor at ambient temperature plus 50° C of the nameplate voltage
- Provide an Underwriter's Laboratory(UL) rating
- For vertical pumps, provide WP-1 enclosed squirrel cage induction type motors. For horizontal pump provide Open Drip-proof squirrel cage induction type motors.
- Enclosure openings shall be covered with metal guard screens having a mesh size no larger than ½ inch square.
- Provide vertical turbine pump motors that have a hollow shaft for ease of adjustment
- Motor frame shall be cast iron
- Motor windings shall be copper. Aluminum windings are not acceptable.
- Insulation shall be Class "F" with epoxy coating
- Provide heavy-duty 100,000-hour rated bearings. Oil lubricated bearing shall be provided with a visual oil level indicator.
- The starting code letter/locked rotor kVA shall comply with NEMA code "F" criteria or better.
- Provide an over temperature safety switch installed in the motor windings
- Provide a heater element installed to reduce condensation for motor size 50 hp and above. The motor heater element is strip type that automatically disconnects when the motor starts.
- Equip motor with anti-reverse rotation ratchet. Also, install a lockout limit to prevent motor start if the pump control valve is closed. Verify minimum rotational speed when specifying variable frequency drives and anti-reverse ratchet.

#### C. Variable Frequency Drives

Variable frequency drives (VFDs) are normally used on pumping units to control the pumping speed during start-up and shut-down and to maintain pressure on closed zone systems. Refer to Section 20.

#### D. Internal Combustion Engine Drives

1. If requested by the Utility, the Engineer shall provide engine drives for the number of pumps designated by the Utility. The Engineer shall determine the recommended engine drive based on costs and other technical factors.
2. Internal combustion engine drives shall be low emission natural gas engines with heat exchanger, exhaust system, fuel system, starting batteries, battery charger, oil reservoir, instrumentation and control panel, sound attenuation metal enclosure with removable roofs and other support systems. A separate enclosure with PLC shall be installed adjacent engine control panel and interfaced with pump station PLC. Engine shall also be capable of operating on liquefied petroleum gas (LPG) as an alternative fuel on a temporary basis in case of natural gas supply failure.



3. The natural gas engine shall be capable of continuous operation without load interruption or cycling at its rated engine power takeoff output horsepower, as determined by the Engineer for the requirements of the Project.
4. The position of the engine drive shall be determined by site layout and with full consideration of the distance from the exhaust pipe to the property line as it pertains to the setting of emission standards. Engines drive sound pressure levels (dBA) shall be in accordance with City of El Paso Municipal Code for the affected Zone. The Environmental Compliance Manager must be consulted about internal combustion engine drive location.

#### 14.4.7 Testing of Pumps

Testing should be done in accordance with the Hydraulic Institute Standards. Several testing situations are listed below:

- Certified Pump Curves: Certified pump curves should be specified for most pumps. Manufacturers will generally supply a certified pump curve, indicating actual performance of a same size pump and same speed. Manufacturers will generally perform this test using water.
- Performance Test: Manufacturers will perform this test on the pump supplied.
- Hydrostatic Testing: This test should always be specified. This is usually done above 125 percent of shut-off head or 150 percent of rated head, whichever is greater.
- Other Tests: These tests may include manufacturer's or in-field tests for vibration, noise, or mechanical functioning. Certified test reports should be provided for all pump performance testing.
- Benchmarking and Trending: Owner has created and is maintaining a pump station information database so that it can more effectively operate its water system efficiently. Benchmark and trending data is required for water pumps. Owner has a pre-approved Benchmarking Specialist to perform this work. Refer to standard testing specification.

### 14.5 PUMP STATION/EQUIPMENT LAYOUT

#### 14.5.1 Operator Friendly Features

- A. In general, the pumping equipment layout shall provide convenient access for operation and maintenance personnel, equipment installation, adjustment of component parts, maintenance and equipment removal utilizing conventional general purpose tools.
- B. One of the most important aspects of design is that the station should be easy to clean and maintain. All equipment (motors, switches, etc.) shall be splash-proof so that a high pressure hose can be used everywhere for wash down. Floors shall be sloped to drain.
- C. Make adequate provision for removal, hoisting and replacing all equipment. The following guidelines are provided when the pumping equipment is located inside a building. Hoist equipment selections shall be performed on a case by case basis and will be provided by Engineer recommendations and are subject to EPWU direction and coordination with Operations personnel. Examples of hoist equipment are provided below:
  - On large pumping stations with three or more horizontal split case pumps having motors of 100 hp or greater, provide a traveling bridge crane of the top running type

consisting of electric drives, end truck, trolley hoist, and controls. Install an access door at the end of the crane rail to allow for positioning and removal of equipment.

- On smaller pumping stations with a horizontal pumping configuration, provide a hoist system using monorails or jib crane systems with manual hoists.
- On pumping stations using vertical turbine pumps, provide roof access hatches or operable skylights for removal of pumps and motors using truck-mounted mobile cranes if pumps are installed indoors. A monorail or jib crane system with manual or electric hoists should be provided for maintenance and repair over control valves and flow meters.

- D. Make adequate provisions for access for personnel and for vehicles. Allow access for maintenance vehicles around the pump station.

#### **14.5.2 Station Layout**

- A. The station layout shall take into consideration such items as pump orientation, location of valves, access to equipment, clearances required, floor slope, location of switchgear, motor control centers (MCC's), and controls. Layouts shall be in conformance with governing local building codes.
- B. Provide a minimum clearance between piping or personnel access of 42-inches flange to flange. Vertical floor to overhead obstruction clearances must be a minimum of 7 feet-6 inches. Where equipment manufacturers recommend a minimum clearance for maintenance, provide an additional 1-foot over the recommended clearance. Minimum clearance requirements shall also comply with El Paso Electric and other industry requirements.
- C. Slope floor at 3/8-inch per foot to a gutter. The gutter can be flat, but preferably should be sloped to a drain sump.
- D. For pumping stations with an electrical room and pump room in the same building, the electrical room shall be elevated at least 4-inches to provide positive drainage in the event of a pipe failure. Provide a window in the wall between the pump room and the electrical rooms for safety and to view pump operation in compliance with NEC Code.
- E. For instances where the pumps are located outside, an enclosed electrical room shall be provided and located a minimum of 4-inches vertically above the natural ground elevation of the pumps. The electrical room shall be provided with a window overlooking the pumps to provide a clear view of the pumps in compliance with NEC Code.

#### **14.6 PUMP INLET CONFIGURATION AND PIPING LAYOUT**

- A. Utility Standard Details provide general representations of the pump configuration and piping layout for vertical turbine and horizontal split case pumps, respectively. The schematic details provide general layouts of the pumps, pump inlet configuration, and pump discharge configuration. Deviations from these layouts may be developed by the Engineer for site specific conditions, upon review and approval by the Utility.
- B. A relief or bypass line with a pressure relief valve shall be designed to relieve the discharge manifold to the suction manifold in the event of an overpressure condition. This bypass line can also be used to re-circulate fire pump test flows. A vacuum relief valve must be provided after the pressure relief valve.

Alternately, the bypass line can be provided through a check valve to protect against suction surge pressure or to supply low pressure flow in the event of a pumping station failure.

- C. Pipe restraints shall be designed at elbows/joints to resist the maximum anticipated operational and surge pressures on exposed piping. Base elbow fittings shall not be designed to carry any side thrust loading. The Engineer shall design intermediate flanges for thrust restraint at locations where piping enters valve vaults or underground walls.
- D. Proper design and selection of couplings is required for the appropriate operation of the pumping facility. The use of flexible couplings is preferred in order to avoid rigid connections between the pump and fixed discharge manifold piping. For restrained couplings, flanged adapters, sleeve-type compression couplings, or grooved-end couplings should be provided with a suitable harness for longitudinal restraint.
- E. Pressure gauges shall be provided on the suction piping and discharge pipe of each pump. The gauge assembly shall be mounted off the piping in a separate stand to isolate the gauge from pump vibration. A built-in safety plug shall be provided for protection in an overpressure condition.
- F. As needed, Engineer shall consider site specific and current EPWU Operations requirements for sampling or additional drain taps.

## **14.7 TRANSIENT SURGE ANALYSIS AND SURGE CONTROL**

### **14.7.1 Transient Surge Analysis**

The Engineer shall evaluate pumping stations to determine the potential for hydraulic transients. Computer programs such as LIQT (Stone Associates), Pipe 2000 Surge (University of Kentucky), Network-Surge (John List), Hammer (Haestad Methods), H<sub>2</sub>O Surge (MWH Soft), or other programs as approved by the Utility shall be used to evaluate all transient phenomena and proposed surge control measures. The hydraulic transient calculations shall be provided, together with a description of any potential for hydraulic transients and a list of steps the Engineer recommends for further action or mitigation of the hydraulic transients.

### **14.7.2 Surge Control**

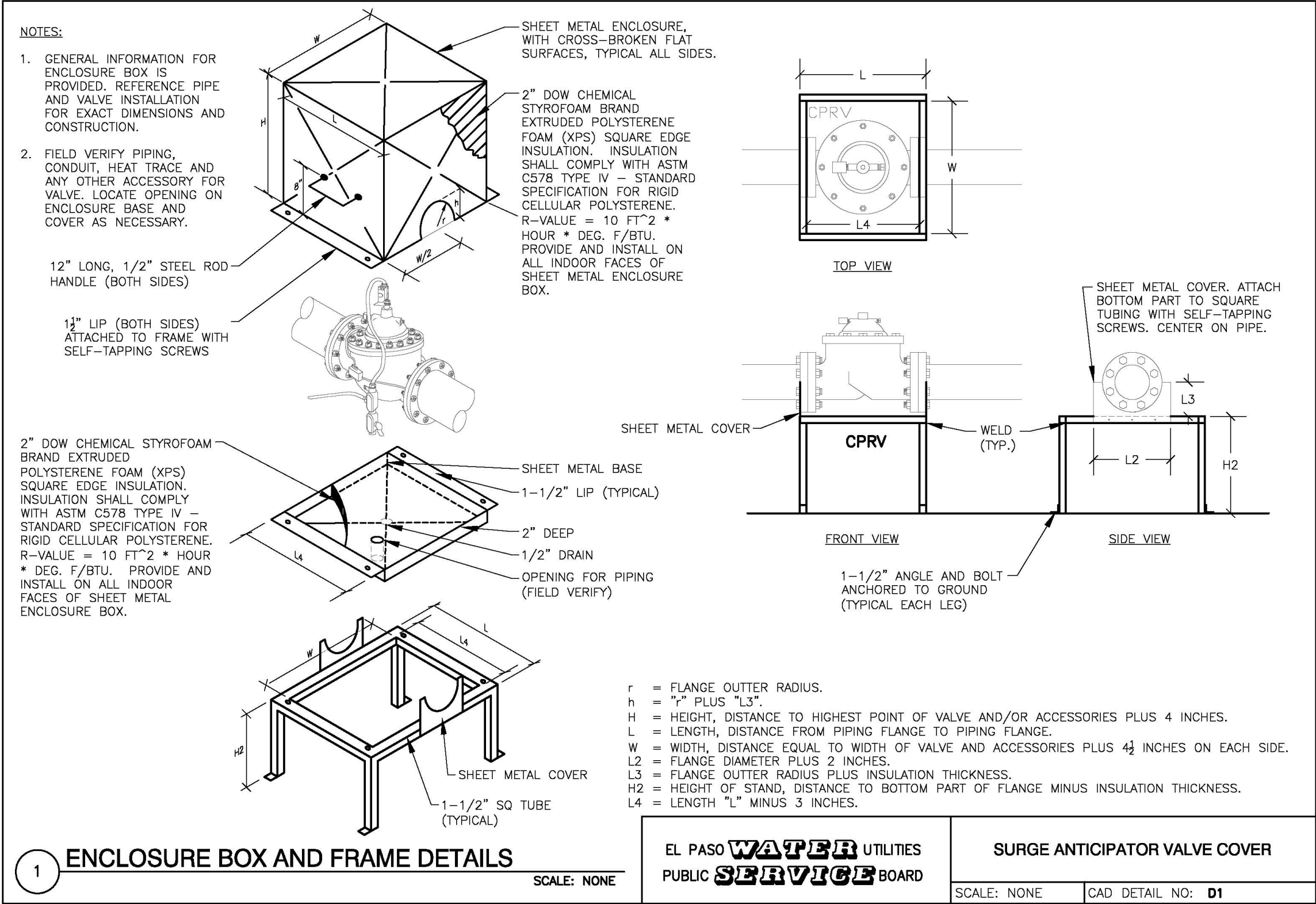
- A. Surge protection is normally required at all pumping stations. Surge control measures suitable for raw water and treated water pipelines are also employed for reclaimed water pipelines.
- B. Transient control measures may be considered independent of or in combination for water systems and are limited to the following:
  - Water pipeline alignment revisions to eliminate potential column separation zones
  - Globe-type pump control valves on inlet or discharge pipelines
  - Proper location and sizing of air/vacuum valves
  - Use of Surge tanks, or hydropneumatic tanks: Size the tanks to reduce incremental surge pressure increase to a maximum of 33 percent of the discharge pipeline design pressure. Surge tank should be designed, fabricated and tested in accordance with the ASME Code for Unified Pressure Vessels, and equipped with a compressed air system controls to maintain the air to water ratio and initiate alarms. Equip tanks with

level probes, add/vent air pressure solenoids, and pressure switches to maintain water level near center of the tank.

- Surge anticipator relief valves which sense a loss of power and/or pressure surge wave and opens on set time delay or high pressure respectively. Install piping and valves to provide pressure relief from the pump discharge side to the suction side. Figure 2 depicts a surge anticipator relief valve cover.
- Installation of a pressure relief valve from discharge manifold for routine rapid changes in system demand.

Figure 2 - Surge  
Cover

Anticipator Valve



## 14.8 VALVES

Appropriately selected valves shall be recommended by the Engineer. Valve materials must be compatible with the fluid being conveyed in the pumping station. The types of valves to be provided include but are not limited to:

- Gate Valves – installed on the pump inlet, pump discharge line, pump manifold lines, bypass lines, and surge protection line for removal and maintenance of pumps and accessory equipment. Valves should be installed a minimum distance of three (3) pipe diameters downstream of pump control valves.
- Pump Control Valves – provide controlled valve opening and closing during pump start-up and shutdown, and provide an emergency closing feature to close the valve at the controlled rate in the event of motor power loss. Also, the valve provides pump reverse anti-rotation protection.
- Air/Vacuum Relief Valves – provided at critical locations in the pumping station pumping to prevent small quantities of air from being captured inside the piping system, to vent large quantities of air during filling of the piping, and to prevent piping collapse because of vacuum conditions caused by rapid drainage of the pipe. Valves should be placed at the end of the suction or discharge manifolds or on each pump's suction or discharge pipe as required to prevent air accumulation or to provide vacuum relief. If no air release valve is provided in the line, a ½-inch diameter air bleed should be provided on each pump suction line. On each pump discharge line, provide a ½-inch diameter air bleed before the pump control valves and an air release valve after the pump control valve.
- Drain Valves – to be provided with a capped fitting on the suction and discharge side of each pump to drain pumps and check for residual pressure during maintenance prior to opening fittings.
- Check Valves – may be used on the discharge side of all pumps in place of pump control valves, if required by a surge analysis.

Engineer shall consider where appropriate, at a minimum, visual valve position gauge.

## 14.9 STATION SUPPORT SYSTEMS

This section provides information related to station support systems including, but not limited to, air systems, water/sewer systems, heating/cooling, and communications systems.

- A. The Engineer shall size and evaluate the air demand for each individual pumping station facility. Motor controlled valve or compressed air shall be used for the pump control valve hydraulic operator, valves, surge tanks, maintenance air tools, etc. Air piping shall be designed to provide a separate piping header to each type of service to ensure that priority equipment will have a continuous, uninterrupted supply of compressed air.
- B. Potable water shall be provided to the facility. The potable water supply system shall be protected by a reduced pressure principle backflow preventer, in accordance with local code requirements. Water systems shall be designed to avoid possibility of contamination.
- C. Pumping stations shall be equipped with a toilet facility, where feasible. Sanitary drains from the toilets shall discharge to a municipal sewer system.
- D. The drainage system shall consist of a floor drain, hub drain, cast iron drain pipe, grease interceptor, holding sump and sump pumps. The drainage system shall be designed to handle drainage from the pump seals, housekeeping, and evaporative coolers.

- E. The pumping station will be supplied with a heating/cooling system for the pump rooms, motor control center and control rooms, and local exhaust systems for rest rooms. Local exhaust systems shall provide 10 air changes per hour or 100 CFM, whichever is greater, by means of ceiling fans with wall or roof discharge.
- F. Appropriate site lighting shall be provided in compliance with City of El Paso Municipal Code requirements and IES Standards.
- G. Emergency Power Generator - refer to Section 20.4B Chapter 20
- H. Disinfection.

#### **14.10 INSTRUMENTATION AND CONTROLS**

- A. A control strategy for the operation of the facility shall be developed by the Engineer with approval by the Utility. Instrumentation and control facilities shall be provided to measure, control, and monitor pumping operations, including ancillary equipment. Specific guidelines are provided in Chapter 21.
- B. Process and instrumentation diagrams (P&ID) shall be developed to indicate each instrument, monitoring and control device, and communication device for the pumping station, including components of the subsystems of the pumping station.
- C. Pumping stations will be operated either locally or remotely, manually or automatically. Under normal conditions, the pumping system will be programmed to convey water through the Utility's supervisory control and data acquisition (SCADA) system. The SCADA system will transmit and receive signals in order to operate the number of pumping units to match the flow demands.

#### **14.11 OTHER ISSUES**

Other issues that must be addressed during the design phase shall include, but are not limited to:

- Building insulation requirements
- Noise and vibration control
- Installation, operation, and maintenance accessibility
- Energy efficiency (Engineer shall strive to achieve as many LEED silver criteria requirements where applicable and subject to EPWU approval)
- Corrosion protection
- Chlorine storage and feeding system – need section to address
- Lighting
- Freeze protection of piping, valves, etc
- TAAS Building Review & Inspection
- Landscaping and site aesthetics
- Security Fencing
- Trip/Fall hazard analysis

END OF SECTION

# CHAPTER 15

## WASTEWATER COLLECTION SYSTEMS

### 15.1 GENERAL

- A. This chapter provides guidance and minimum design criteria for the modification and construction of conventional wastewater collection systems.
- B. Wastewater collection systems are defined as both gravity and pressure pipe designed to be leak-proof and convey sanitary sewage from the general population to a treatment plant or other disposal facility.
- C. Engineer shall obtain approval from the Utility for exceptions or deviations from these requirements. Exceptions or deviations may be granted on a project by project basis only.
- D. The Engineer shall develop Contract Drawings and conform to the requirements as noted in Chapter 2.
- E. The design of wastewater collection systems shall adhere to the requirements of the Texas Commission on Environmental Quality (TCEQ). A copy of TCEQ design/construction checklists is available at [www.sos.state.tx.us/tac/](http://www.sos.state.tx.us/tac/).

### 15.2 SEWER LINE CLASSIFICATION BY FUNCTION AND SIZE

Pipe size shall mean the actual or the nominal inside diameter of the pipe. The basic classifications of sewer lines by function and approved standard sizes are:

- A. Service Lines  
Also referred to as laterals, shall generally be 4-inches in diameter and used to convey wastewater from establishments to collector lines located in public right-of-way. Design criteria in this Chapter is not applicable for service lines.
- B. Collector Lines  
Generally, 8-inches and 12-inches in diameter, these lines collect wastewater from service lines and convey it to trunk lines.
- C. Trunk Lines  
Generally, 15-inches to 30-inches in diameter, with 3-inch increments, used to convey wastewater from collector lines to interceptor lines.
- D. Interceptor Lines  
Generally, 36-inches in diameter and larger used to intercept a number of trunk lines and convey wastewater to treatment or lift station(s).
- E. Force Mains  
See Chapter 16.



### 15.3 BASIC DESIGN REQUIREMENTS

The design and selection of sewer lines shall satisfy the following general requirements. Deviation from these requirements shall be approved by the Utility.

- A. The collection system shall be designed to provide a minimum performance life cycle of 50 years.
- B. The minimum diameter for all sewer lines, except service laterals and force mains, shall be 8-inches.
- C. Sewers shall be laid in straight alignment with uniform grade between manholes. Refer to Section 15.3.2 for allowable minimum and maximum slopes.
- D. Design all pipe for positive embankment conditions. Compaction of pipe zone bedding and backfill are a critical element for pipeline stability and long service life. Refer to Utility Standard Details for compaction requirements.
- E. Engineer shall consider design requirements of sanitary sewer lines for materials that are resistant to hydrogen sulfide corrosion in order to extend system infrastructure service life.

#### 15.3.1 Velocity of Flow

- A. All gravity sewer lines shall be designed and constructed with slopes such that a minimum velocity of 2.0 ft/s is maintained when flowing full.
- B. The maximum velocity, at maximum discharge shall be 10 ft/s. When this velocity and acceptable grades (provided in Table 15-1) are exceeded, special provisions shall be made to protect against pipe displacement due to erosion of bedding, and/or shock.

#### 15.3.2 Acceptable Grades

The grades indicated in Table 15-1 represent acceptable slopes necessary to sustain the required minimum velocity. They are determined using Manning's formula with a minimum "n factor" of 0.013, regardless of the pipe material type.

TABLE 15-1 ACCEPTABLE GRADES FOR GRAVITY SANITARY SEWER LINES (n = 0.013)					
PIPE SIZE I.D. (in)	MIN SLOPE (%)	MAX SLOPE (%)	PIPE SIZE I.D. (in)	MIN SLOPE (%)	MAX SLOPE (%)
8	0.33	8.40	27	0.060	1.65
10	0.25	4.88	30	0.055	1.43
12	0.20	4.88	33	0.050	1.26
15	0.15	3.62	36	0.045	1.12
18	0.11	2.83	39	0.04	1.01
21	0.09	2.30	>39	*	*
24	0.08	1.93	* For pipes larger than 39 inches in diameter, the slope shall be determined by Manning's formula to maintain a velocity greater than 2.0 feet per second and less than 10.0 feet per second when flowing full.		

### **15.3.3 Internal Loads**

Internal pressure heads shall not, under any circumstances, exceed the burst strength of the installed pipe. Internal surcharge designs of gravity sewer systems shall be avoided, unless specifically warranted by field conditions and with approval from the Utility. When a surcharge condition is anticipated, pressure rated pipe and special embedment shall be considered in the system design.

### **15.3.4 External Loads**

Pipe strength must be sufficient to resist external forces due to soil trench backfill, the weight exerted by traffic and other anticipated external forces. Vertical deflection of flexible pipe shall not exceed 5% and shall be in accordance with minimum TCEQ requirements.

Embedment of the pipe is significant in determining external load-carrying capacity. Pipe embedment and backfill shall be placed so as not to disturb alignment of pipe.

### **15.3.5 Standard Cover**

Generally, minimum cover shall be 6 feet measured from top of pipe to finished grade.

### **15.3.6 Separation Distances**

Separation distances of Utility lines shall be in accordance with Chapter 4 and the Utility Standard Details.

## **15.4 DESIGN PARAMETERS**

The design and selection of sewer lines shall be based upon an analysis of the service area with respect to the maximum sewage discharge flows projected for the existing service population or the anticipated growth of the area. Sewer collection system design shall be based on the following parameters.

### **15.4.1 Location of Facilities**

Define the extent of the area to be served, its physical nature, and identify possible points of contribution to the collection system. Location of the facilities shall consider such factors as natural drainage patterns and existing or proposed right-of-ways within the service area. Establish the most appropriate location for the sewer within the service area being considered. Lift stations require special approval from EPWU in lieu of gravity collection systems. Lift station locations, if any, shall be identified.

### **15.4.2 Design Period**

The capacity of the sewer facilities shall be designed for the specified design period and shall be adequate for the region to be served. This design period shall be determined according to the following conditions:

A. Existing Developed Zones

The design period shall consider total existing population and expected growth of this populated zone.

B. New Area Developments

The design period shall be either of the following:

1. The **total** expected growth of the area to be served (Ultimate Design).

### 15.4.3 Character of Wastewater

The character of wastewater is dependent upon the type of contributors located within the tributary study area and shall be determined according to the following guidelines:

A. Land Use

Available zoning and planning data, both current and future, shall be obtained. This data shall be used to determine the type and number of contributors of wastewater flows within the tributary study area. Contributor types shall be categorized as follows:

Domestic - Areas consisting of residential and/or institutional developments as defined below.

**Residential Developments** shall consist of single and/or multiple family housing within the study area. The contributor unit of measure shall be "per person" (capita). Generally, residential developments shall be divided into the following five categories according to density:

1. Rural or Low Density Residential - single family housing on substantial acreage
2. Medium Low Density Residential - typical single family urban development on large lots
3. Mixed Medium Low/High Residential - typical single family urban development on small and large lots
4. Medium High Density Residential - typical single family urban development on small lots
5. High Density Residential – Multiple family residential developments shall generally denote apartment complexes

Commercial - shall include, but is not limited to the following: areas designated for retail stores, office buildings, minor manufacturing, schools, churches, hospitals, university/colleges, sports complexes, and prisons. The contributor unit of measure shall be "acre."

Industrial Developments - Areas where industrial wastes, from factories, refineries, etc., are predominant. Contributor unit of measure shall be "acre."

B. Tributary Area

The tributary area is the existing or proposed populated area for which the sewer is to be designed.

All tributary areas or sub-areas shall be classified by contributor type. Total acreage allocated for the projected number of domestic, industrial, or commercial establishments shall be estimated.

Large Tributary Areas are characterized by areas that may generate large wastewater flows requiring trunk or interceptor lines. Large tributary areas shall generally consist of several residential subdivisions and/or large commercial and industrial areas.

- Layout of the proposed sewer and points of contribution for each sub-area shall be defined as a requisite for line size determination.
- "Pipeline sections" shall be defined between locations of major junctions or points where the sewer might change slope or size within the proposed layout. Determination of size within a particular pipeline section shall depend upon all drainage sub-areas contributing within the specified section.
- Under special circumstances, the design of the collection facilities may provide adequate capacity for a portion of the large tributary area, with future relief sewers constructed as growth patterns become better established.

Small Tributary Areas are characterized by small service sub-areas or a single subdivision where anticipated flows would require only collector lines.

- In designing for sewer facilities within small tributary areas, "pipeline sections" shall be defined between proposed manhole locations. Determination of the size of the line shall depend upon all contributions occurring upstream and within the specified pipeline section.

#### 15.4.4 Number of Contributors

The number of contributors to the sewer system shall be determined according to the following guidelines:

##### A. Service Population Contributors

Domestic population to be served in either large or small tributary areas must be estimated for both the current conditions and those projected for the life of the facilities. Determination of the residential population shall be based on either of the following two methods:

##### 1. Existing Populated Zones:

The following procedure shall be used to estimate the population of an existing zone.

##### Persons Per Household

The number of persons per household generally depends on location and land use. The City Department of Planning shall be consulted for demographic and census data.

##### Population Density Factor

When the study area is predominantly residential, a **Population Density Factor ( $D_f$ )** measured in persons/acre shall be determined from known data or map records and may be applied to other areas of similar land use. This factor shall be estimated by the following relationship:

$$D_f = \frac{\text{No. of Households} \times \text{No. Persons/Household}}{\text{Acreage}}$$

Generally, the Population Density Factors presented in Tables 15-2, 15-2A and 15-2B are applicable for the conditions indicated. These numbers may be adjusted if localized information is available.

<b>TABLE 15-2 RESIDENTIAL POPULATION DENSITY FACTORS</b>			
<b>Residential Category</b>	<b>No. Persons per Household</b>	<b>Avg. No. Houses Per Acre</b>	<b>Avg. Pop. Density Factor (pers/acre)</b>
Low and Rural	3.06	2.0	6.12
Medium	3.06	4.5	13.77
Mixed Medium	3.06	6.0	18.36
Medium High	3.06	7.0	21.42
High	3.06	9.0	27.54

<b>TABLE 15-2A RETIREMENT COMMUNITY GENERAL MIXED USE DENSITY FACTORS</b>			
<b>Residential Category</b>	<b>No. Persons per Household</b>	<b>Avg. No. Houses Per Acre</b>	<b>Avg. Pop. Density Factor (pers/acre)</b>
Context Zone 3	3.06	3.6	11.02
Context Zone 4	3.06	6.4	19.58
Context Zone 5	3.06	15	45.90

<b>TABLE 15-2B GENERAL MIXED USE DENSITY FACTORS</b>			
<b>Residential Category</b>	<b>No. Persons per Household</b>	<b>Avg. No. Houses Per Acre</b>	<b>Avg. Pop. Density Factor (pers/acre)</b>
Single Family	3.06	4.0	12.24
Duplex	3.06	6.0	18.36
Triplex	3.06	8.0	24.48
Quadraplex	3.06	10.0	30.60
Apartments	3.06	14.0	42.84

Total Existing Population ( $P_t$ ) within the given tract shall be estimated according to:

$$P_t = A_1D_1 + A_2D_2 + A_3D_3 + A_4D_4 + A_5D_5 + \dots + A_nD_n$$

where

$A_n$  = Total area within tract conforming to the Residential Categories described above

$D_n$  = Corresponding Population Density Factor as described above

Existing Population Estimates shall be correlated with City Census Data, Land Use Plans, and other demographics to ensure accuracy and reliability of data. Twenty-five year projections shall be made in five-year increments for planning purposes and for possible phasing of construction facilities.

#### New Area Developments:

Projected population shall be based on City of El Paso Department of Planning, Research and Development's Land Use or approved Master Plan of the study area. Approved subdivision plats shall indicate projected land use patterns, the number of lots and permitted zoning, and expected population densities. This information may be used to estimate the total population within a new area development.

When the population size for Institutional/Recreational contributors must be determined, an estimate from similar existing local institutions may be used.

B. Commercial Contributors

Location and type of future commercial facilities shall be identified through a City Master Plan that includes the tributary design area. City zoning regulations limit the use of property through varying degrees of commercial use. For existing developments, the ratio of commercial acreage to residential acreage may be used to project future commercial developments.

C. Industrial Contributors

Location and type of future industrial facilities shall be identified through a City Master Plan that includes the tributary design area. City zoning regulations limit the use of property through varying degrees of industrial use.

### **15.4.5 Design Flow Determination**

Unless otherwise specified, the terms "flow" and "flow rate" shall be used interchangeably to denote the volume of wastewater (water) per unit of time anticipated to flow through a pipe system. The units of measure are gallons per minute (gpm) or million gallons per day (mgd).

Design flows necessary to properly and adequately size each pipeline section shall be determined based on the following criteria:

A. Flow Definitions

The following flows shall be determined either from previous operating data or computed flows:

*Daily Minimum Flow* - The minimum flow within a 24-hour time period. The design of a sewer collection system shall be such that it functions at or above this minimum flow throughout the design period to ensure that the deposition of solid materials is prevented.

*Daily Maximum Flow* - The maximum flow within a 24-hour time period.

*Daily Average Flow* - The average obtained by analyzing daily operating data over a 12-month period. When this data is not available, daily average flow shall be estimated as described below in Sub-section B.

*Peak Flow* - The average rate during the maximum 15 minutes for any 12-month period. When applied to the design period, this flow determines the size and hydraulic capacity of gravity sanitary sewer lines.

**B. Average Unit Flows and Other Factors**

1. Average Unit Flow shall be determined, for each contributor type, by using existing water use data, if available, or estimated by the figures provided in Table 15-3. The figures in Table 15-3 have been determined for the City of El Paso as the average discharge based on total population.

2. Domestic Unit Flow (gpd/capita)

In determining unit flow for Domestic Contributors, measured in gallons per day per capita, the following distinction shall be made:

- Small Residential District Flows may generally consist of the smaller sub-areas within the large tributary area. Small residential district flows are generally based on population density and the average per capita contribution.
- Large Residential District Flows may include many small residential districts and be associated with the larger tributary area. Generally, these flows shall consider the land-use areas and anticipated population density factors.
- These domestic unit flows shall be determined using actual flow data from selected typical residential areas located near the proposed service area.

Unit Flows from Institutional/Recreational Contributors shall be estimated from existing similar facilities with the commercial Unit Flows defined in Section 15.4.5B.3.

3. Commercial Unit Flows (gpd/acre) are measured in gallons per day per acre and are based on similar existing developments. When the commercial development is insignificant, allowance for commercial sewage may be incorporated within the per capita domestic sewage. Determine the degree of anticipated wastewater flows based upon light, medium, and heavy water use.

<b>TABLE 15-3 AVERAGE UNIT FLOWS</b>		
<b>CONTRIBUTOR</b>	<b>UNIT</b>	<b>UNIT FLOW</b>
Domestic	Person	55 gpd/cap
Commercial	Acre	490 gpd/ac
Industrial	Acre	815 gpd/ac

4. Industrial Unit Flows (gpd/ac) are measured in gallons per day per acre and vary with type and size of industry, and the extent of water reuse programs.

In the absence of actual data, the unit flows in Table 15-3, listed according to type of contributor shall be used.

- a. Reduction Factors may be applied to account for water conservation programs, water rate increases, increased public awareness, industrial water reuse, and wastewater treatment programs.
- b. Extraneous Contributors shall be considered in the design of the sewer system. Extraneous contributors shall include the following:
  - Infiltration shall mean underground water entering the sewer system through such means as defective pipes, pipe joints, service connections or manhole walls. Infiltration shall be negligible unless the sewer line is installed below the water table. Infiltration rates shall be based on field studies and shall be minimized through proper design and construction of sewage facilities.
  - Inflow is generally discharged into the sewer system from such sources as roof leaders, foundation drains, area drains, cooling water discharges, manhole covers, and unauthorized service connections.

C. Average Design Flow (gpm or mgd)

An estimate of the average design flow shall be obtained to determine the peak flow for designing the sewer facilities. In the absence of actual data, the following relationship may be used to estimate the average design flow for each contributor type, with appropriate reductions taken:

$$\text{Average Design Flow} = \text{Unit Flow} \times \text{Total Units}$$

where

Unit Flow = Defined above, as determined through actual measurements or from Table 15-3

Total Units = Defined in Table 15-3, designates the total units within the service area for the respective contributor

$$Q_{\text{avg}} = (\text{Avg Flow})_{\text{domestic}} + (\text{Avg Flow})_{\text{commercial}} + (\text{Avg Flow})_{\text{industrial}}$$

where

$$Q_{\text{avg}} = \text{the Cumulative Average Design Flow (gpm)}$$

The Cumulative Average Design Flow (Q) shall include infiltration contributions when they are determined to be significant.



D. Peak Factor (PF) and Minimum Factor (MF)

Peak Factor is the ratio of peak flow to average flow for any one day. Minimum Factor is the ratio of minimum flow to average flow for any one day and shall be used to verify that anticipated minimum daily flows generate the minimum required velocity of 2 ft/s.

Peak Factor or Minimum Factor shall be established based on actual flow-measurement records of similar circumstances. In the absence of such data, the Peaking Factor and Minimum Factor shall be established according to the following conditions:

1. Domestic Wastewater Flow

When the area to be serviced consists mostly of domestic wastewater flows, it is necessary to differentiate between the following service populations:

Total Residential Population is considered when flow from an entire area, encompassing numerous sections of varying residential densities, as defined in Section 15.4.3 A., is to be determined.

Individual Area Residential Population is considered when the sewer is designed to serve an area consisting of only one residential density type, as defined in Section 15.4.3 A.

The Peak Factor and Minimum Factor, for the appropriate service domestic population shall be determined by:

$$PF = 5 / P^{0.2}, \text{ where } P \text{ is population in thousands.}$$

The Peak Factor shall be approved by the Utility.

2. Domestic, Commercial, and Industrial Flows

When the area to be serviced includes domestic flows, and significant commercial and industrial flows, the peak factor shall depend on the cumulative average design flow (Q as defined in Part C of this Sub-Section). Minimum factor shall not be determined in these circumstances.

In the absence of actual data the following Peak Factors shall be used:

**Average Wastewater Flow less than 10,000 gpm:**

$$PF = 7.25 / Q^{0.14} \text{ (Q in gpm)}$$

**Average Wastewater Flow greater than or equal to 10,000 gpm:**

$$PF = 2.0$$

When Commercial and Industrial Flows comprise 25% or more of the average design flows, peak factors for the various contributor types of flow shall be estimated separately.

E. Design Flows

Design of the size and hydraulic capacity of the sewer line shall be based on determination of peak flow and cumulative peak design flow. Once the sewer line is sized, the minimum flow shall be used to verify that a minimum velocity of 2.0 ft/s is maintained when the line is flowing at this minimum flow.

Peak Flow (gpm or mgd), as defined in Section 15.4.5 A., shall be determined from the following relationship:

$$\text{Peak Flow} = \text{PF} \times Q_{\text{avg}}$$

where

PF = Peak Factor determined in Part D of this Sub-Section

$Q_{\text{avg}}$  = Cumulative Average Design Flow defined in Part C of this Sub-Section

Cumulative Peak Design Flow (gpm or mgd) shall generally denote the additive total of the peak flows in the current pipeline sections and all pipeline sections located upstream. Cumulative Peak Design Flow shall be used for sizing the collection facilities and is determined accordingly as the design of the sewer line progresses through each "pipeline section."

Minimum Flow (gpm or mgd), as defined in Section 15.4.5 A., shall be determined to ensure that a minimum velocity of 2.0 ft/s is maintained. Minimum flow shall be determined according to:

$$\text{Minimum Flow} = \text{MF} \times Q_{\text{avg}}$$

where

MF = Minimum factor determined in Part D of this Section

$Q_{\text{avg}}$  = Cumulative Average Design Flow defined in Part C of this Section

#### 15.4.6 Pipe Sizing

Manning's Hydraulic Equation for closed conduit gravity flow shall be used to determine the pipe diameter:

$$d = \frac{(2.16 \times n \times Q)^{3/8}}{s^{3/16}} \times 12 \text{ (in/ft)}$$

where

d = Diameter in inches

n = Coefficient of roughness, n=0.013, regardless of the pipe material

s = Slope as determined

Q = Cumulative Peak Design Flow converted to ft<sup>3</sup>/s (1 ft<sup>3</sup>/s = 448.8 gpm)

For the determined pipe diameter, the minimum flow (determined in Section 15.4.5) is used to calculate the corresponding velocity to verify it is 2.0 ft/s. Manning's Equation shall be used with the slope and n factor above, and the appropriate wetted perimeter.

#### 15.5 PIPE MATERIAL TYPE

The following section provides general information on the types of acceptable pipe materials. Additional information regarding these material types is included in Table 15.4.

##### 15.5.1 Polyvinyl Chloride Pipe (PVC)

Flexible pipe that shall be manufactured in the United States and shall conform to applicable ASTM Standards listed in Table 15.4. Pipe diameters of 8, 12, and 15-inches shall have a solid wall type. Larger sizes of PVC may be either solid or profile wall type.

Open Profile shall denote, according to ASTM F-794, a pipe product consisting of an essentially smooth waterway braced circumferentially or spirally with outside projections or ribs.

Closed Profile shall denote, according to ASTM F-794, a pipe product consisting of an essentially smooth waterway braced circumferentially or spirally with outside projections or ribs which are joined by an essentially smooth outer wall.

#### 15.5.2 Ductile Iron Pipe (DIP)

Shall generally be used for Collector Lines, unless special conditions require that it be used for other main classifications. DIP shall be manufactured in accordance with AWWA C-151/A21.51. Manufacturer shall provide a standard asphaltic exterior coating in accordance with AWWA C-151. Pipe shall have approved interior lining in accordance with AWWA C-104/A21.4

#### 15.5.3 High Density Polyethylene (HDPE)

Flexible pipe manufactured in the United States and shall conform to ASTM Standard F-894. HDPE shall have an open profile wall type and shall be used in diameters 18-inch and larger. This pipe material shall be used only upon approval by the Utility.

#### 15.5.4 Fiberglass

Shall be in accordance with ASTM D-3262 and shall be acceptable in sizes 33-inch and larger.

### 15.6 PIPE MATERIAL SELECTION

- A. Gravity sewer mains shall be designed and constructed to satisfy requirements established in Table 15-4 for various diameters, material type, and stiffness shown. Selection of pipe material shall be approved by the Utility.

TABLE 15-4 GRAVITY SEWER SYSTEM - ALLOWABLE MATERIALS					
PIPE SIZE (in)	ASTM STANDARD	MATERIAL	WALL TYPE	MIN STIFFNESS	STD LENGTH (ft)
8 12 15	D-3034	PVC/DIP	SOLID (SDR-35)	46 psi	20
	F-2736	HDPE	DOUBLE WALL	46 PSI	20
18	F-679	PVC	SOLID T1-WALL	46 psi	20
	F-794	LARGE DIA PVC	PROFILE OPEN	46 psi	13
	F-2736	HDPE	DOUBLE WALL	46 PSI	20
	F-894	HDPE	PROFILE OPEN	RSC 100	20
21 24	F-679	PVC	SOLID T1-WALL	46 psi	20
	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	13

TABLE 15-4 GRAVITY SEWER SYSTEM - ALLOWABLE MATERIALS					
PIPE SIZE (in)	ASTM STANDARD	MATERIAL	WALL TYPE	MIN STIFFNESS	STD LENGTH (ft)
	F-894	HDPE	PROFILE OPEN	RSC 100	20
	F-2736	HDPE	DOUBLE WALL	46 PSI	20
27	F-679	PVC	SOLID T1-WALL	46 psi	20
	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	20
	F-894	HDPE	PROFILE OPEN	RSC 100	20
	F-2736	HDPE	DOUBLE WALL	46 PSI	20
30	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	13
	F-894	HDPE	PROFILE OPEN	RSC 100	20
	F-2736	HDPE	DOUBLE WALL	46 PSI	20
33 36					
	D-3262	FIBERGLASS	SOLID	72 psi	20
	F-794	LARGE DIA PVC	PROFILE OPEN OR CLOSED	46 psi	13
	F-894	HDPE	PROFILE OPEN/CLOSED	RSC 100	20
	F-2764	HDPE	TRIPLE WALL	46 PSI	20
42 48	D-3262	FIBERGLASS	SOLID	72 psi	20
	F-794	LARGE DIA PVC	PROFILE CLOSED	46 psi	13
	F-894	HDPE	PROFILE OPEN	RSC 100	20
	F-2764	HDPE	TRIPLE WALL	46 PSI	20
54 60					
	D-3262	FIBERGLASS	SOLID	72 psi	20
	F-894	HDPE	PROFILE OPEN	RSC 100	20
	F-2764	HDPE	TRIPLE WALL	46 PSI	20

## 15.7 MANHOLES

### 15.7.1 Manhole Location

Manholes shall be located at the following locations: changes in alignment, grade or size of sewer lines, the intersection of sewer lines, points of transition between dissimilar sewer line material types, the end of all sewers that will extend at some future date, and at any other locations indicated in the drawings. Other locations may be required and shall be approved by the Utility. Manhole spacing shall be in accordance with Table 15-6.

#### A. Changes in Alignment

Manholes shall be placed at changes in sewer alignment defined by horizontal and vertical points of intersection.

When manholes are placed at bends, the minimum radius of curvature of the centerline of the pipe or smooth mortar channel, constructed within the manhole, shall not be less than 1.5 times the pipeline diameter.

- B. Changes in Grade  
Drop Manholes are constructed when the grade of an influent pipe is 2 feet above the manhole invert. Construction of drop manholes should be avoided and is generally used only when it is not feasible to steepen the incoming sewer. Drop manholes shall be in accordance with Utility Standard Details.
- C. Changes in Size  
In manholes with different size pipes, the tops of the pipes shall be placed at the same elevation and flow channels in the invert shall be evenly sloped from pipe to pipe.
- D. Intersection of Sewer Lines  
Manholes are required at a junction where two or more sewer lines intersect. On lines less than 48-inches this junction is made within the standard manholes. For sewer lines 48-inch and larger, a cast-in-place concrete junction box shall be constructed.
- E. Future Extensions  
Plugs are required at the end of sewer lines less than 200-feet that will be extended at a future date. Greater than 200-feet, a manhole will be provided.
- F. Cul-de-sacs  
Manholes are required at the end of lines at cul-de-sacs.
- G. Dead-ends (no future extension)  
A manhole shall be provided at the end of the sewer line.

#### **15.7.2 Manhole Size**

The inside diameter of a manhole shall not be less than 48 inches.

#### **15.7.3 Material Types**

The design of deep manholes shall be performed by the Engineer. For manholes deeper than 20-feet, special consideration shall be given to material type and structural integrity.

- A. Pre-cast Concrete Manhole  
Shall be in accordance with the Utility Standard Details.
- B. Cast-in-Place Concrete Manhole  
Shall be used only when specific conditions require it.
- C. Fiberglass Manholes and HDPE Manholes  
These types of manholes are allowed upon approval by the Utility.

#### **15.7.4 Manhole Types and Applications**

Manhole type, in accordance with Utility Standard Details, shall be used according to the applications provided in Table 15-5. Refer to Utility Standard Details regarding manhole coating requirements.

TABLE 15-5 MANHOLE TYPE AND APPLICATIONS	
MANHOLE TYPE	APPLICATION
STANDARD Manhole Type "A"	For line sizes 21" and smaller
STANDARD Manhole Type "A1"	For line sizes 21" and smaller and shall not be installed in groundwater
SPECIAL Manhole Type "A2"	For line sizes 21" and smaller when special soil conditions require foundation be stabilized
STANDARD Manhole Type "B"	To be used for line sizes 24" and larger or when sewer monitoring equipment is necessary
STANDARD Manhole Type "B1"	To be used for line sizes 24" and larger when under special loading conditions generally greater than H-20, or when required by other governing agencies
STANDARD Manhole Type "C"	To be used for line sizes 24" and larger when installed within TXDOT ROW.

#### 15.7.5 Manhole Frames and Covers

- A. Shall be in accordance with the Utility Standard Details, thereby allowing sufficient access to the sewer.
- B. Manhole frames and covers within a 100-year flood plain (as defined by most current FEMA mapping) shall have gaskets and be bolted.
- C. Special consideration shall be given to locking type manhole covers near government buildings, hospitals, neighborhoods, manholes with flow meters, and other Utility approved sensitive areas.

#### 15.7.6 Manhole Spacing

- A. Maximum recommended manhole spacing for sewers with straight alignment and uniform grades are designated in Table 15-6.

TABLE 15-6 MAXIMUM MANHOLE SPACING	
PIPE DIAMETER	MAX SPACING
8 – 15 inch	500 ft
18 – 30 inch	800 ft
36 – 48 inch	1000 ft
54 or larger	Project specific & Utility approval required

#### 15.7.7 Manhole Connection to Sewer Main

- A. Connection shall utilize a resilient connector, conforming to ASTM C-923 and shall be in accordance with the Utility Standard Details.

- B. The connection shall form a watertight seal between sewer and manhole.

#### **15.7.8 Manhole Access**

- A. For depths greater than 4 feet, the manhole access diameter shall be of adequate size to allow the placement of a ladder for access.
- B. Ladder rungs shall not be provided for manholes.

#### **15.8 INVERTED SIPHONS**

- A. An inverted siphon shall denote any dip, sag, or sewer depression that shall pass under existing structures.
- B. The minimum pipe diameter shall be 8-inches, dependent upon hydraulic grade line and maximum flow to wastewater to be carried.
- C. Sufficient head and pipe size shall provide a minimum velocity of 3 feet per second through the siphon at initial and design flows.
- D. A minimum two barrels are required. The arrangement of inlet and outlet details must divert the normal flow to one barrel.
- E. A system must allow any barrel to be taken out of service for cleaning.
- F. Manholes shall be installed at each end of a depressed sewer to provide access for rodding and pumping.
- G. Pipe material for depressed sewers shall withstand internal pressures and anticipated external pressures

#### **15.9 SEWER SERVICE CONNECTIONS**

- A. When required, a service lateral with a minimum diameter of 4-inches shall be provided for future customer service connections.
- B. Service connections are not allowed within manholes unless approved by the Utility,.
- C. A minimum 3-foot separation distance between service taps is required.
- D. Service lines shall extend 18 inches beyond existing or proposed improvements, such as pavement, curb and gutter, sidewalk, etc., in accordance Utility Standard Details.
- E. The separation between a water service lateral and a sanitary sewer service lateral from the property line to the water distribution main and the sanitary sewer collection main shall be 5-feet minimum of undisturbed or compacted earth.

END OF SECTION

# CHAPTER 16

## WASTEWATER PUMPING STATIONS

### 16.1 GENERAL

- A. This chapter outlines the design of wastewater pumping stations to meet the service needs of users and the operational responsibilities of the Utility. The term wastewater pumping station shall include lift stations as synonymous with wastewater pumping stations.
- B. The Engineer shall justify in writing the requirement for any new wastewater pump stations identifying the options considered in making the decision. New pump stations must be approved by the Utility during the preliminary engineering phase of the development. Justifications shall be in the form of a Technical Memorandum submitted EPWU Planning and Development defining the options considered and cost analysis for capital investment and operating and maintenance costs. Specific design and equipment requirements for the project shall be developed by the Engineer in coordination with the review and approval by the Utility.
- C. The Engineer shall coordinate with the Utility to determine the applicability of these design standards to planned wastewater pumping stations. The Engineer shall submit a written verification of special pumping station criteria to be incorporated into the design of the pumping station. To the extent practical, wastewater pumping station design shall conform to the guidelines given herein.
- D. The Engineer shall develop contract drawings to meet the needs of the project. The contract drawings shall conform to the requirements as noted in Chapter 2.
- E. The design of wastewater pumping stations shall adhere to the requirements of the Texas Commission on Environmental Quality (TCEQ) and recommendations from the Hydraulic Institute. Coordination, review, and approval by the TCEQ is required, where applicable. TCEQ design requirements and checklists can be found at [www.sos.state.tx.us/tac/](http://www.sos.state.tx.us/tac/).
- F. The design of wastewater pumping stations shall generally include consideration of:
  - Civil work and security systems, see Chapters 9 and 10
  - influent / effluent piping
  - fittings / valves
  - wet wells and accessories
  - sewage pumps, motors and starters
  - liquid level sensors
  - instrumentation and controls
  - communication (SCADA and other devices, see Chapter 21)
  - status and alarm systems
  - electrical systems, see Chapter 20



- ventilation and odor control systems
- support systems

## 16.2 CODES AND STANDARDS

- A. Refer to Section 14.2 for a listing of applicable codes and standards to be used in the design of pumping stations.
- B. The design of wet well/dry well pumping stations shall be adhere to the requirements of the National Fire Protection Agency NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

## 16.3 STATION CLASSIFICATION

Wastewater pumping stations are classified according to design flows. Further classification of pumping stations is based on station configuration as described herein.

### 16.3.1 Capacity

- |                |                         |
|----------------|-------------------------|
| • Small        | 0 to 1 MGD              |
| • Intermediate | Greater than 1 to 6 MGD |
| • Large        | Greater than 6 MGD      |

### 16.3.2 Configuration

- A. Submersible Station
  - Motor horsepower limited to 60 hp
  - Number of pumps shall be determined by the Engineer to meet varying flow rates with one redundant pump
  - A concrete valve vault
- B. Packaged Lift Stations
  - Use of packaged lift stations shall be limited to exceptional circumstances and may only allowed when approved for use by the Utility.
  - Submersible station used when peak flow range is from 0-1 mgd.
  - Pre-fabricated fiberglass consists of wet well with isolated integral valve vault. Pre-plumbed submersible duplex pumps, controls, discharge piping, check valves, isolation valves and access hatches.
  - 2 pumps are provided (with one as backup)
- C. Wet Well / Dry Well Station
  - Used when motor size is larger than 60 hp.
  - Number of pumps shall be determined by the Engineer to meet varying flow rates with one redundant pump
  - A separate accessible dry well housing pumping equipment
  - Wet well/ Dry well forced ventilation system
  - Variable station capacity desirable
- D. Variable Capacity Station

- Use of VFD pump control shall be determined by the Engineer to provide flow control for stations with capacity of 30 hp and above.

More specific design features for each classification of pumping station are described below.

### **16.3.3 Submersible Station and Packaged Stations**

#### **A. Wet Well**

- The wet well is constructed of a reinforced concrete pipe with Type V sulfate resistant cement, polymer concrete, or FRP manhole.

#### **B. Valve Vault**

- A prefabricated or poured in place reinforced concrete box shall be provided with typical dimensions as specified in the Utility Standard Details.

#### **C. Hoisting Equipment**

- Hoisting equipment may be portable equipment temporarily installed in a socket at the wet well hatch, provided the weight of the pump does not exceed the capacity of the hoist and its socket. Permanent motor operated hoist shall be furnished for pumps greater than 40 hp

### **16.3.4 Wet Well / Dry Well Stations**

A. Wet well/ dry well stations with vertical dry well access tubes are not to be design for new installations.

B. Wet well and dry well shall be a cast in place, reinforced concrete structure with Type V sulfate resistant cement.

C. Each accessible section shall be equipped with push –pull ventilation system in accordance with NFPA 820, and shall include an odor control system. Hazardous gas monitoring sensors and alarms shall be portable type and provided by the Utility.

#### **D. Hoisting Equipment**

- Hoisting equipment must be capable of conveniently raising or lowering each of the pumps in the dry well. It must have a lifting capacity equal to at least the weight of the heaviest pump, and the equipment must be designed to permit positioning the hoist directly above each of the open access hatches while still allowing clearance for the hoist from its supporting trolley and beam. Hoist and trolley shall be motorized, and a housing shall be provided to secure the hoist.

### **16.3.5 Variable Capacity Stations**

A. Stations requiring variable capacity capability as determined by the Utility shall be designed using pumps with variable speed controllers (VFDs).

B. Trench type wet well design shall have the end pump configured where the trench is self-cleaning. A control sequence shall be programmed into the Pump Control Panel to periodically draw down the wet well and pump out debris, at a schedule determined by the Utility.

## **16.4 DESIGN FEATURES**

### **16.4.1 Installation Purposes**

It is the goal of the Utility to minimize the number of lift stations in the system. Lift stations shall be considered for inclusion into the collection system when the following situations arise:

- A. Elevation of service area is too low to be drained by gravity into existing or proposed main sewers.
- B. Service is to be provided to areas located outside natural drainage area but within service district.

### **16.4.2 Capacity**

- A. Lift stations shall be designed for total firm capacity (i.e., capacity available with the largest pump out of service) to pump the expected daily peak flow.
- B. Based on design flow, the wet well capacity should provide a pump cycle time of not less than 6 minutes for lift stations with submersible pumps, and not less than 10 minutes for lift stations with non-submersible pumps.
- C. In the case of power outages or equipment failure, sufficient holding capacity shall be provided in the wet well and piping system to allow for wastewater storage. Provisions for a minimum wastewater retention period of 20 minutes shall be provided, per TCEQ requirements.

### **16.4.3 Wet Well**

- A. Materials of construction shall be reinforced concrete, polymer concrete or FRP. Type V sulfate resistant shall be used for concrete.
- B. Structural design of wet wells and dry wells shall account for ground water loads and structure buoyancy. All construction joints shall be sealed.
- C. The bottom of the wet well shall have a minimum slope of 10 percent toward the pump intakes and shall have a smooth finish.
- D. Engineer shall design drop pipe extensions and pipe penetrations to allow for differential settling movement of the wet well structure and pipe.
- E. Wet well configuration shall limit influent impingement onto the pumps, and shall limit the distance of the influent pipe vertical drop to minimize excessive aeration resulting in pump cavitation.
- F. Coatings, see 16.4.8

### **16.4.4 Dry Well**

- A. Materials of construction shall be reinforced concrete. Type V sulfate resistant cement shall be used for concrete.

- B. The bottom of the dry well shall slope toward either a sump pump or drain pipe which drains into the lift station wet well. The drain shall prohibit entry of potentially hazardous gases into the dry well.
- C. Provide an intruder door switch for wet well, electrical room and/or dry well access doorways.
- D. A portable fire extinguisher shall be provided at the access to the dry well.

#### **16.4.5 Pipe Clearances**

- A. Pipe clearances shall consider the size of the wet well/dry well in which they will be installed and the clearances and other dimensions required to install, remove, or repair them. Channels, sumps, and sump pumps shall be provided to allow drainage. A minimum 3-foot clearance shall be maintained between the force main piping and the wall of the dry well.

#### **16.4.6 Access Hatches**

- A. Wet well access hatches to the submersible pumps shall be provided at the top of the wet well. Hatches shall be sized and located so that the pumps can be raised and lowered through the hatches without hindrance. The access hatch shall be a hinged aluminum lid. The hatch shall be rain-tight and fitted with a handle and positive automatic latching device. A lock shall be provided that can be opened with a knob from the inside and a key from the outside. Valve vault access hatches shall be provided for access to valves. Vault hatches shall be similar in design to wet well hatches.
- B. Dry well and equipment hatches shall be provided at grade, accessible for loading equipment.
- C. Hatches shall maintain fall prevention protection when opened. Dry well equipment hatches should include temporary safety railing as needed.

#### **16.4.7 Pumps**

- A. Refer to APPENDIX I for a list of approved pump manufacturers.
- B. All raw sewage pumps shall be of a non-clog design, capable of passing a 2-½ inch diameter sphere and shall have no less than 3-inch diameter suction and discharge opening. Pumping units and grinder pumps shall be reliable and easily maintained with compatible characteristics.
- C. Pumps units shall be provided with a check and isolation valve on the discharge side of the pump and it shall be easily accessible for maintenance. Check valves shall be swing check type with external levers. Isolation valves shall be plug valves.
- D. All pumps shall be securely supported so as to prevent movement during operation. Riser pipes shall be supported at maximum 5-foot intervals.
- E. The number of pump starts per hour shall be in accordance with Hydraulic Institute recommendations and shall not exceed the motor manufacturer recommendations.
- F. For submersible pumps, rail-type pump support systems incorporating manufacturer approved mechanisms designed to allow the operator to remove and replace any single pump without first entering or dewatering the wet well shall be provided.

- G. Power cable shall terminate in the electrical disconnect box. Cable entries to the box shall be sealed type, and shall be designed for removal of the power cable and re-sealable when the pump is re-installed. Sewer gasses shall not be allowed to enter the electrical box.
- H. The Engineer shall specify pump operating ranges and determine the criteria for use of variable frequency drive (VFD) or constant speed motors. A pump control strategy shall be developed for proper facility operation.
- I. A hydraulic profile of the station and force main shall be prepared to ensure proper operation of the system. Plans shall include a station system capacity-head curve indicating operating point and operating range. The installed pump performance data superimposed on the system head curve, and manufacturer test performance curves for each pump unit shall be submitted along with the operation and maintenance (O&M) manual for record.
- J. Plans for wet well/dry well configurations shall include a scaled sectional drawing of the suction pipe and pump arrangement indicating relevant elevations. Sectional drawing shall show a superimposed hydraulic grade line relative to the pump volute for the suction piping.
- K. The number of pumps starts per hour shall be in accordance with Hydraulic Institute recommendations and shall not exceed the motor manufacturer recommendations
- L. For submersible pumps, rail-type pump support systems incorporating manufacturer approved mechanisms designed to allow the operator to remove and replace any single pump without first entering or dewatering the wet well shall be provided.
- M. The Engineer shall specify pump operating ranges and determine the criteria for use of variable frequency drive (VFD) or constant speed motors. A pump control strategy shall be developed for proper facility operation.
- N. Self-priming wastewater pumps shall not be allowed in the system.
- O. Vacuum-priming wastewater pumps shall not be allowed for new installations.
- P. Grinder pumps shall not be allowed in the system.
- Q. Standard nominal voltage used for lift stations shall be 480/277 Volt, 3-phase, 4-wire.
- R. Dry well motors shall be premium efficient design. Dry well variable frequency driven motors shall be inverter duty rated.

#### **16.4.8 Protective Coating**

- A. Protective coatings shall be applied by authorized/ certified coating applicators for the product being applied.
- B. In groundwater, all wells and structures in contact with soil shall be outside coated with a minimum 50 mils of coal tar epoxy.
- C. The wet well interiors and any appurtenances exposed to sewer gasses inside the wet well shall be coated with Sauereisen Sewerguard No. 210 or similar protective coating approved by the Utility.

- D. Wet wells lined with mechanically anchored corrosion resistant liner plates shall not be allowed.

#### **16.4.9 Electrical System**

- A. Electrical service shall be supplied to the lift stations for power, lighting, and communications. All electrical equipment shall conform to the requirements of the National Electric Code and the guidelines in Chapter 20 of this manual. Special consideration shall be given to the design of electrical equipment in accordance with NFPA 820, or where a flammable gas exists
- B. To the extent possible, all equipment containing electronic boards shall be specified with conformal coating. See Chapter 20 for details.
- C. Phase loss/voltage monitor protection shall be provided on the main electrical panel. Unit shall be Symcom Motors Saver Model 250, with DPDT output contacts. Input to unit shall be protected with 10 Amp KTK fuses mounted in enclosed fuse holder.
- D. Classified areas per NEC Article 500 shall be clearly identified on the design drawings. All equipment used within classified areas shall be in full compliance with area classification.

#### **16.4.10 Pump Control Panels**

- A. Design of the occupied control room shall be in accordance with City of El Paso International Building Code IBC.
- B. Small lift stations – provide a standalone control room. Provide thermostat controlled exhaust fan with gravity damper. Soft start equipment is preferred for motors less than 30 hp, unless a VFD is required.
- C. Intermediate lift station – provide a standalone control room. Provide thermostat controlled exhaust fan with gravity damper. For equipment with VFDs provide heating and air conditioning to suit the electrical operating parameters.
- D. Large lift stations – provide a standalone or integrated control room including motor starters, VFDs, station control panel, UPS and transfer switches as needed. Provide HVAC to suit the electrical operating parameters.

#### **16.4.11 Pump Control Panels**

All electrical equipment and any protective measures shall be designed for the site specific design and temperature conditions. Aka the environment. . Control panels (CP), if approved by the Utility, shall contain a main breaker where applicable, metering instruments, programmable equipment, relays and timers, starters, circuit breakers, and switches. MCP shall be easily accessible within the control room and easily maintained.

#### **16.4.12 Alarm System**

- A. Audible alarms, strobes, warning lights, or other unit malfunction indicators shall not be installed at the pumping station, unless otherwise specified.
- B. The alarm system shall annunciate via the SCADA system (Refer to Chapter 21).

- C. The alarm system shall be activated in case of power outage, pump failure, site intrusion, or at a specified high water level.
- D. The alarm system shall be designed in conjunction with the facility instrumentation and control system supported by the Utility. An uninterruptible power supply (UPS) with adequate backup battery shall be integrated into the design of the alarm system.

#### **16.4.13 Backup Generator**

- A. All wastewater pump stations shall include lugs and a manual transfer switch located on the exterior of the control room/building for connection of portable generators.
- B. A permanent stand-by generator sized to power the station rated power demand shall be furnished for intermediate and large stations. The Utility shall determine the engine fuel source to be provided.
- C. For natural gas fueled engine sets, design natural gas service and site piping as required for the specified engine.
- D. For diesel fueled engine sets, design the storage tank capacity in accordance with run times as determined by the Utility.

#### **16.4.14 Liquid Level Controls**

- A. Liquid level controls shall be ultrasonic or radar as specified in Chapter 21. An automated backup controller, such as a float system, shall be provided and hardwired to pump controllers directly bypassing the process controller PLC.
- B. The liquid level control shall signal the pump controls to automatically start the duty pump(s) at an operator settable predetermined high liquid level(s) and to automatically stop at an operator settable predetermined low liquid level(s). The automatic start and stop sequence shall alternate between pumps. The automated liquid level controller can be a simple process controller solution or a more complex PLC enabled solution. The specific automated liquid level control solution will be determined by the type and complexity of the system and shall be decided upon by the Engineer and Utility.

#### **16.4.15 Odor Control Equipment**

- A. Submersible stations shall have passive ventilation for the wet well and valve vault.
- B. Mechanical odor control equipment shall be furnished on intermediate and large stations.
- C. Equipment and ductwork shall be corrosion resistant and shall have vibration isolation devices.
- D. Odor control media shall be granular activated carbon or as approved by the Utility.
- E. Odor control equipment shall be set on acid resistant concrete containment base. Equipment supports shall be acid resistant. Galvanized steel support materials shall not be allowed.
- F. Provisions for enhanced odor control provisions at the station shall be determined by the Utility.

#### **16.4.16 Hose Bib**

- A. Each station shall be provided with water from the potable water system. Water for wash down or sanitary services shall include a reduced pressure type backflow preventer with hot box. Wash down station to include: hose bib, wash down hose and a galvanized hose rack.
- B. When water service is not available to the site, wash down provisions listed above shall be provided so that the system can be connected at a future date.

#### **16.4.17 Restroom Facilities**

- A. Restroom facilities for lift stations shall be designed in accordance with International Building Code (IBC), including accessibility requirements of the Texas Accessibility Standards (TAS).
- B. Restroom facilities shall be approved by the Utility for incorporation into the design of large stations.

### **16.5 SITE DESIGN AND LAYOUT**

- A. Lift station site layout shall be in accordance with City of El Paso Municipal Code, and Chapter 10.
- B. Site must be of sufficient size to permit the station to be constructed and the attendant facilities installed without encroaching on other adjacent properties. The minimum lift station site shall be designed within a 50 foot x 50 foot area, and a temporary 50-foot construction easement around the perimeter of lift station site shall be provided.
- C. Site layout shall be in accordance with Section 16.4 and shall additionally consider the design of a control building, pump hoisting facilities. Large stations with ancillary access needs shall facilitate the turning radius of maintenance and delivery vehicles used by the Utility.
- D. The site shall be surrounded with an eight-foot high rock wall or similar approved wall system. Barb wire strands shall not be used for site security measures without approval by the Utility.
- E. Provide exterior security lighting, full-cut-off LED light fixtures for electrical building or other structures on the site. Wet well area lighting is not generally provided.
- F. Site shall have adequate vehicular access to and from public streets. Generally, a minimum 20-foot entrance wrought iron double swing gate to the station site shall be provided, unless otherwise specified. The Utility will provide chain and lock to secure the site.
- G. Grade is to slope away from the lift station and the site shall generally be paved throughout. Gravel surface may be used upon approval by the Utility. Where applicable, on-site drainage shall be provided per City requirements.



## 16.6 FORCE MAIN LINES

A force main line is a pressure rated pipeline that conveys wastewater from a pumping station to a discharge point. Proper design of the force main and pumping station shall take into consideration the hydraulic profile of the combined system.

### 16.6.1 Pressure Rating

Minimum rating shall withstand anticipated internal pressures, including those imposed by water hammer. Minimum pressure rating shall be 150 psi.

### 16.6.2 Velocity

The velocity range shall be 3.5 to 5 ft/s for small-size or medium-size stations with intermittent pumping at any rate including maximum. A velocity of 3.5 ft/s will re-suspend deposited solids. Pump capacities required to maintain sufficient velocities for smaller diameter force mains are listed in Table 16-1.

TABLE 16-1 PUMP CAPACITIES FOR MINIMUM FORCE MAIN VELOCITIES	
FORCE MAIN DIAMETER	PUMP CAPACITY for V = 3.5 ft/s
4 inch	135 gpm
6 inch	301 gpm
8 inch	555 gpm
12 inch	1236 gpm

### 16.6.3 Force Main Size

- A. Force main size shall be a minimum of four inches in diameter. Size shall be sufficient to maintain an adequate velocity at minimum flow to prevent solid depositions or from re-suspending settled solids.
- B. Size shall be determined by hydraulic conditions of the system to include static head and pumping required to overcome friction losses.
- C. Force mains shall include provisions for venting trapped gases.

### 16.6.4 Force Main Material Types

Acceptable force main materials shall be PVC pressure pipe conforming to the standards indicated in Section 12.4 or lined Ductile Iron Pipe (DIP) conforming to standards indicated in Section 15.5. Appropriate lining shall be provided as determined by the Engineer. Similar requirements for dual markings at the spigot end of pipe or installation of pipe stops (in lieu of the dual markings) for PVC pipe forcemains shall be specified to mitigate over-homing potentials.

### 16.6.5 Depth of Cover

A uniform minimum depth of cover shall be 5 feet to minimize load impact.

#### **16.6.6 Appurtenances**

- A. Air Release Valves or Combination Air Release/Vacuum Valves shall generally be installed at each high point where air could become entrapped. Discharge shall be into a sewer manhole, vented dry well, or other suitable place.
- B. Blow-off Valve shall generally be provided in a manhole at a low point of a long depressed section of a force main. It shall be large enough to provide adequate velocity to flush the main and generally no smaller than 6 inches.
- C. Plug Valves shall generally be provided for isolation purposes on the discharge side of the pump. Knife gate or ball valves may be used in force mains for isolation valves.
- D. Check Valves or other appropriate devices shall be used to control water hammer by limiting the pressure changes in a force main. Check valves shall be of swing check type with external levers or silent check type with approval of the Utility.

#### **16.7 OTHER**

Refer to Sections 14.8 - 14.11 for additional information pertaining to the design of lift stations.

END OF SECTION

# CHAPTER 17

## RECLAIMED WATER SYSTEMS

### 17.1 GENERAL

- A. This chapter provides guidance and minimum design criteria for the modification and construction of reclaimed water systems owned and operated by the El Paso Water Utilities (Utility). The Engineer shall adhere to all applicable local and state requirements regarding the production, distribution, and use of reclaimed water.
- B. Reclaimed water mains are defined as a closed pressure pipe designed to be leak proof and convey reclaimed water suitable for beneficial public use in place of potable and/or raw water.
- C. Reclaimed water use is classified into two categories, in accordance with the Texas Administrative Code (30 TAC 210). Type I reclaimed water use is the use of reclaimed water where contact between humans and the reclaimed water is likely. For Type II reclaimed water use, contact between humans and the reclaimed water is unlikely. All reclaimed water produced by the Utility complies with Type I reclaimed water standards.
- D. Specific uses of reclaimed water are provided in 30 TAC 210. EPWU approved uses of reclaimed water may include landscape irrigation, non-food processing industrial uses, and compaction and dust control for construction. The distribution and use of reclaimed water shall not adversely affect the ground and surface waters.
- E. All piping shall be either purple pipe, painted purple, or purple polyurethane coating (AWWA C222). Wrapped with purple plastic wrap is not allowed. The purple tape/wrap shall be a 2-ply polyethylene wrap with an 8-mil minimum thickness. All pipes should be stenciled in white with a warning reading "NON-POTABLE WATER".
- F. Prior to implementation of a reclaimed water system, viability of end user shall be conducted to ensure successful candidate for its use. Assessment of site soil conditions and landscape shall be considered. Subsequent and periodic monitoring of water use, site conditions, and soil conditions will be required and conducted by the user and the Utility at reclaimed water sites.

### 17.2 RECLAIMED MAIN CLASSIFICATION BY FUNCTION AND SIZE

Pipe size shall denote the actual or the nominal inside diameter of the pipe. Generally, the basic classifications of reclaimed water lines by function and approved standard sizes are:

- A. Transmission Lines  
20-inches in diameter and larger. Standard pipe sizes are generally 20, 24, 30, and 36-inch.
- B. Distribution Lines  
6-inches to 16-inches in diameter. Standard pipe sizes shall be 6, 8, 12, and 16-inch.
- C. Service Lines  
 $\frac{3}{4}$ -inch to 8-inches in diameter

### **17.3 DESIGN PARAMETERS**

The design and selection of reclaimed water mains comprising the distribution system shall be based on the parameters defined in the following subsections.

#### **17.3.1 Design Flow Capacity of the Main**

- A. The design of a reclaimed water distribution system shall be done on a demand only basis. Reclaimed water demand rates shall be determined in accordance with Average Daily Demand, Maximum Daily Demand, and Maximum Hourly Demand as defined in Chapter 12.3.1.A.
- B. Reclaimed water transmission and distribution mains shall be sufficient in capacity to supply the larger of the Maximum Hourly Demand or the Maximum Daily Demand.
- C. No minimum water pressures are required; however, the distribution system shall be designed to meet pre-existing pressures of the water system (i.e., match potable water pressures).
- D. Where no previous conditions exist, a minimum static pressure of 20 psi must be provided. However, the distribution system shall be designed to meet pre-existing pressures of the water system (i.e., match potable water pressures).

#### **17.3.2 Hydraulic Flow (Limiting) Factors**

- A. Maximum rate of head loss due to friction in a distribution or transmission main shall be 5-7 feet per thousand feet.
- B. Velocity in transmission mains shall not exceed 4-5 feet per second.
- C. Velocity in distribution mains shall not exceed 5-7 feet per second.

#### **17.3.3 Anticipated Pressure Conditions**

In providing material suitable for the anticipated pressure conditions, consideration shall be given to pressure class, working pressure, surge pressure, and pressure rating, as defined in Chapter 12. Selection of the appropriate pressure class or pressure rating shall be based on the anticipated total system pressure which shall be defined as the sum of the working pressure plus surge pressure.

- Selection of Pressure Class or Pressure Rating for a pipe to be used in a particular area shall be based upon the area's anticipated normal operating pressures as determined by system analysis or field data.

Refer to Table 17-1 for information regarding appropriate Pressure Class, Pressure Rating and Pipe Material Selection.

#### **17.3.4 External Load Factors**

- A. Pipe strength must be sufficient to resist external forces including standard backfill, the weight exerted by traffic and other anticipated external forces.
- B. Embedment of a pipe is significant in determining external load-carrying capacity. Pipe embedment shall provide uniform longitudinal support under pipe and shall ensure that external loads will not deflect nor cause pipe settlement beyond allowable limits.

### 17.3.5 Separation Distances

Separation distances of Utility mains shall be in accordance with Chapter 4, the Utility Standard Details and TAC 210/290 requirements.

## 17.4 PIPE MATERIAL TYPE

The following section provides general information on the type of pipe materials acceptable for use. Additional information regarding these material types is included in Section 17.5. Information regarding corrosion control of the various pipe materials is addressed in Chapter 19.

All piping 12-inch in diameter and small shall be manufactured in purple, in accordance with PSB Rules and Regulations No. 12. All pipes larger than 12-inch diameter shall be either manufactured in purple color, purple polyurethane coated, and/or painted with purple permanent color. Purple polyethylene wrap and tape wrap are not allowed.

### 17.4.1 Poly Vinyl Chloride (PVC) Pressure Pipe

- A. Shall generally be used for Distribution and Transmission Lines, unless special conditions require another material. All PVC shall conform to AWWA Standards C-900 and C-905. Outer diameters shall be comparable to cast iron pipe or fittings.
- B. Designation of PVC C-900 shall be according to pressure class as defined in Paragraph 17.3.3.
- C. Designation of PVC C-905 shall be according to pressure ratings as defined in Paragraph 17.3.3.
- D. PVC products shall be made in the USA.

### 17.4.2 High Density Polyethylene (HDPE)

HDPE pipe is to conform to ASTM Standard F-894. HDPE shall have an open profile wall type and shall be used in diameters 16-inch and larger. Use of HDPE pipe shall be approved by the Utility.

### 17.4.3 Steel Cylinder Concrete Pipe (SCCP)

Shall be used for Transmission Lines and shall conform to AWWA Standards C-303. Concrete pressure pipe shall be bar-wrapped steel cylinder type. Pre-stressed pressure pipe is not used by the Utility. Steel cylinder concrete pipe per AWWA C-301 is no longer used by the Utility and shall be replaced with an appropriate equivalent.

### 17.4.4 Steel Pipe

Shall generally be used for Transmission Lines and shall conform to AWWA standard C-200 with mortar lining (AWWA C-205), and polyurethane coating (AWWA C-222)

### 17.4.5 Ductile Iron (DIP)

Shall generally be used for Transmission Lines, unless special conditions require that it be used for Distribution Lines. DIP shall be accordance with AWWA C-151/A21.51.

Designation of DIP shall no longer be according to thickness class, but rather the pressure class of the pipe. Pressure class shall be for the rated working pressure plus a surge allowance of 100 psi in accordance with AWWA C-151/A21.51.

## 17.5 PIPE MATERIAL SELECTION

### 17.5.1 Allowable Material and Pipe Class

Reclaimed water mains shall be designed and constructed to satisfy the requirements established in Table 17-1 for the various diameters, material type, and pressure class shown.

Selection of pipe material or alternates for transmission lines shall be approved by the Utility with respect to alternate bid materials, prices, and other considerations.

TABLE 17-1 RECLAIMED WATER SYSTEM ALLOWABLE MATERIALS AND PIPE CLASS							
PIPE DIAMETER (inch)	MATERIAL	AWWA STANDARD	<u>ZONE</u> <sup>1</sup>	Min PC <sup>1</sup> (psi)	Min PR <sup>1</sup> (psi)	DR	STD LENGTH (ft)
6 8 12	PVC	C-900	1	235		18	20
			2	305		14	20
	DIP	C-151 / A21.51	1 & 2	350		NA	18
	HDPE*	C-906	N/A	***		***	20
16	PVC	C-905	1		235	18	20
			2		305	14	20
	DIP	C-151 / A21.51	1 & 2	****		NA	18
	HDPE*	C-906	N/A	***		***	20
20 - 36	DIP	C-151 / A21.51	1 & 2	****		NA	18
	HDPE*	C-906	N/A	***		***	20
	STEEL	C-200	1 & 2	***		NA	32
	SCCP	C-303	1 & 2	***		NA	20
42, 48, 54, 60	DIP	C-151/A21.51	1 & 2	***		N/A	20
	STEEL	C-200	1 & 2	***		N/A	45
	SCCP	C-303	1 & 2	***		N/A	32
	HDPE*	C-906	N/A	***		***	20
	<sup>1</sup> PC (pressure class) and PR (pressure rating) defined in Section 17.3.3 * HDPE pipe size designated as nominal outside diameter. Use of HDPE to be approved by the Utility. *** Pipe Class shall depend upon specific project requirements and shall be determined by the pipe manufacturer. **** Pressure Class to be determined in accordance with AWWA C151/A21.51						

### **17.5.2 Line Addition within Existing Network**

When a new line is to be installed within an area such that the existing network of this area consists of one material type, this material type shall generally be used for the new line to provide consistency within the network area.

### **17.5.3 Replacement/Maintenance of Existing Pipelines**

Projects designed to replace existing pipelines with the same pipe material shall be in accordance with the standards and schedule set herein.

## **17.6 STANDARD COVER**

Generally, minimum cover shall be 5-feet measured from top of pipe to finished grade. However, where natural topography, or other circumstances warrant a lesser depth, minimum cover shall not be less than 3-feet measured from top of pipe to finished grade, upon approval by the Utility.

## **17.7 FITTINGS AND VALVES**

- A. Fittings and valves for reclaimed water systems shall conform to the guidelines specified in Chapter 12 with the exception that any plastic wrapping of fittings and valves must be in purple plastic.
- B. A square bonnet box shall surround and provide restricted access to each buried valve of the reclaimed system. Standard manhole covers shall be used for butterfly valves and other appurtenances. All hose bibs and faucets shall be painted purple and designed to prevent connection to a standard water hose. Hose bibs and above-ground quick couplers shall be located in locked vaults. At or below ground quick couplers shall be capped with special lockable caps and placed within valve boxes. All new irrigation system valve boxes shall be manufactured in purple. All existing valve boxes shall be painted in purple. Cast iron bonnet box covers shall be painted in purple.
- C. The system shall have valves in sufficient locations so that relatively small parts of the system can be shut off for repairs or replacement without discontinuing service to large areas.
- D. Valves on reclaimed water mains shall generally be placed at a maximum distance of 500 feet.
- E. Generally, the number of valves at an intersection is one less than the streets coming into an intersection. Valves shall be aligned with the property line of the street.
- F. The number of valves required to isolate an area shall generally be three (3) and the maximum number shall be five (5).
- G. One isolation valve shall be placed on each side of major canals, railroads, utility corridors, etc.
- H. Shut-off valves and 2-inch meters shall be provided on every post-hydrant lateral.
- I. Post-hydrant laterals shall be 2-inch in diameter.
- J. Post-hydrants shall be purple color from the manufacturer.

## **17.8 SERVICE CONNECTIONS**

- A. When required, a service lateral with a minimum diameter of 4-inches shall be provided for future customer service connections.
- B. Service lines shall extend 12-inches beyond existing or proposed back of curb improvements, in accordance with Utility Standard Details.
- C. Meters shall be accessible at all times. Meters or services will not be placed on the outside of the curb line on any existing street or newly constructed streets unless the outside grading (property side of curb) is within 4-inches of the finished grade for a distance of 10-feet from the property side of the curb. If a curb does not exist then the meters shall be placed flush with the existing roadway surface.
- D. New reclaimed water meters, unless otherwise specified, will be furnished and installed by the Utility. All other materials including meter boxes shall be furnished and installed by the contractor. Meter box covers shall be painted with permanent purple paint.
- E. Sizing of a meter shall depend upon anticipated required flow rates, pressure at the service connection, and friction losses. Selection of meter size requires approval from the Utility.

## **17.9 OTHER**

### **17.9.1 Flushing Stations**

- A. An automatic flushing unit shall be provided near the end of a reclaimed water line to automatically flush the desired amounts of reclaimed water from the distribution system. The flushing unit shall be enclosed in a below-grade bottom vented base, and the discharge line shall tie-in to an existing wastewater line. An air gap or other separation shall be provided.
- B. The automatic flushing unit system shall include de-chlorination capabilities, freeze protection, and hand-held programming capabilities.
- C. Internal piping for the flushing unit shall be PVC pipe with a static pressure rating of 150 psi and an operational rating of 100 psi or as case specific.
- D. The control valve shall be a globe valve type design, constructed of a non-corrosive glass-reinforced nylon or equal, and fitted with stainless steel hardware.
- E. Easy access to the unit for maintenance and repairs shall be provided through a quick disconnect mechanism.
- F. Backflow prevention shall be provided through the use of a reduced pressure principle assembly.
- G. Enclosure shall be manufactured in color purple and approved by the Utility.

### **17.9.2 Dispensing Stations**

- A. Reclaimed water dispensing stations shall be provided when appropriate. The station will be designed with a drain to capture overflows. The system shall be a modern electronic



system designed for the control and accounting of reclaimed water dispensed or collected from one or more sites.

- B. The dispensing station will require that customers utilize access codes to activate each hose.
- C. The data entry devices, including keypad and pump control circuits, shall be integrated in a single stand-alone enclosure of rugged construction to withstand extended use and discourage vandalism.
- D. The pump control unit shall be CSA certified and must meet all local electrical code requirements for installation on the pump island or wall mounting.
- E. Electrical components, devices, and accessories shall comply with labeling requirements in NFPA 70, Article 100.

### **17.9.3 Warning Signs**

- A. Warning signs shall be posted at reclaimed water facilities and at every access point to the property being serviced with reclaimed water.
- B. The number and size of warning signs depends on the size of the site and the amount of traffic, as approved by the Utility.
- C. Signs shall be in English and Spanish, and not smaller than 8-inches by 8-inches at residential sites and 18-inches by 24-inches at all other irrigated sites, in accordance with the Utility Standard Details. Lettering shall include "Warning – Reclaimed Water – Do Not Drink" in white letters on purple background.

### **17.9.4 Standpipes**

Standpipes for construction should be allowed for connection to reclaimed water facilities provided that if the equipment (standpipe) is used again on a potable water system, a backflow preventor is utilized. While backflow preventors are not required for reclaimed water systems, if used on a reclaimed water system, they shall be painted purple and they cannot be used again on a potable water system without thorough disinfection.

### **17.9.5 Thrust Restraints**

Thrust restraints for reclaimed water lines shall be designed in accordance with Section 12

### **17.9.6 Tapping Sleeves and Valves**

- A. Multiple tapping shall not be on a common line parallel to the longitudinal axis of the pipe.
- B. Taps shall be separated by a minimum distance of 18 inches on the longitudinal axis of the pipe.

### **17.9.7 Storage Tanks**

Reclaimed water storage tanks shall be designed in accordance with Chapter 13, with the exception of meeting provisions or fire fighting and emergency storage. Provisions shall be made for re-chlorination.

### **17.9.8 Pumping Stations**

- A. Reclaimed water pumping stations shall be designed in accordance with Chapter 14. Provisions shall be made for re-chlorination and re-circulating systems.
- B. Instrumentation and Control. Monitoring and control or Reuse facilities shall be incorporated into the Utilities' SCADA system. It is the Engineer's responsibility to provide automated monitoring and control via instrumentation and automated controllers as per facility requirements and complexity of designed system per Chapter 21 of these design standards unless otherwise specified.

### **17.9.9 Reclaimed Water Hydrant**

- A. Reclaimed water hydrants are not recognized by AWWA Standard C-502 for dry barrel hydrants, however they do need to be manufactured to the same quality of materials and workmanship.
- B. Public reclaimed water hydrants shall only be installed along open dedicated streets, city property, or at other approved locations.
- C. The maximum distance of a hydrant from the face of the curb shall be 2 feet, in accordance with Utility Standard Details.
- D. The standard size is 2-inch in diameter, Style 33 Post type with 2-¼ inch nozzle. Shut-off valves and meters shall be provided on every post-hydrant lateral.
- E. Reclaimed water hydrants shall be purple color from the manufacturer.

### **17.9.10 Testing and Disinfection of Reclaimed Water Lines**

- A. All hydrostatic testing of installed pipe shall be performed using potable water, unless otherwise approved by the Utility.
- B. Disinfection of reclaimed water lines is not required.

END OF CHAPTER

# CHAPTER 18

## TRENCHLESS CONSTRUCTION

### 18.1 GENERAL

- A. These guidelines pertain to underground utility crossings by methods other than open-cut/trenching. The guidelines contained herein are intended solely to prevent unnecessary failures and to provide sufficient information and requirements to insure uniform application of the guidelines.
- B. Trenchless operations methods require the design engineer to provide sufficient information to reasonably anticipate obstacles that might be encountered, and how drilling or boring operations should be carried out. Surface and subsurface survey information will assist in determining the suitability of utility installation by the specific trenchless process. Identification of work area requirements, grade elevation data, above-grade structures, bore or pit locations, manhole or valve boxes, and existing utilities and difficult soil or subsurface conditions, to name a few, should be identified in the surveys.
- C. Additional information on trenchless construction is available from the International Society for Trenchless Technology (ISTT), North American Society for Trenchless Technology (NASTT), and Trenchless Technology – Pipeline and Utility Design, Construction, and Renewal by McGraw Hill publisher.

### 18.2 TRENCHLESS TECHNOLOGY TYPES

Trenchless technology methods are generally categorized into the following:

- A. **Trenchless Construction Methods (TCM)** – for “new” utility and pipeline installations below grade without direct installation into an open-cut trench. This category includes and may involve one or several combinations of the following:
  - 1. Horizontal Earth Boring (HEB) may include the following subcategories:
    - a. Horizontal Auger Boring (HAB) – for installation of steel casing for new utility installations. The steel casing is jacked from a drive pit. Spoil material is removed with a rotating flight Auger having a cutting head.
    - b. Horizontal Directional Drilling (HDD) – for installation of pressure pipelines and cable conduits. Stage 1 involves drilling a small diameter pilot hole along the centerline of the proposed pipeline. Stage 2 enlarges the pilot hole to the desired diameter, and pulling the line through.
    - c. Pipe Ramming (PR) – for installation of utilities under a roadway, highway, or railroad crossing. Uses an air compressor to hammer the steel casing from a drive pit. Then uses air pressure to push the spoil out of the steel casing.
    - d. Microtunneling (MT) – for installation of gravity sewer lines. Uses a microtunneling boring machine using laser guidance, remote-controlled.

Uses a drive shaft (pit) for jacking the pipe, and an exit shaft for retrieving the MT boring machine.

- e. Pilot-Tube Microtunneling (PTMT) – alternative to conventional microtunneling for installation of small diameter gravity pipes (6-10 inches). Uses the steering system of a directional drill, spoil removal system of an auger boring machine, guidance system.

- 2. Pipe Jacking (PJ) by itself denotes a “specific installation technique”. However, when used as a “process” in other trenchless technology methods, this implies a tunneling operation with use of thrust boring and pushing pipes with hydraulic jacking force. The jacking technique involves forcing the pipe forward with hydraulic jacks as the pipe jacking face is excavated. The spoil is transported through the inside of the pipe to the drive shaft for removal. The jacking cycle repeats itself for each pipe segment installed.
- 3. Utility Tunneling (UT) involves the construction of underground utility lines by removing the excavated soil from the front of the cutting face and installing liner segments to form a continuous ground support structure. This method requires person-entry inside the lining during the tunneling process. Soil excavation can be accomplished by hand mining, mechanical excavation, or tunneling shields. The most frequently used liner material is prefabricated liner plate, although rib and lagging systems may be used.

**B. Trenchless Renewal Methods (TRM)** – for renewing, rehabilitating, and/or renovating an existing, old, or host pipeline or utility system, for the purpose of extending the design life of a pipeline system. This category includes the following:

- 1. Cured-in-Place Pipe (CIPP) - as an alternative to sliplining, cured-in-place lining is a pipe rehabilitation technique that is primarily used for gravity sewer lines.
- 2. Sliplining (SL) - appropriate liner materials are typically polyethylene and fiberglass reinforced polyester.
- 3. In-line Replacement (ILR) – may include the following:
  - a. Pipe Bursting (PB) (Pneumatic or Hydraulic) – for renewing sewer, water, and other pipelines, and to upsize their capacity. A cone-shaped tool (bursting head) is inserted into the existing pipe, forced through and fracturing the pipe, and pushing its fragments into the surrounding soil. Then, a new pipe is either pushed or pulled into place. Pneumatic system uses compressed air to hammer the bursting head in strokes thus breaking the pipe. Hydraulic system uses an axially mounted hydraulic piston that drives the lateral expansion and contraction of the bursting head.
  - b. Pipe Removal (Pipe Reaming, Pipe Eating) – Used in directional drilling, uses a reamer with cutting teeth which grinds and pulverizes the existing pipe as the reamer is pulled back along the pipe. Pipe fragments and excess material from upsizing are carried with drilling fluid to reception pits, and retrieved with vacuum truck or slurry pump for disposal. EPWU has used a patent method called INNEREAM similar to the one described here. The Pipe Eating method uses a microtunneling boring machine and jacking operation.

### **18.3 SELECTION OF RENEWAL METHOD**

It is important for the design engineer to follow a program for selection such as the following in order to make rapid quality and cost-effective decisions on the method to be used in a particular project circumstance. The engineer should:

- A. Define the problem and conduct a complete and accurate pipeline condition assessment;
- B. Identify the candidate methods focusing on their limitations and compatibility with project conditions;
- C. Make a final selection of the method;
- D. Develop a better understanding of the method (refer to references);
- E. Identify technology providers (contractors);
- F. Provide the solution (develop the design and contract documents).

### **18.4 CASINGS AND TUNNEL LINERS**

- A. Casings shall be provided when Utility lines cross under highways, railroads, canals, or other structures, as deemed necessary to protect the pipeline and as required by the governing agency of these infrastructures.
- B. Casings shall be provided when the minimum separation distance of water and sewer lines, as required by the Texas Commission on Environmental Quality (TCEQ), cannot be achieved.
- C. Casings shall be steel pipe and shall be sized and installed in accordance with the design details. In the absence of such details, installation shall be in accordance with the Utility Standard Details. Reinforced concrete pipe may be used as a casing upon approval by the Utility.
- D. Tunnel liners shall generally be used for larger water, sewer, or reclaimed water lines, where approved by the Utility.
- E. Casings and tunnel liner plates shall be designed to withstand the external loads and forces to which they will be subjected.
- F. Casings and tunnel liners shall be of sufficient length to extend under all pavements and in no case shall the end of the casings be closer than 5 feet from the pavement edge including paved shoulders, or 2 feet from the back of curb plus additional length as necessary to extend to the excavated slopes of the jacking and receiving pits. In no case shall the length be less than required by the approving agency.

#### **18.4.1 Annular Space**

- A. The annular space between the casing and carrier pipe shall be pneumatically filled with sand, for all pipe installations other than in groundwater. In groundwater, the annular space shall be grout filled or supported by means of hydraulic jacks.

- B. When the casing pipe has been cathodically protected, then insulated spacers shall be required for pipe other than PVC. Under these circumstances, the annular space between casing and carrier pipe shall remain void.
- C. When the governing agencies of the above mentioned infrastructures are involved, the annular space shall be filled according to any of their applicable regulations.

#### **18.4.2 End Seal**

The end of casing and carrier pipe shall be sealed by one of the following methods, as may be suitable for the design condition, and as specified and approved by the Utility:

- A. With brick and mortar
- B. With bulkhead and grout
- C. With synthetic rubber-end seal. This shall be the standard method when the system is cathodically protected.

END OF SECTION

## CHAPTER 19

### **CORROSION CONTROL OF PIPING AND STORAGE SYSTEMS**

#### **19.1 GENERAL**

- A. Design of a cathodic protection system shall depend on field measurements taken to determine the corrosion pattern and the current required for protection.
- B. Design for corrosion control of a water pipeline shall consider such installations as Cathodic Protection Test Stations, Insulating Flanges, Insulated Pipe Flange Test Stations, Pipe Joint Bonding, Insulating Blankets, Pipe Casing Insulators, Heat Shrink Sleeves, and other items.
- C. Joint bonding shall be in accordance with Utility Standard Details for the pipe material specified. Bond wires shall not be installed across insulating flanges.
- D. Partial protection may be considered, with Utility approval, when localized conditions require that the pipeline be protected for a limited area.
- E. All materials, workmanship, and installation shall conform to the National Association of Corrosion Engineers (NACE) Publication RP01-69 (Revised 1983). Of special interest is Section 19.5, regarding Corrosion Control Test Stations, Connections and bonds. Installers and designers shall be NACE certified.

#### **19.2 STANDARD TYPES OF PROTECTION**

The following information describes standard types of corrosion control to be considered with the installation of water pipelines. Selection of type of protection type shall depend on the material used, environmental conditions and any other relevant factors.

##### **19.2.1 Polyethylene Wrap**

Protective coating shall be manufactured of polyethylene material conforming to the ASTM D-1248 and installed in accordance with AWWA C-105. Polyethylene wrap provided for corrosion protection may be used alone or in conjunction with other methods of cathodic protection. The minimum thickness of the polyethylene wrap shall be 30 mils.

##### **19.2.2 Sacrificial Anode Protection**

Requires no external power source and shall be directly connected electrically to the water line to be protected. Depending on the soils characteristics, the corrosion consultant shall design project specific sacrificial anode protection. Depending on such factor as the current required to achieve complete protection and soil resistivity, either of the following sacrificial anodes may be selected:

- A. Zinc anodes have a low driving voltage thereby limiting its applications to low resistivity soils except when it is used to protect very well coated structures.

- B. Magnesium anodes possess a higher driving voltage and are well suited for soils with sulfate ions. Other factors to consider with regards to magnesium anodes are its high consumption rate and cost associated with it.

A special backfill usually consisting of a mixture of gypsum, bentonite, and sodium sulphate shall be used to surround the anode, in accordance with Utility Standard Details.

### 19.2.3 Impressed Current Protection

- A. Sacrificial anodes shall be connected to the positive terminal of a DC power source. Use of impressed current requires that the water line be electrically continuous. Impressed current protection may be used for almost any current and soil resistivity requirements. Interference with neighboring structures should be considered.
- B. In considering the use of impressed current, such factors as initial and operating cost must be addressed to include the power consumed by the system.

### 19.2.4 Miscellaneous Types of Protection

The following are miscellaneous types of corrosion protection, and are to be considered when special conditions require them and with approval from the Utility.

- A. Insulating Blanket, in accordance with Utility Standard Details. Blankets shall be installed at all locations where any portion of the new pipeline crosses within 18-inches of any cathodically protected pipeline or at locations where the pipeline crosses any other non-cathodically protected, metallic pipeline (8-inch diameter and larger) that is not abandoned. Blankets shall be installed at a depth midway between the two crossing lines. Consideration shall be on an individual basis and with approval from the Utility.
- B. Multiple Magnesium Anode Bed - Consideration shall be dependent on specific project conditions. Design shall be considered on an individual basis and general reference shall be in accordance with Utility Standard Details.

## 19.3 STANDARD PROTECTION FOR VARIOUS PIPE MATERIAL

The following information provides standard protection for steel cylinder concrete pipe, steel pipe, and ductile iron. However, prior to method selection and pipe installation, a corrosion evaluation shall be performed to ensure that the method of protection is adequate for the particular situation. The method chosen for protection shall be based on the evaluation with approval from the Utility.

### 19.3.1 Steel Cylinder Concrete Pipe

- A. Polyethylene Wrap under special circumstances may be used to protect SCCP applied at a minimum thickness of 30-mil in accordance with AWWA Standard C-105/A21.5.
- B. Sacrificial Anode Protection shall be based on special conditions including, but not limited to, the pipeline's environment which may also require localized protection if deemed necessary. Methods used may be either anode sacks or ribbon type.
- C. Impressed Current on SCCP shall be based on a life cycle cost analysis of the system relative to other pipe materials. Careful monitoring shall be performed to prevent hydrogen embrittlement of the spiral wires.



### 19.3.2 Steel Pipe

- A. Tape Coating Systems shall be in accordance with AWWA Standard C-214 and shall provide minimal protection for steel pipe and fittings.
- B. Impressed Current shall be standard corrosion protection for steel pipe unless otherwise specified. When sacrificial anode protection is utilized, lead wire attachment shall be in accordance with Utility Standard Details.

### 19.3.3 Ductile Iron

- A. Polyethylene Wrap shall be standard protection for DIP and fittings less than 36-inches in diameter. The polyethylene wrap shall be applied in accordance with AWWA C-105/A21.5 except that minimum thickness shall be 30-mils.
- B. Tape Coating, in accordance with AWWA C-214, shall be used for pipe sizes 36-inch and larger.
- C. Sacrificial Anode Protection shall be based on special conditions including, but not limited to, the pipeline's environment which may also require localized protection if deemed necessary.

## 19.4 JOINT BONDING

The following is general information regarding joint bonding for cathodically protected lines. Joint bonding shall be in accordance with Utility Standard Details.

### 19.4.1 SCCP, Steel and Ductile Iron Pipe

Cement mortar and protective coating applied in the factory, shall be held back for bond wire installation.

### 19.4.2 Appurtenances

Bonding across valves and couplings shall be in accordance with Utility Standard Details.

### 19.4.3 Bond Wires

Bond wires shall not be installed across insulated flanges. Wires shall be of sufficient length to provide slack and prevent stretching during backfilling. Wire size and number of bond wires shall be as specified in the Utility Standard Details.

### 19.4.4 Welding

All wires shall be bonded using alumino-thermic welds in accordance with Utility Standard Details.

## 19.5 STANDARD CATHODIC PROTECTION TESTING

The following information pertains to test stations to be included in the design of a corrosion protection system for those pipe materials listed above. All test stations shall be installed behind any existing curb and out of traffic lanes for safe access during testing. Method of pipe lead wire attachment shall be in accordance with Utility Standard Details.

### **19.5.1 Cathodic Test Station**

The cathodic test station is generally designated for use with SCCP, DIP, and Steel Pipe. Test wire attachment and test station installation shall be in accordance with Utility Standard Details. Installation of test station at grade level, or above grade level shall be dependent on the requirements of any governing agency for the location specified. Test stations shall be located at a maximum interval spacing of 500 feet unless otherwise specified.

### **19.5.2 Two Wire Test Station**

Two-wire test station shall be in accordance with Utility Standard Details. Two-wire test stations shall generally be installed along the pipeline at a maximum of 500-foot intervals from either another test station or an insulating flange.

### **19.5.3 Insulating Flange and Test Station**

Insulating flanges, in accordance with Utility Standard Details, shall generally be provided where dissimilar metals are in contact (i.e. at fitting installations), where a new pipeline is joined to a previously installed and existing pipeline. Also, insulating flanges shall be considered in any situation where current from another source (e.g., water line crossing under another utility line that is also cathodically protected) may promote accelerated corrosion of the water line. In this instance, a sufficient length of the water line shall be isolated by the insulated flanges to localize the accelerated corrosion and provide easier line section replacement, if and when required.

Insulating flange test stations, in accordance with Utility Standard Details, shall be installed where insulating flanges are used. A zinc reference electrode, in accordance with Utility Standard Details, shall be installed 6-inches below the pipe and a zinc grounding cells shall be installed at each insulating flange to provide protection against surge.

### **19.5.4 Metallic Casing Test Station**

The metallic casing test station shall be installed where carrier pipe exits the casing pipe. For pipe casing exceeding 100 feet in length, test stations shall be installed at both ends of the casing pipe in accordance with Utility Standard Details.

## **19.6 STANDARD PROTECTION FOR STORAGE SYSTEMS**

Cathodic protection systems for storage reservoirs shall be designed with the necessary equipment and wiring to secure the passage of direct current from an electrode or multiple electrodes through the liquid contents to the submerged surfaces of the tank.

The protection system shall be an automatic voltage regulated system and shall generally include the following elements:

- Anodes
- Rectifier and elements
- Reference electrodes

### **19.6.1 Anodes**

Impressed current anodes shall be designed to be suspended from the reservoir roof. Anodes shall be suspended in a way that will prevent contact with tank surfaces and shall be hung clear of man-made access roof hatches and such items as ladders, heater pipes, and stay-rods. A hand hole having a minimum diameter of 6-inches shall be designed in the tank roof for each anode string to permit replacement or inspection of anodes. Anode connections shall be

electrically connected to the positive DC header cable with compression connectors or split bolts, or the header cable may be terminate in a junction box for connection with all anode cables.

#### **19.6.2 Rectifier and Elements**

The rectifying unit shall consist of a transformer, rectifying elements, terminal block, and other ancillary components required for the cathodic protection system. The elements shall be wired and assembled in a weatherproof metal cabinet with a hinged door and hasp for locking. Adequate ventilation shall be provided for cooling the electrical components.

#### **19.6.3 Reference Electrodes**

Reference electrodes shall be copper-copper sulfate type provided with micro pore diffusion window for water contact, and watertight plug for renewal of copper sulfate crystals and solution. Permanent reference electrodes shall be calibrated against a standard electrode before installation.

#### **19.6.4 Criteria of Protection**

The minimum criterion of protection shall be a tank-to-water potential of at least -0.85 volt as measured between the tank and a saturated copper-copper-sulfate reference electrode. The maximum potential shall be limited to a negative voltage of -1.1 volt, measured with the electrode located between 0.25 and 0.5 inch away from the steel surface but not touching it. The potential shall be measured free of the effect of voltage gradients (IR drops). System design life shall be 20 years.

#### **19.6.5 Electrical Equipment and Components**

Electrical components shall comply with the requirements in Chapter 20. Electrical equipment shall be rated for 120 VAC, single phase service. All exposed conduit shall be of the rigid galvanized type. Conduit installed underground shall be factory-coated with a 20 mil PVC coating. All conductors in conduit shall be stranded copper wire with Type THW insulation. Lighting and surge protection devices shall be designed to protect components from line surges, unbalances, or lightning strikes.

#### **19.6.6 External Ground Protection**

The external steel floor of the ground storage tank shall be protect with the a passive sacrificial anode system to be designed by the Corrosion Engineer on a per project basis.

END OF CHAPTER

## CHAPTER 20

### ELECTRICAL DESIGN STANDARDS

#### 20.1 GENERAL

This chapter covers acceptable design standards and design criteria applicable to EPWU facilities. It includes minimum acceptable requirements for the design, specification, construction and testing of any installation intended to use electrical energy. All systems under the jurisdiction of the National Electrical Code (NFPA 70), be it directly or indirectly by reference, are included under this chapter. While it is sometimes convenient for complex systems covered under other chapters to include the electrical systems as a turn-key package, those electrical systems still fall under the jurisdiction of this chapter.

All engineering work performed under this chapter shall be in full compliance with the Texas Engineering Practice Act of the Texas Board of Professional Engineers. This chapter in no way shall be interpreted as being a substitute for the Engineer's responsibility to prepare a complete set of design documents that complies with the EPWU contract and all applicable codes, standards and laws.

#### 20.2 DEFINITIONS

The following definitions apply to this Chapter only, unless stated otherwise elsewhere.

- A. AHJ: Authority Having Jurisdiction, see definition in Art. 100 of NEC. For EPWU projects, the AHJ for code compliance is the City of El Paso Building Permits and Inspections Division. For all other matters addressed in the definition, AHJ is the licensed electrical engineer at EPWU or the qualified representative designated by the PEM.
- B. Corrosion Protection: Specialized discipline to protect piping systems and extend their useful life. See Chapter 19 for details. Any components and wiring methods used in corrosion protection that fall under the jurisdiction of the NEC are subject to the requirements of Chapter 20.
- C. Design Documents: Set of drawings, specifications, studies, calculations and other technical documents required to fully convey the Engineer's design intent for the project and that comply with the requirements of this Chapter.
- D. Design Intent: A detailed explanation of the ideas, concepts and criteria that are defined by the Owner to be important (See ASHRAE Guideline 1 – 1996, The HVAC Commissioning Process).
- E. Electrical Systems: Any and all parts of a more complex system that fall under the jurisdiction of the NEC.
- F. Engineer of Record: Also referred to as Engineer in this Chapter, it is the electrical engineer either selected by EPWU or identified by the Lead Consultant as directly responsible for the design of electrical systems for a specific project. It is the Engineer's responsibility to insure the electrical design complies with all applicable codes and standards, the requirements of EPWU's Design Standards Manual, and is in compliance

with acceptable industry practices. The Engineer must be registered as a Professional Engineer in the State of Texas.

- G. Lead Consultant: Engineering, Architectural or other type of professional services firm that has entered into a contract with EPWU to provide consulting services.
- H. Instrumentation and Control: Specialized discipline covered in detail in Chapter 21 of this manual. Any components and wiring methods used in Instrumentation and Control that fall under the jurisdiction of the NEC are subject to the requirements of Chapter 20.
- I. Labeled or Listed: All electrical equipment specified for an EPWU project and used therein shall be Listed or Labeled. The definition of Listed and Labeled shall be as it appears in Art. 100 of the NEC. The Engineer shall contact the Utility's AHJ for any case where the specification of non-listed or non-labeled equipment or systems is planned or required.
- J. NEC: National Electrical Code, published by the National Fire Protection Association as NFPA 70.
- K. SCADA: Supervisory Control and Data Acquisition, see Chapter 22 for details. Any components and wiring methods used in SCADA that fall under the jurisdiction of the NEC are subject to the requirements of Chapter 20.
- L. Texas Board of Professional Engineers: State agency responsible for regulating and enforcing the practice of engineering in the State of Texas.

### 20.3 CODES AND STANDARDS

The Engineer of Record is responsible for ensuring that the project's electrical system is designed in compliance with all codes and standards applicable at the time of the design and construction. This responsibility shall include, but not be limited to the standards listed below. The latest published or adopted revision of each code or standard shall be applicable. It is the Engineer's responsibility to as a minimum, note the applicable NEC version on the drawings and specifications, as well as any other code or standard whose relevance has a direct impact on the design.

- A. National Electrical Code (NEC), published by NFPA as Standard 70
- B. El Paso Municipal Code, Ch. 18.16 Electrical Code
- C. National Electrical Safety Code, IEEE Standard C2
- D. Standard for Electrical Safety in the Workplace, NFPA 70E
- E. IESNA Lighting Handbook
- F. International Energy Conservation Code
- G. ASHRAE 90.1
- H. Outdoor Lighting Ordinance, Chapter 18.18 of the El Paso Municipal Code
- I. Underwriters Laboratories (UL), Factory Mutual (FM) or similar nationally recognized testing laboratory
- J. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. IEEE 80 – Guide for Safety in AC Substation Grounding

2. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
  3. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
  4. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
  5. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
  6. IEEE 519 – Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
  7. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- K. American National Standards Institute (ANSI)
  - L. National Electrical Manufacturer's Association (NEMA)
  - M. National Fire Protection Association (NFPA)
  - N. EPWU Energy Policy

## **20.4 DESIGN INTENT, STUDIES, AND CALCULATIONS**

Any successful electrical design requires a design intent, studies and calculations. The Engineer is responsible for the timely preparation of the design intent and applicable studies and calculations. As a minimum, the Engineer shall submit to EPWU for review the design intent, studies and calculations listed below. The Engineer shall prepare additional studies and calculations as he deems necessary, as required by the project or as specifically requested by EPWU, the project scope of work or the AHJ. The use of software programs such as Power Tools for Windows by SKM Systems Analysis, Inc. is acceptable to produce the studies and calculations listed below. The Engineer may not delegate to others not under his direct supervision, the preparation of any of the studies and calculations listed below. The Engineer may and must require the Contractor to submit additional studies and calculations as he deems necessary, in case the Contractor intends to use components different than those used and identified by the Engineer in the project's design documents.

### **A. Design Intent:**

1. The Engineer is responsible for scheduling a meeting or meetings with EPWU to develop a clear understanding of the ideas, concepts, and criteria that are important to the Owner. See definitions section.
2. The Engineer is responsible for preparing in written form a design intent that fairly and accurately describes EPWU's needs and expectations for the project. The written document must be sent to EPWU for review and comment.
3. It must be understood by the Engineer that complete design intent cannot be developed in a single meeting and that follow-up consultation with the Owner may or will be required. The Engineer is responsible for maintaining an updated design intent document.

4. EPWU considers the design intent as being met when, a) the design documents convey to an experienced Bidder the Engineer's intent with nothing more than a written response to a RFI, b) the constructed project meets or exceeds the Owner's needs and expectations and, c) the Contractor successfully completes the installation without a change order that is due to a design deficiency or oversight.

B. Basis of Design Report:

1. Feasibility Study. The report shall address the project-site availability of electrical energy in the quantity and magnitude required by the project. The report shall identify the electric utility providing service, proposed service voltage and type, preliminary estimate of installed capacity, and service availability date. The Engineer shall also include an opinion of whether the estimated demand will revenue-justify the new electric service or if additional compensation may have to be paid to the electric utility.
2. Energy Efficiency. All pumps specified for use in any EPWU installation shall comply with the latest version of EPWU's Energy Policy. This compliance shall meet the spirit of the Policy Statement: "EPWU will promote the efficient use of energy to produce and deliver water and services to its customers."

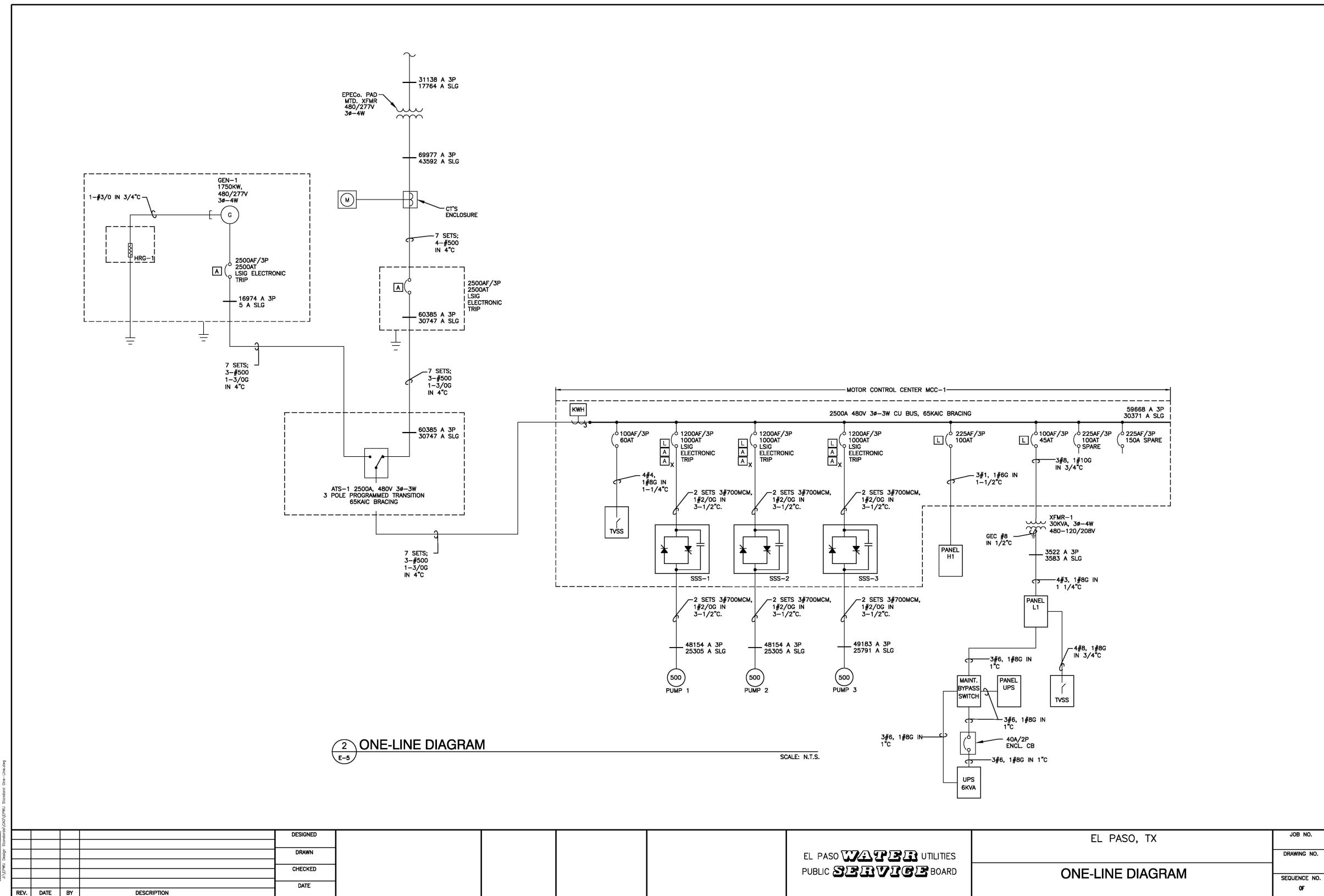
EPWU understands this policy to require its designers and consultants to specify and select pumps based on a "lowest life-cycle cost" bases, rather than the "lowest initial cost" bases. The life-cycle cost analysis must include, in addition to equipment supply and installation, the cost of the energy to operate the pump during its design life, as well as the estimated maintenance and repair cost. EPWU believes this policy promotes the specification of pumps with highest "wire to water efficiency", with "wire" meaning the input energy to the motor drive, and "water" meaning the amount of useful water produced by the pump's operation. Other factors tied to "lowest life-cycle cost" include materials, finishes, accessories, and options that result in pumps with proven much longer run times without component problems, reduced preventive maintenance costs, and much lower wear due to contact with work fluids and contaminants. EPWU's designers or consultants must request input from Operations Superintendents regarding equipment brands and features with proven successful performance at EPWU facilities.

3. The Engineer must address energy efficiency as one of the report topics. Specifically, the Engineer must review in sufficient detail the suitability of the proposed approach to comply with EPWU's Energy Policy. A simple statement such as "the design shall comply with EPWU's Energy Policy" is not acceptable. The Engineer must describe in detail the approach proposed to be taken to comply with EPWU's policy.

C. Design Phase:

1. One-Line Diagram. Also called single-line diagram, this is the master control document for any electrical design. A commonly called "riser diagram" shall not be acceptable as a substitute for a one-line diagram. See Figure 1 for acceptable one-line diagram.

Figure 3 - Standard One-Line Diagram





2. Short Circuit Study. One-line diagram that shows the available short circuit at each electrical bus. The Engineer must obtain from the electric utility the short circuit current (three phase fault, single phase fault) available at the service point. The Engineer shall ensure that the ICEA short circuit current for insulated conductors is not exceeded for specified conductor sizes.
3. Coordination Study. Required when protective devices are used. Must be in compliance with IEEE 141, IEEE 242 and IEEE 399.
4. Voltage Drop Calculations. Must show the percent voltage drop at each electric bus when maximum design loads flow through the system. See FPN 4 of NEC Art. 210.19, and FPN 2 of NEC Art. 215.2(A)(3) for recommendations.
5. Grounding Design per IEEE-80, using step and touch potential.
6. Arc Flash Study per IEEE-1584 and NFPA 70E.
7. Control Diagrams. May also be called process control diagrams, or schematic diagrams. For any control diagram other than SCADA (see Chapter 22), the Engineer must show the required control logic and components for the intended application. The Engineer may not delegate this design function to the Contractor.
8. Substitutions. If the Contractor desires to request a substitution for any of the Engineer's design systems, sub-systems or components, the Contractor must notify the Engineer in writing. The Engineer must establish the detailed procedures that the Contractor must follow in order for the substitution to be evaluated and approved. Any requested studies and/or calculations similar to the ones specified in this section must be prepared by the Contractor's Engineer or by the manufacturer used by the Contractor. The Engineer must make sure the proposed substitution complies with EPWU standards and the design, and must contact the Utility's AHJ when there is any doubt about the substitution's suitability for the EPWU project. If the Engineer fails to comply with the substitution requirements, the Utility's AHJ has the right to reject an Engineer-approved substitution.
9. Energy Policy. The Engineer of record is responsible for making sure the design phase fully addresses the intent included in the Basis of Design Report to comply with EPWU's Energy Policy. The level of compliance will be measured by the degree that it is represented in the drawings and specifications. A general compliance statement will not count towards compliance.

## 20.5 SAFETY

The Engineer shall always regard safety as a prime consideration for any design. In addition to complying with the safety requirements of the codes and standards applicable to this Chapter, the Engineer is responsible for ensuring the design complies with acceptable safety practices in the industry and the Engineer's design does not inherently create unsafe work conditions, either during construction, when the project is in operation or during maintenance. While personnel safety must take precedence in any design, equipment safety and continuity of service must also be major considerations.

All components of an electrical design are directly or indirectly related to safety. The Engineer must pay special attention to safety when preparing the following portions of the system:

- A. One line Design
- B. Grounding Design
- C. Short Circuit Study
- D. Coordination Study
- E. Arc Flash Study
- F. Equipment Layout
- G. Installation Details

The Engineer must carefully balance the competing needs of the design so that safety and continuity of service are properly addressed.

## 20.6 DRAWINGS

A complete set of drawings and specifications is critical for a successful project. It is vital for any EPWU project that the Engineer's drawings successfully and with clear and sufficient details convey the design intent to the Owner, AHJ, Bidders, Contractor, and others. EPWU will provide feedback to the Engineer when the goals of this paragraph are not being fully met. The list below conveys an idea of the type of drawings that EPWU expects to see in a set of design drawings. Depending on the scope of work for the project, some of the drawing types below may or may not be required.

- A. One-Line Drawing. Include basic device ratings and short circuit current available at each bus.
- B. Utility Layout. Include detail of the service acceptable to the utility, using the utility's standard designation.
- C. Grounding Design Drawing. Include grounding calculations results and grounding system layout. Grounding design shall comply with IEEE Std. 80 – IEEE Guide for Safety in AC Substation Grounding and shall specify the maximum acceptable resistance to ground to meet step and touch potential limits. Evenly spaced ground rods are preferred over ground rod clusters.
- D. Equipment Layout Drawings. Must show all major equipment requiring an electrical connection. When applicable must use as background drawings prepared by other disciplines that convey the project's overall layout.
- E. Power Distribution Drawings. Show with sufficient detail the location, arrangement, and design characteristics for switchboards, panelboards, motor control centers, generators, UPS, transfer switches and any other significant electrical components that the Engineer intends to include in the design. Design characteristics include but are not limited to technical ratings, physical dimensions, clearances required, installation requirements, schedules, wiring information. Even in cases where a separate set of specifications will accompany the drawings, the drawings must contain sufficient information to allow EPWU personnel to obtain the basic technical requirements of each component (such as, but not limited to rated voltage and current, interrupting capacity, transformer KVA, impedance and connection, wire size and insulation, conduit size, motor controller size and type, motor size, as applicable).
- F. Electrical Details. The Engineer is responsible for including all the necessary details to sufficiently illustrate the design intent. See Section 20.4.

- G. Lighting Drawings. Include layouts, designed lighting levels, fixture schedules and needed installation details.
- H. Special Systems Drawings. Includes but is not limited to life safety, security, communication, data, paging, and other similar systems.
- I. Engineer's Notes. The Engineer must use his best judgment to determine the nature and type of notes that must be included in the drawings to successfully convey the design intent. Notes must be used to make clear the design intent, but must not be used to substitute for a necessary detail. Notes must not be used to pass on to the Contractor either the responsibility for figuring out the design intent, or the sole responsibility for complying with codes and standards.
- J. General Electrical Notes. The Engineer must use these notes to convey to the Bidders and selected contractor the standards expected and required for the project. In addition to listing the applicable codes and standards, the Engineer must clearly state the project is of industrial class, requiring suitable construction materials, techniques and finishes acceptable for an industrial environment and acceptable EPWU standards.

## **20.7 SPECIFICATIONS**

All specifications produced for this Chapter must follow the CSI MasterFormat standard. The appropriate division and section numbers must be used as recommended by CSI. The Engineer must be careful to review and edit the specifications to coordinate the callouts between divisions and sections, being careful to remove those paragraphs and sentences not applicable to the specific project.

The Engineer must be careful to edit the specifications such that they reflect the EPWU preferences that are published in the Standards Manual. At a lower level, the Engineer must reflect preferences stated by EPWU representatives directly assigned to be involved with the specific project. Where no preferences are published or stated, the Engineer must use his best judgment to specify materials and methods that best meet the needs of the specific EPWU project. The Engineer is free to consult EPWU's AHJ or PEM on any situation where there is doubt.

While it may be convenient and cost effective for the Engineer to start the process using a set of standard specifications that have been used on a similar EPWU project, the Engineer is responsible for their editing so they address the needs of the specific project. The Engineer must not only make sure that references to a prior project conditions be deleted, but also make sure that the specific conditions of the project at hand are uniquely and fully addressed.

It is also acceptable for the Engineer to make use of the resources available from various product manufacturers. On the other hand, it is not acceptable for the Engineer to be so specific and so detailed in his specifications that for practical purposes it creates the impression (in the opinion of EPWU) that a given product is being sole-sourced. The Engineer must avoid this practice and proceed to "open" the specifications when so directed by EPWU. If any equipment or product needs to be sole sourced, the Engineer is responsible for submitting to the PEM written documentation justifying the sole sourcing. EPWU will review the Engineer's recommendation and reply in written form through the PEM.

## **20.8 DOCUMENT SEALING AND PERMITTING**

- A. The Engineer of Record is responsible for properly identifying and sealing all design documents in compliance with the Texas Engineering Practice Act of the Texas Board of Professional Engineers. While it is recognized that the electrical design may be part of a

much larger design prepared under the direction of another registered engineer, all engineering documents to be prepared under this Chapter must comply with this paragraph.

- B. The Engineer of Record is responsible for requesting and securing the necessary approvals by the City of El Paso Building Permits and Inspections Division for his design, or the corresponding County or State agency if applicable. Since EPWU is part of the City, applicable design review and approval fees are waived. The Engineer must exercise this option when submitting for approval.

## **20.9 NOT USED**

## **20.10 GENERAL REQUIREMENTS**

- A. Introduction. All electric work to be designed and constructed must comply with the codes and standards listed in this Chapter, as well as any other codes and standards applicable at the construction site. EPWU has in many cases specific preferences regarding design and construction approaches to be taken, depending on the project type and location.
- B. Direct line of Responsibility. The Engineer of Record is the person directly responsible for preparing a scope of work that reflects EPWU's preferences for the specific facility under consideration. While this Chapter is to be considered a general compilation of EPWU preferences, the Engineer is also expected and required to ask as many questions as needed from EPWU representatives directly involved with the project. This not only includes the EPWU's PEM and AHJ, but also the Section head with direct responsibility over the facility.
- C. General Electrical Notes. The scope of work, and by extension the design documents, must describe in sufficient detail the type and nature of the industrial facilities under consideration. This includes the presence of special or corrosive environments, chemicals and other materials that should be factored into the design and construction of the project. The Engineer will include in one drawing a summary of the general electrical notes that conveys the essence of the electrical design intent, codes, standards, construction means, methods, industry acceptable standards and quality standards required for the project. The Engineer is responsible for preparing the general electrical notes and EPWU is responsible for reviewing them.
- D. Anti-Seize Compound. Unless specifically directed to the contrary by an authorized EPWU representative (Section Head, AHJ), the Engineer must make sure to specifically and clearly include in the design documents the need for the Contractor to use anti-seize compound when using bolts and screws to install any and all types of pre-manufactured equipment. This includes transformers, panels, switchgear, motors, motor controllers, panels and other fixtures that are Contractor installed. This does not apply to factory-assembled systems that have a UL or similar label, unless the Engineer deems it necessary, or is requested by EPWU to make it a requirement. Common sense on the part of the Engineer is required when addressing specific cases. In case of doubt, the Engineer must contact an authorized EPWU representative for a decision. Acceptable anti-seize compounds are:
  - 1. Permatex Anti-Seize
  - 2. Loctite Anti-Seize
  - 3. Bostik Never Seez

- E. Anti-Corrosion Compound. The Engineer will require in the design documents the use of anti-corrosion compound to protect busbar splices or conductor terminations in corrosive areas. The user shall be required to apply it compliance with manufacturer instructions and also require wiping off all excess compound to prevent accumulation of dirt or contaminants. In corrosive areas insulating boots shall also be required over splices. Acceptable anti-corrosion compound is no-OX-id A Special Electrical Grade or EPWU approved equal.
- F. Arc Flash Mitigation. The proper means to mitigate the arc flash effects are actively being debated in codes and standards, especially NFPA 70E. The Engineer is responsible for reviewing with EPWU's AHJ the design philosophy proposed to be taken in the project. The Engineer will summarize in the design intent a summary of arc flash mitigation procedures to be included in the design.
- G. All equipment, material and fittings specified for EPWU projects shall be listed or labeled by UL or equivalent approval agency.
- H. The section heads responsible for the project construction and operation can request exceptions to any portion of the Electrical Design Standards provided they comply with the applicable NEC version, the request is documented in written form, and the Engineer reports this change to EPWU's PEM and AHJ. EPWU's AHJ may comment or take exception as applicable and Engineer must resolve discrepancy to AHJ's satisfaction.
- I. Energy Policy. EPWU has adopted an Energy Policy that is applicable to all EPWU projects. The Engineer is responsible for being familiar with this policy and applying it to the project.
- J. All floor mounted equipment shall be bolted on a concrete service pad, minimum of 4 inches high. The service pad shall be finished and leveled to match or exceed the tolerance required or recommended by the manufacturer and prevent equipment problems due to misalignment or buckling. Equipment that is specifically designed and required to be installed without a service pad are exempt from this requirement. The Engineer shall clearly identify each location where this requirement applies or not.
- K. The Engineer must make sure to convey to the selected installer that the application is for an industrial location (unless not applicable) and list for the installer the minimum required standard of quality. This requirement shall be made extensive to all equipment, material and components required for a fully functioning electrical system. The Engineer is required to contact the EPWU PEM or AHJ for any questions regarding this clause.
- L. When the project involves or includes adding new load to an existing facility, the Engineer shall request from PEM historical electrical data for the previous 12 months or other representative 12 month period. The Engineer shall use this data and refer to it as part of its sizing calculations for new load.

## **20.11 ELECTRIC UTILITY AND SERVICE**

- A. It is recognized that while El Paso Electric Company (EPE) is not the sole electric utility providing service in EPWU's service territory, it will most likely be the one providing service. While EPE is being used as the electric service provider for this section, the standard must be adjusted accordingly to meet the requirements of another electric service provider. As part of preparing the electrical design, the Engineer must contact and meet with the EPE Planner assigned to the project. The Engineer must confirm the availability of electric service at the project's location, as required in the Studies section of

this Chapter. The Engineer must also review with the Planner the electric service requirements of the project, as well as coordinate with the Planner EPE's requirements for the service type being planned. The Engineer should select the option with the highest benefit/cost ratio to provide electric service to the project. This means the Engineer must include in the evaluation specific project conditions.

- B. The Engineer will prepare design drawings including the layout plan and related details showing the location of the proposed electric service, routing agreed to with EPE and as approved by EPWU, meter location and provisions for meter installation, the EPE standard or standards applicable to the requested service and sufficient technical information so an Electrical Contractor can build the specified service in compliance with EPE standards, and at the initially quoted price.
- C. The Engineer of Record is responsible for preparing and submitting to the Electric Utility an electric service request. The Engineer will be assisted by EPWU to identify the specific project information and right-of-way information required for the application. Fees charged by the Electric Utility for permanent electric service will be paid by EPWU.
- D. Current EPWU standard is to contract electric service at the following voltages:
  - 1. 480 VAC, 3 PH: for all new projects, large and small. Contact EPWU in case the project size requires a different voltage.
  - 2. Medium voltage: for existing facilities being upgraded or expanded, provided EPWU agrees to continue service at the same voltage.
  - 3. Under 480 VAC, 3 PH or 1 PH: for very small loads like a cathodic protection station. Voltage level and type as dictated by load requirements.

## **20.12 GROUNDING AND BONDING**

- A. The Engineer will design a grounding and bonding system that meets NEC and IEEE 80. The design will be based on a single grounding system for the entire project. In case of projects that involve expansions and/or modifications to existing facilities, the Engineer's design must bond the new grounding system to the existing systems, such that a single grounding system will result. The Engineer is free to contact EPWU's AHJ for any situation or condition that requires further evaluation.
- B. As a minimum, the grounding system must meet the following EPWU standards:
  - 1. Grounding calculations: per IEEE 80, using the step and touch method.
  - 2. Soil resistivity: Engineer is responsible for using the most suitable method to determine values at project site.
  - 3. Resistance to ground: as calculated per IEEE 80, using step and touch potential method.
  - 4. Ground grid depth: no less than 30 inches below earth's surface (NEC 250.53.F).

5. Ground rods:  $\frac{3}{4}$  in by 10 ft long, copper clad.
6. Ground grid conductor: stranded copper 1/0 AWG minimum or as required by maximum available fault current. Engineer must note that per EPWU's standards, the conductor's mechanical considerations and longevity take precedence over minimum required conductor size.
7. Buried connections:
  - a. Acceptable Exothermal: Cadweld brand products listed for the application.
  - b. Acceptable Compression Type: Burndy Hy Ground products listed for the application.
  - c. EPWU approved equal.
8. Isolated ground rods: NEC specifically prohibits using isolated ground rods (or earthing) as the sole means of equipment grounding.
9. Test wells: not used on new projects.

## **20.13 LIGHTNING, SURGE AND OTHER PROTECTIONS**

- A. Lightning Protection. It is EPWU's policy to evaluate lightning protection on a case by case basis. The engineer is responsible for asking EPWU if lightning protection is required at the project. EPWU will evaluate the need for this protection and respond to Engineer. In cases where lightning protection is required, it must be designed by a trained and certified lightning system designer or by an approved lightning system manufacturer per applicable NFPA standards and must be specified using UL listed components. Lightning protection systems using UL listed air terminals and components are acceptable to EPWU. No other types of lightning protection systems are acceptable unless approved in writing by EPWU.
- B. Surge Protection. It is EPWU's policy to protect its electrical systems with surge protective devices (SPD). The Engineer will design a surge protection system complying with the standards and guidelines listed in this section.
  1. Surge Protection Standards. The Engineer's design must comply with the following standards:
    - a. IEEE C62.41 – Guide for Surge Voltages in Low Voltage AC Power Circuits
    - b. IEEE C62.45 – Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
    - c. IEEE Std. 1100 – Emerald Book

- d. UL 497A – Standard for Safety Secondary Protectors for Communication Circuits
- 2. Surge Protection Approach: SPD protection must be coordinated in a staged or cascaded approach, as presented in the IEEE Emerald Book.
- 3. Minimum SPD Protection Requirements:
  - a. Protective Technology: Metal Oxide Varistors (MOV). Silicon Avalanche Diodes (SAD) are allowed only for protection of data or communication signals. Selenium cells are not allowed.
  - b. Surge Current per Phase: 200 KA maximum at service equipment, 120 KA maximum per phase at required distribution or branch panels. Coordinated SPD protection at equipment when recommended by manufacturer or requested by EPWU. Higher ratings need to be justified by Engineer's written report.
  - c. Let Through Voltage: per IEEE C62.41.
  - d. Effective Filter: noise attenuation at 100 kHz based on MIL-STD-220 insertion loss test. Attenuation should exceed 45 dB (L-N mode).
  - e. Installation: factory installed as part of service equipment. Prefer factory installed in branch panels. SPD in separate cabinet must minimize lead length with no more than 3 feet between protecting and protected cabinets.
  - f. Safety and Overcurrent Protection: included.
  - g. Monitor and Diagnostic System: show operating status of protective system.
  - h. Independent Testing: must be performed by independent test laboratory to certify compliance of factory model with surge current ratings.
  - i. SPD Protection for Electronic Equipment: in accordance with manufacturer's recommendations.
- 4. Acceptable Manufacturers:
  - a. Eaton Cutler Hammer
  - b. General Electric
  - c. Square D
  - d. EPWU approved equal.



- C. Lightning or Surge Arresters. It is EPWU policy to protect systems over 1 KV using surge arresters. Priority items are insulated cables, transformers, switchgear and motors. The Engineer will design a surge arrester system complying with the standards and guidelines listed in this section.
1. Surge Arrester Standards:
    - a. NEC Article 280
    - b. ANSI/IEEE C62.11
  2. Surge Arrester Characteristics:
    - a. MOV, gapless
    - b. Distribution class, heavy duty
    - c. Polymer housing
    - d. MCOV: per manufacturer's recommendations for intended application.
  3. Lead length: Engineer's design must limit lead length to no more than 4 feet. Consult EPWU's AHJ for longer lead length conditions.
  4. Acceptable Manufacturers:
    - a. Ohio Brass PVD series
    - b. GE Tranquell series
    - c. Cooper Power UltraSil series
    - d. EPWU approved equal

## **20.14 POWER DISTRIBUTION**

- A. The Engineer must plan the power distribution for the project keeping in mind EPWU's design intent for the project. Depending on the project's complexity, the power distribution may essentially be overhead, underground or a combination of both. The electrical equipment must also be specified taking into consideration EPWU's design intent for the project. The Engineer will interview as a minimum the section or plant superintendent for the project, as well as the Utility's AHJ. The engineer must take a team approach such that the needs of the project, budget constraints and Owner's needs are properly addressed and take precedence over the Engineer's preferences. In cases where spare raceways are desired or needed, the Engineer will make note of that in the design intent document, as well as in the design documents.

## **20.15 SWITCHGEAR**

- A. It is EPWU's standard to limit the specification of switchgear to water plants and major projects justifying its features. Where justified by the project (see section 20.14), switchgear shall be:
1. Metal enclosed, preferably for indoor installation, NEMA type to meet ambient conditions. Always bolted on a concrete service pad, minimum of 4 inches high. See section 20.10 for additional requirements.
  2. Rated for the project's designed load, environmental, and elevation conditions.
  3. Busbars: Copper, tin plated splices. Specify silver plated splices on Wastewater projects. See section 20.10.E for corrosion protection. Specify insulating boots over splices for Wastewater projects.
  4. Insulated/isolated bus bar system. For corrosive applications (all Stormwater projects) specify epoxy coated busbars.
  5. Breaker compartment doors without ventilating slots.
  6. Mechanism to draw breaker to disconnected position with door closed.
  7. Finish: ANSI-70 Light Gray.
  8. Power circuit breaker with adjustable solid state trip unit. Engineer must select trip unit functions based on requirements of coordination and arc flash studies.
  9. Engineer must include arc flash reduction features in the life-cycle costs analysis and review results with PEM and AHJ.
- B. Acceptable Manufacturers:
1. Cutler-Hammer
  2. General Electric
  3. Square D
  4. EPWU approved equal

## **20.16 SWITCHBOARDS AND PANELBOARDS**

- A. Switchboards. EPWU prefers the use of switchboards for mid and large projects. Where required by the project (see section 20.14), switchgear shall be:
1. Metal enclosed, preferably for indoor installation, NEMA type to meet ambient conditions. Always bolted on a concrete service pad, 4 inches high. See section 20.10 for additional requirements.
  2. Rated for the project's load, environmental, and elevation conditions.

3. Busbars: Copper, full tin plated. See section 20.15 for additional requirements when applicable.
4. Finish: ANSI-70 Light Gray.
5. Feeder circuit breaker with adjustable solid state trip unit. Engineer must select trip unit functions based on requirements of coordination and arc flash studies.
6. Bolted type molded case circuit breakers. Single handle for each 3-pole unit. Bracket to allow locking in off position for breakers feeding motor loads.
7. Acceptable Manufacturers:
  - a. Cutler-Hammer
  - b. General Electric
  - c. Square D
  - d. EPWU approved equal.

B. Panelboards. Where required by the project (see section 20.14), switchgear shall be:

1. Metal enclosed, preferably for indoor installation, NEMA type to meet ambient conditions.
2. Rated for the project's load, environmental, and elevation conditions.
3. Busbars: Copper, full tin plated.
4. Finish: ANSI-70 Light Gray
5. Hinged cover designed to provide easy access to internal components without removal of cover assembly.
6. Bolted type molded case circuit breakers. Single handle for each 3-pole unit.
7. Bracket to allow locking in OFF position of breakers feeding motor loads. Bracket to allow locking in ON position of breakers feeding night lighting or emergency circuits.
8. Acceptable Manufacturers:
  - a. Cutler-Hammer
  - b. General Electric
  - c. Square D
  - d. EPWU approved equal.

## **20.17 MOTOR CONTROL CENTERS (MCCs)**

It is EPWU's standard to limit the specification of MCCs to treatment plants and major projects justifying its features. Where justified by the project (see section 20.14), MCCs shall be:

- A. Metal enclosed, preferably for indoor installation, NEMA type to meet ambient conditions. Always bolted on a concrete service pad, 4 inches high. See section 20.10 for additional requirements.
- B. Rated for the project's load, environmental, and elevation conditions.
- C. Busbars: Copper, full tin plated. Specify silver plated splices on Wastewater projects. See section 20.15 for additional requirements when applicable.
- D. Finish: ANSI-70 Light Gray.
- E. All pilot lamps shall be LED type. No incandescent type allowed.
- F. The Engineer must include in the MCC specifications features that have been identified by EPWU as acceptable for mitigating arc flash. Some of these features are:
  - 1. Insulated horizontal and vertical bus.
  - 2. Shutters to isolate the vertical bus when a bucket is removed.
  - 3. Mechanism to disconnect bucket unit with door closed.
  - 4. Visual indication that stabs are disconnected from bus.
  - 5. Door latches designed to contain the arc flash inside the compartment.
- G. Acceptable Manufacturers:
  - 1. Cutler-Hammer
  - 2. General Electric
  - 3. Allen Bradley
  - 4. EPWU approved equal

## **20.18 MOTOR CONTROLLERS**

- A. General. Out of the multiple types of motor controllers available, EPWU has standardized on certain types of controllers that cover the majority of its applications. The Engineer is required to review with EPWU (see section 20.14) the motor controller type that is best suited for the project. The most common controllers are listed below.
  - 1. All pilot lamps associated with controllers shall be LED type. No incandescent type is allowed.

- B. Full Voltage Starter. To be used in applications where a soft start/stop or speed control of the load is not required. Unless instructed otherwise by an authorized EPWU representative, all full voltage controllers must comply with the following:
1. Listed by UL or equivalent agency.
  2. Microprocessor based overload unit, adjustable type preferred. For Wastewater projects specify thermal overloads, non-adjustable.
  3. Phase loss, phase unbalance and ground current protection.
  4. Acceptable Manufacturers:
    - a. Cutler-Hammer
    - b. General Electric
    - c. Allen Bradley
    - d. EPWU approved equal.
- C. Soft-Starter. To be used in all applications where soft start/stop, but not speed control, is required for the load. Unless instructed otherwise by an authorized EPWU representative, all soft-start controllers must comply with the following:
1. Listed by UL or equivalent agency.
  2. Ramp start with pump control option.
  3. Built-in overload protection. Include phase loss, stall, phase reversal, shorted SCR detection.
  4. Built-in run bypass contactor.
  5. Programmable overload settings.
  6. Soft stop control.
  7. SCR-based power section, minimum 6 back-to-back SCRs with minimum 1,500 V peak inverse rating.
  8. Acceptable Manufacturers:
    - a. ABB
    - b. Allen Bradley
    - c. Cutler-Hammer
    - d. General Electric
    - e. EPWU approved equal.

- D. Variable Frequency Drive (VFD). To be used in applications where soft start/stop and speed control is required for the load. Unless instructed otherwise in writing by an authorized EPWU representative, all soft-start controllers must comply with the following:
1. Listed by UL or equivalent agency.
  2. See PEM and AHJ for IEEE 519 compliance.
  3. Six pulse full wave rectifier.
  4. PWM type output section with IGBT devices.
  5. DC bus inductor or AC line reactors, integral to unit, sized to reduce harmonics.
  6. Supplemental line filters as required for IEEE 519 compliance when required.
  7. EMI/RFI filters.
  8. Ability to adjust carrier frequency to avoid resonant frequencies.
  9. V/Hz, sensorless vector speed control.
  10. All printed circuit boards (PCB) shall be protected against corrosion with conformal coating per IEC 61721-3-3 or industry recognized equivalent. Conformal coating shall be minimum class 3C2 for all Water Division applications and class 3C3 for all Wastewater Division applications.
  11. Minimum of one 4-20 mA input. See Chapter 21 – Instrumentation and Control for detailed requirements regarding this chapter.
  12. Modbus RS-485 communication. Contact SCADA section for additional communication requirements.
  13. Local keypad user interface with integral display. Interface shall be removable type.
  14. Intelligent start-up assistant.
  15. Cooling fans controlled by drive. Control options are:
    - a. Always off when drive is not running.
    - b. Fans turn on when drive starts.
    - c. Option: fans are temperature controlled by drive but always off when drive is off.
  16. Preference for wall or floor mounted cabinet.
  17. Use shielded power cable recognized for VFD use, between drive and motor.
  18. Efficiency: 98% at full load.
  19. Acceptable Manufacturers:

- a. ABB ACS 550 or ACS 800
  - b. Allen Bradley Power Flex
  - c. Cutler-Hammer SVX9000
  - d. Danfoss VLT5000
  - e. Baldor VS1SP
  - f. EPWU approved equal.
20. Single-phase VFD. The Engineer shall contact the PEM for specific EPWU when single-phase drives are required.

## 20.19 MOTORS

- A. General. Most of the energy used at EPWU is for pumping applications. Therefore, it is EPWU's policy to specify premium NEMA efficiency motors for all applications, unless not available. The Engineer will contact the PEM and utility AHJ for any application where premium efficiency motors are not available. An exception to this rule is motors for storm water projects, where the Engineer is required to perform a life-cycle cost analysis to determine if premium efficiency motors are justified.

Regarding motor disconnecting means per NEC, it is EPWU policy to apply the requirements per Art. 430.102, Exception to (1) and (2). EPWU regards the presence of a disconnecting means at the motor is impractical or introduces additional or increased hazards to persons or property. The Engineer shall review expected exceptions to this disconnecting standard with the AHJ and provide credible justification for each exception.

- B. Pump Motors. The Engineer must specify the motor that closely matches the pumping application (see Chapter 14 for Water Pumping stations and Chapter 16 for Wastewater Pumping Stations). Unless instructed otherwise by an authorized EPWU representative (see section 20.10), all pump motors shall comply with the following features:
1. Premium NEMA efficiency induction motor.
  2. Four pole, 1800 RPM or as required by the application.
  3. Environment: 4,000 ft elevation, 45 degrees C maximum ambient temperature if outdoor; 40 degrees C indoor.
  4. Class F insulation.
  5. Copper windings.
  6. 1.15 service factor.
  7. Heavy duty, long life bearings.
  8. Enclosure: NEMA WPI or as required by application.

9. Inverter duty when VFD motor control will be used. Grounding ring at 15 HP and larger, insulated upper bearing at 100 HP and larger.
10. Non-reverse ratchet where applicable.
11. Thermal protection: contact EPWU representative for requirements.
12. Vibration detector: contact EPWU representative for requirements.
13. Acceptable Manufacturers:
  - a. US Motors
  - b. General Electric
  - c. Baldor
  - d. EPWU approved equal.

C. General Purpose Motors. For applications other than pumping, motors shall comply with the following features:

1. Premium NEMA efficiency induction motor.
2. Four pole, 1800 RPM, or as required by the application.
3. Environment: 4,000 elevation, 45 degrees C maximum ambient temperature.
4. Class F insulation.
5. Copper windings.
6. 1.15 service factor.
7. Acceptable Manufacturers:
  - a. US Motors
  - b. Baldor
  - c. General Electric
  - d. EPWU approved equal.

## 20.20 TRANSFORMERS

- A. General. The Engineer is responsible for sizing and specifying a transformer that meets the load conditions, while maximizing energy efficiency during no-load and load conditions. The Engineer must take into consideration the transformer's ability of handling overloads during short-lived peaks in order to avoid over sizing the transformer. The Engineer is responsible for performing a life-cycle cost study to identify the lowest cost



solution. The Engineer can visit the webpage [www.copper.org/applications/electrical/energy](http://www.copper.org/applications/electrical/energy) for acceptable samples of life-cycle calculations.

- B. Medium Voltage Transformer. It is EPWU's standard policy to contract electric service at low voltage levels (see section 20.11). If the Engineer is contemplating using a medium voltage to serve an EPWU load, the PEM and AHJ must be contacted for review and response. EPWU will respond on what voltage to use, and if a medium voltage is justified, the requirements for medium voltage components.
- C. Low Voltage Transformer. EPWU's requirements for low voltage transformers are:
  - 1. Dry type, self ventilated.
  - 2. Copper windings.
  - 3. 220 degrees C rated insulation.
  - 4. 80 degrees C temperature rise.
  - 5. Core of grade M6 low loss silicon steel or better.
  - 6. Compliance with DOE CSL-3 Final Rule – October 2007.
  - 7. Outdoor type enclosure. Note: preferred location of dry type transformers is outdoors to reduce heat load on cooling unit.
  - 8. If single phase unit is not available in EPA level CSL-3, it shall be CSL-1 (NEMA TP-1).
- D. Acceptable Manufacturers:
  - 1. Cutler Hammer
  - 2. General Electric
  - 3. Square D
  - 4. EPWU approved equal.

## **20.21 GENERATORS**

- A. General. The Engineer is responsible for reviewing with EPWU the intended generator application. The Engineer will compile a list of parameters impacting the generator sizing and specification, including duty cycle, load types, fuel type, and emission levels, among others. In sizing the generator, the Engineer must identify the critical loads to be powered by the generator and arrange them in a step approach starting with the largest load, such that not all critical loads will be energized by the generator in a single step. The Engineer will include on the drawing set a list of all critical loads broken down by steps, with the corresponding electrical rating for each load. This same list will be included in the

generator specification. Engineer will submit to EPWU a copy of the generator sizing calculations for review and comment.

B. Required Generator Features. The following is a list of required features for EPWU generators, unless specifically requested otherwise by the PEM or an authorized EPWU representative:

1. Application: emergency standby unit or non-emergency standby unit. Engineer must contact EPWU's Environmental Manager for correct designation.
2. Fuel: natural gas. If diesel is specifically requested, it must be stored in a double-walled sub-base tank per UL-142, or separate tank if required, with fuel level indication and leak detection, compliant with TCEQ regulations to avoid a fuel spill containment feature. Contact EPWU for fuel storage capacity.
3. Engine type: reciprocating engine, lean-fuel burn or as directed by EPWU's Environmental Manager to comply with applicable Emission standards.
4. Engine Emission Levels: Engineer must contact EPWU's Environmental Manager to identify applicable EPA tier level.
5. Limit voltage dip to 15% and frequency dip to 10%.
6. Power Rating: Engineer must specify rating for either continuous, load shed or standby application.
7. Battery bank and charger. Per manufacturer standard.
8. Include a 1 year service contract for entire generator system. Service contract shall include at no additional cost to EPWU all factory recommended maintenance work and supplies. Service contract shall be performed by a Contractor recommended by the factory and to ensure warranty terms are met or exceeded.

C. Connection Provisions. The Engineer shall include in its design provisions for connecting a portable generator as described below.

1. For all new or upgraded booster stations, lift stations, storm water stations and other facilities that don't include in its scope of work a permanent generator, the Engineer shall include in the design provisions for connecting a portable generator. The Engineer is required to review with the PEM or corresponding Section Superintendent the generator connection provisions for each facility.
2. For smaller load facilities, usually under 200 A at 480 VAC or as directed by the Section Superintendent, the Engineer shall comply with NEC Art. 702, based on manual transfer equipment, non-separately derived system. Instead of signals per NEC Art. 702.7, provide auxiliary contact at disconnect switch to signal when switch is closed and send signal to SCADA. See Chapter 21 for additional details.
3. For larger facilities, i.e. those requiring a main switchgear or MCC, the Engineer shall include provisions for a portable generator based on the following approach:

- a. Dedicated circuit breaker at the main switchgear or MCC for the portable generator.
- b. Key interlocks at main and generator circuit breakers. A single key shall be used to require the main circuit breaker to be tripped before the generator circuit breaker can be allowed to be closed. For Water Division facilities, three sets of keys shall be required and delivered to the Section Superintendent upon acceptance of the electrical system. For Waste Water Division facilities, one key shall be installed at the main circuit breaker and a duplicate key shall be delivered to the Section Superintendent upon acceptance of the electrical system.
- c. A NEMA 3R junction box (JB) located outside the electrical room pre-wired to the generator circuit breaker and feed cables terminating at power splicer blocks. Cable wiring shall be arranged such that the incoming generator cable are pulled from the bottom of the JB. A short nipple (no larger than 6 in long) and of diameter equal or larger than the conduit used to carry the feed cables from the JB to the generator circuit breaker, shall be installed on the bottom of the JB and sealed with a blind threaded cap. The JB shall be sized such that it will provide at least 150% of the bending space required for cables to be terminated.
- d. Power splicer blocks shall be similar to Marathon 140X303, either 2 or 3 poles, designed to be installed with a minimum of 2 bolts per block. Blocks with a single point of attachment shall not be allowed.
- e. The arrangement specified above shall comply with photos 20.21-1 and 20.21-2 below.



Photo 20.21-1 JB Front View

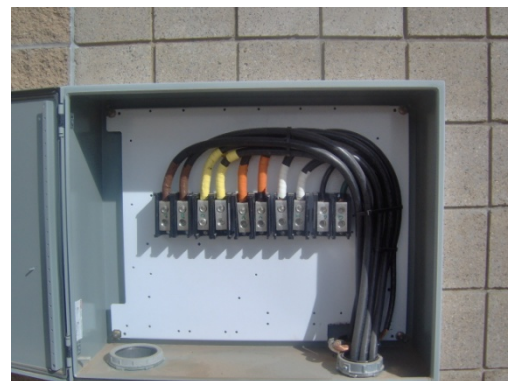


Photo 20.21-2 JB with Internal Details

D. Acceptable Manufacturers:

- 1. Caterpillar
- 2. Waukesha
- 3. Cummins
- 4. EPWU approved equal.

## 20.22 OTHER EQUIPMENT

- A. General. In the case of other specialty equipment such as UPS, renewable energy system and other, the Engineer must contact the PEM and AHJ to review EPWU's preferences and needs for each type of specialty equipment.

## 20.23 LIGHTING

- A. General. The Engineer must be familiar with EPWU's Energy Policy and must be careful to incorporate its applicable provisions when designing and specifying any and all EPWU lighting systems. The basic premise is to reduce energy and maximize energy efficiency without compromising required task performance. The Engineer must enforce in the specifications EPWU's policy of not allowing the use of any incandescent or mercury vapor lamps and must contact EPWU's PEM or AHJ for any exception. The Engineer's lighting designs must comply with IESNA Lighting Handbook (latest edition) guidelines and ASHRAE 90.1 (latest adopted edition). Light levels will be as recommended in the IESNA Lighting Handbook or as stated in this section. The Engineer will contact EPWU's AHJ for any lighting questions and thus avoid unnecessary re-design. Consultant must submit a lighting design for any EPWU project where artificial lighting is part of the project. Lighting levels based on past practices that don't comply with this section will be rejected and will be redone at Engineer's cost. The Engineer shall only allow lighting substitutions that are properly documented to his satisfaction on the basis of equipment that perform equal or better than the specified equipment, and that include the necessary lighting calculations and detailed equipment specifications. Contractor substitutions that are primarily made to achieve a lower cost to the Contractor but don't meet all the Engineer's specifications shall be automatically rejected and brought to the attention of the project's PEM or AHJ.
- B. Indoor Lighting. The Engineer is responsible for using his best judgment to determine the most cost-effective lighting system approach, and that is suitable for the intended application. EPWU preferences are:
  - 1. Lamp
    - a. CFL: where a smaller footprint lamp with smaller wattage is called for.
    - b. Fluorescent tube: T8 type, 28 W or 32 W, CRI of 80 or better.
    - c. HID: high pressure sodium or metal halide where required. See fixture portion for additional preferences.
    - d. LED: must use in exit signs and where it can economically compete with other lamp types on a life-cycle cost basis. Preferred in hard to reach locations or where access is difficult
  - 2. Fixture
    - a. Mounting: surface, pendant or flush-mounted depending on application. Fixture type and class must match the application. For example, an

architectural type fixture is not an acceptable solution for an industrial location.

- b. Enclosure type: open, enclosed, sealed, vapor tight or other depending on application.
- c. Finish: suitable for the environment where installed.
- d. Multi-lamp fluorescent type is preferred for bay lighting over HID type. It's up to Engineer to justify exceptions to this preference.
- e. Grade: industrial, with extra options as required by application.

3. Ballasts

- a. Electronic, low-ballast factor (0.8 or less), and high power factor (0.9 or better), except where not available or not applicable.

4. Controls

- a. Light switch: as required for application. Where designing controls for large areas, Engineer must consider multiple switches for large area to allow reduced lighting level or to control every other lamp on a separate switch.
- b. Motion sensor: for areas with low traffic or that are regarded as normally un-attended. Combination of motion sensor with manual override to comply with NEC Art. 110.26.(D). Sensor type shall be either passive infrared (PIR), ultrasonic or combination, suitable for the application and clearly noted by the Engineer on the construction documents.
- c. Automatic On/Off control: industrial grade photo cell sensor or electronic based controller with a combination of photo cell and astronomical clock sensors that can be justified for the application. Controls shall be placed by Engineer considering manufacturer's recommendation and maintenance accessibility. Fixture mounted controls for area lighting are not allowed, except in the case where a single fixture is required by the project at an elevation accessible using a 6 foot ladder.
- d. Emergency lighting or battery backup. Provide in compliance with applicable NFPA standards.
- e. See Chapter 21 - Instrumentation and Control for additional control information.

C. Outdoor Lighting. The Engineer is responsible for using his best judgment to determine the most cost-effective lighting system approach, and that is suitable for the intended application. EPWU preferences are:

- 1. Use one compact fluorescent fixture (around 23 to 32 W) above the main entrance door. Use additional similar fixtures if requested by EPWU.

2. Provide one or more (as requested by EPWU and depending on project) floodlights aimed at the EPWU equipment located outdoor.
3. Lamp: same as indoor lighting. Engineer must select the lamp type that provides the most cost-effective solution for the application, in compliance with EPWU's Energy Policy.
4. Fixture: same as indoor lighting section above plus
  - a) Optics: Engineer must specify the most cost-effective solution for the application considering energy cost, lighting task, light quality. Must also comply with City's Dark Sky Ordinance.
5. Ballasts: same as indoor type.
6. Controls: same as indoor lighting as applicable. Motion sensors are preferred to control perimeter lighting at control rooms. A photocell control is required to ensure power is off during daylight hours. Phtocell shall be mounted at accessible location and shall never be pole mounted. An HOA switch is to be included in the light control circuit to allow for manual control of lights. Se Chapter 21 for additional details.
7. Floodlights: coordinate with PEM or Section Superintendent for floodlight requirements specific to the project. Engineer must comply with City's Dark Sky ordinance.

## **20.24 RACEWAYS AND FITTINGS**

- A. General. All material shall be listed by UL or equivalent as suitable for the intended application and designed to be installed per applicable NEC articles. See section 20.10 for additional requirements. The engineer is responsible for performing a cost/benefit analysis to determine the raceway and/or tray cable best suited for the application.
- B. Conduit
  1. Rigid galvanized steel (type RMC): where exposed to damage, indoor or outdoor. Intermediate conduit may be approved by Engineer as substitute where suitable in Engineer's opinion. Where coming off the ground or installed underground, it shall be PVC coated and shall bear the ETL Verified PCV-001 label.
  2. Aluminum RMC: in waste water applications and must be used wherever it may be exposed to H<sub>2</sub>S.
  3. Liquidtight flexible metal conduit (type LFMC): for vibration isolation when making connections to motors, transformers and other equipment subject to vibration.
  4. Rigid PVC: in wet, damp and corrosive environments where not exposed to damage. Shall specify schedule 40, unless in Engineer's opinion schedule 80 is required.

5. Electrical metallic tubing (type EMT): To be used indoors in non-process dry areas, where not exposed to damage. Can be used for lighting circuits where not exposed to damage, unless requested otherwise by EPWU representative. Shall be used with steel set screw fittings only.
6. For all Wastewater projects, Engineer shall contact Section Superintendent for specific conduit needs.
7. Conduit openings: seal all cable-filed openings with flexible sealing mastic or foam sealant. Engineer shall never specify or allow the use of Chico compound for classified area fittings.
  - a. All conduit openings at MCCs, switchgear, control rooms, underground pull box, underground junction box, and other electrical equipment shall be sealed to prevent the entry of corrosive gases, insects and other contaminants. The opposite end of each conduit (in the direction of the process area) shall also be sealed.
  - b. Acceptable sealing mastic shall be non-hardening, non-combustible, approved for conduit sealing, as made by GB Electrical Inc.
  - c. Acceptable foam sealant: Great Stuff Big Gap Filler by Dow.
- C. Cable tray: where required by the application, the Engineer shall design and specify a fully coordinated system specific for the intended application. For wastewater projects, cable tray shall be anodized aluminum or marine grade aluminum alloy.
- D. Fittings: as required by NEC for each intended application. For EMT conduit, prefer steel compression type.
- E. Expansion joints: suitable expansion joints shall be specified by the Engineer where required, including conduit expansion on long runs, conduits crossing building expansion joints or concrete expansion joints.

## **20.25 CONDUCTORS AND CABLES**

- A. General. All material shall be listed by UL or equivalent as suitable for the intended application and designed to be installed per applicable NEC articles. See section 20.10 for additional requirements.
- B. Conductor material. Copper, solid or stranded depending on size and application. Where specified for corrosive environments, specify the use of corrosion protection as required under section 20.10.
- C. Ampacity. The Engineer shall size conductors and cables as required by the voltage drop calculations. See section 20.4.
- D. Low voltage Insulation and color. Conductors for all dry location applications at 600 V and below shall be type THHN, rated 600 V, for conductor sizes below 250 KCM. For conductor sizes 250 KCM and larger, type RHH/RHW shall be specified for added

flexibility, using XLPE insulation or similar. For wet or underground applications, THHW type cable shall be specified and RHW type shall be specified for cable sizes 250 KCM and larger. The Engineer is responsible for specifying other types as required by the application.

- E. Phase identification. Color for application and color coding for power phase identification shall be as required by NEC, except EPWU color coding at 480 VAC calls for Brown (Ph A), Orange (Ph B), Yellow (Ph C), left to right or top to bottom, when viewed from the front. For compliance with this section, Contractor shall be required to use insulating tape of the appropriate color to identify each phase in a 3 phase system. Tape shall be applied at each end of every phase run, at each junction box and at each termination. Colored tape shall be continuously applied for a minimum of 4 inches. The Engineer shall contact the corresponding Section superintendent for other color coding that may be required.
- F. Medium voltage insulation. Engineer must contact PEM and AHJ for review and response. Also see section 20.20.
- G. Multi-conductor cables, low voltage. The Engineer is responsible for specifying the appropriate insulation and jacket, as required by the application.

## **20.26 ELECTRICAL DEVICES**

- A. Shall always use screw-type terminals for wiring all electrical devices. Exception: when acceptable product is only available without screw-type terminals.
- B. Acceptable Manufacturers:
  - 1. Hubbell
  - 2. Leviton
  - 3. Pass & Seymour
  - 4. EPWU approved equal.
- C. Receptacles
  - 1. Indoor: industrial grade, duplex, grounding type, 20 A, 125 VAC, side wired, screw-type terminals.
  - 2. Outdoor: industrial grade, duplex, GFCI type, 20 A, 125 VAC, side wired, screw-type terminals, with spring-loaded hinged flap cover that meets code under operating conditions.
- D. Toggle Switch
  - 1. Industrial grade, heavy duty, number of ways as required by application, 120/277 VAC, side wired, screw-type terminals.
- E. Occupancy Sensors



1. Shall be type passive infrared (PIR), ultrasonic or combination, depending on the application and per manufacturer recommendations.
2. Acceptable manufacturers:
  - a. Hubble
  - b. Leviton
  - c. Watt Saver
  - d. EPWU approved equal.
3. Application. Wall or ceiling mounted depending on required application.
4. Key features:
  - a. All digital technology, single or dual as applicable.
  - b. Self adaptive or self-learning sensing circuits.
  - c. Heavy duty sensor lens.
  - d. Zero voltage switching.
  - e. 5 year warranty.
  - f. Auto ON/auto OFF and manual ON/auto OFF modes.

## **20.27 IDENTIFICATION AND LABELS**

- A. General. The Engineer of record has primary responsibility for specifying identification and labeling systems that meet applicable standards, addresses safety requirements and provides for long-term identification with minimal maintenance.
- B. Underground utilities. An underground warning tape shall be specified to identify the location of all underground power circuits. Tape shall be minimum 3 in wide, with metal trace for instrument detection, colored red and with suitable warning legend along its entire length. Tape shall be installed per manufacturer's specifications. Acceptable manufacturer: Carlon, Brady.
- C. Power Conductor identification: Engineer shall specify conductor identification per NEC Art. 310.12. Methods specified for identification shall be recognized for their durability under adverse conditions and lettering resistance to fading.
- D. Control conductor identification: Engineer shall specify sleeve type marker with permanent lettering. The sleeve may be heat-shrink or non heat-shrink type, depending on application and Engineer's recommendation for the application.
- E. Equipment and component identification: Engineer shall specify a system using nameplates to identify equipment and components. As a minimum, the system shall comply with the items listed below.

1. Nameplates shall be engraved with equipment or component identification and service legend wherever appropriate. Nameplate shall be two-layer plastic, with black letters over white background.
2. Letter size: ¼ in or larger for main labels. ⅛ in or larger for components and legends.
3. Attachment: double-face tape, 3M brand Adhesive 100MP or better.

## 20.28 TESTING

- A. General. The Engineer is responsible for specifying a complete set of tests to ensure that, a) the specified equipment, materials and components have been installed; b) the installation has been done in compliance with manufacturer's instructions, and manufacturer's certification (where applicable) has been complied with; c) equipment performs as designed and intended. The Engineer is solely responsible for preparing a complete and sufficiently detailed set of testing that is specific to the project on hand and that complies with applicable codes and standards. The test procedures must also require the performing Contractor to comply with all applicable safety procedures while performing any testing, especially NFPA 70E.
- B. Documentation. Written report forms for all testing shall be specified and included in the O&M documentation. This shall include written results for all testing required for all equipment installation under this section. The Engineer must also require the Contractor to submit to the Engineer or PEM (as applicable) a written startup procedure for review and approval.
- C. It is EPWU's experience that certain testing is simple and routine enough, such that it can be competently performed by a qualified electrical contractor. Other testing, such as insulation testing and other specialized equipment testing requires that it shall be performed by a third party testing company or a factory-trained representative that is completely independent from the electrical contractor. The Engineer is responsible for making this distinction and the PEM or AHJ have the right to disagree and direct the Engineer to proceed in a way that best represents EPWU's interests.
- D. Grounding test. The Engineer shall specify a grounding test to verify the designed grounding system was installed as designed and performs as calculated. Ground resistance testing equipment shall be of the clamp-on or 3-point type, using calibrated equipment such as that made by AEMC, Extech or Fluke.
- E. Visual inspection. The Engineer shall specify a visual inspection test to verify that, a) the equipment, materials, and components were installed as designed, b) the approved equipment, materials and components were installed, c) all material, components and accessories were installed in compliance with NEC, applicable codes and standards, and manufacturer's instructions, d) all equipment was installed in compliance with manufacturer's instructions, and where specified or required, a factory authorized representative was used to verify the equipment was installed accordingly, was adjusted and calibrated per manufacturer's instructions, and the equipment is performing as designed. See elsewhere in this section for further details.

- F. Insulation test. The Engineer shall specify a comprehensive insulation test that when correctly performed, will ensure the insulation of all equipment, material and components, at all specified voltages, performs in compliance with NEC and manufacturer's specifications. All insulated power cable testing shall be done in compliance with the corresponding IPCEA standard by a third-party testing company.
- G. Medium voltage insulation. Similar to part F above except as required by IPCEA for the specific voltage class. As a minimum, testing with Hi-Pot and/or megger testers shall be specified as required.
- H. Continuity test. A continuity test is mandatory to ensure each wire or conductor is terminated as designed or as required so the conductor performs safely and the circuit performs as intended.
- I. Phase sequence test. The Contractor is always responsible for performing a phase sequence test on all three phase equipment that requires it to prevent damage to other equipment. The Engineer must make sure to enforce this requirement and make the Contractor solely responsible for any damage caused by improper testing or lack thereof.
- J. Startup testing. The Engineer must require the Contractor to follow the manufacturer's written startup procedures to ensure a correct adjustment and startup sequence and to maintain any applicable equipment warranties. If no written procedures are available, the Engineer must still make the Contractor responsible for requesting appropriate written startup procedures from the manufacturer.
- K. Performance tests. The Engineer must require performance testing that confirms the installed equipment performs as rated by the manufacturer. Depending on the specific equipment, the Engineer is responsible for specifying if the performance testing can be made during startup, or be made as a separate test.
- L. Commissioning testing. In this EPWU section, the term Commissioning shall be interpreted as applied in LEED publications by USBC and as regulated by the Building Commissioning Association (BCA) or equivalent organizations. When part of the contract, the Engineer must ensure that all equipment commissioning is performed in compliance with applicable codes, standards and the contract, and that no testing duplication is done due to lack of coordination.
- M. Other testing. It is the Engineer's responsibility to identify and properly specify any other type of testing that may be required by the manufacturer or requested by EPWU.

## **20.29 O&M MANUALS**

- A. General. The Engineer is responsible for specifying in detail the requirements for O&M manuals that comply with this section and other applicable sections of the EPWU contract. Depending on the nature and complexity of the equipment or material, the corresponding O&M information may consist of as little as a few pages, all the way to several bound volumes that may also include software and videos. The PEM or AHJ will review the Engineer's specifications for O&M manuals and make any appropriate requests for engineering changes. The Engineer shall include in its specification proper

wording requiring the Contractor to deliver one complete set of approved O&M manuals to the Section Superintendent with jurisdiction over the project. Depending on the equipment, EPWU will require some or all of the following information:

1. Ordering information. This may be as simple as a complete catalog number or as complex as detailed ordering information with all options included.
2. Support information. Contact information for factory representative, technical support and spare parts.
3. Warranty information. Copy of warranty certificate and maintenance procedures required to maintain the warranty.
4. Shop drawings. A copy of the drawing set used for approval. Prefer a copy of the final set approved by the Engineer. Shop drawings must include all dimensional information and weights needed by a Contractor to correctly install the equipment.
5. Required clearances by code, for servicing, or to maintain applicable warranties.
6. Wiring information. All information to make correct power, control and instrumentation connections. It must also include internal wiring information that is needed for maintenance or troubleshooting purposes.
7. Control logic and any applicable programming information.
8. Detailed operating instructions.
9. Detailed maintenance instructions. Must include all recommended lubricants and related maintenance supplies.
10. Detailed troubleshooting instructions.
11. Recommended spare parts list.
12. List of available maintenance or troubleshooting tools.

### **20.30 RECORD DRAWINGS**

- A. The Engineer is responsible for describing in the contract documents the procedure that the Contractor must follow in order to ensure that an accurate set of record documents is produced at the conclusion of the project.
- B. The Engineer shall contact the PEM for the number of sets of record documents to submit, as well as the format under which the record documents shall be delivered to EPWU.
- C. The Engineer shall include in its specification proper wording requiring the Contractor to deliver one complete set of record drawings to the Section Superintendent with jurisdiction over the project.

- D. Software. The Engineer shall include in its specification proper wording requiring the Contractor to deliver to the Section Superintendent with jurisdiction over the project one complete set of fully functioning software and documentation required by any equipment in the project.

END OF CHAPTER

## CHAPTER 21

### **INSTRUMENTATION AND CONTROL SYSTEMS**

#### **21.1 PURPOSE**

- A. Instrumentation and control systems shall be provided to measure, control, and monitor potable water, raw water, waste water, reclaim, storm water facilities including auxiliary equipment. Pumping operations include pumping stations, lift stations, wells, RO systems, clearwells, forebays, surge tanks, regulating reservoirs, terminal reservoirs, and turnout/rate of flow control stations.
- B. The Engineer shall provide sufficient detail concerning the design and operation of the telemetry and control system in the Basis of Design Report (BDR) or other technical documentation. At minimum, the following information shall be included:
  - 1. Control approach and strategy
  - 2. Design criteria
  - 3. Process and instrumentation diagrams
  - 4. Equipment configurations and interfaces
  - 5. Future expansion capacity
- C. Construction of the instrumentation and control systems shall be in accordance with the Contract Documents.

#### **21.2 DESCRIPTION OF INSTRUMENTATION/CONTROL SYSTEM**

- A. Under normal conditions, the facilities' PLC based control system will be programmed to autonomously operate as per the design of the system while still being remotely monitored by the Utility's supervisory control and data acquisition (SCADA) system. Potable water pump stations, reclaim water pump stations, and wells will be operated in local manual or remote controlled and monitored by the Utility's supervisory control and data acquisition (SCADA) system. The SCADA system will transmit and receive signals to and from the facility's control system. The facility's control system and its autonomous operation shall be able to be modified and/or overridden via the communicating SCADA system. The local Human Machine Interface (HMI) will be used primarily used for local monitoring and control of the facility if and when the need arises on a case by case basis.
- B. El Paso Water Utilities currently utilizes the "Derceto" Energy Management Software that integrates with their existing SCADA system to optimize water production and distribution by reading live field data to create the most effective pump, valve, and water treatment plan schedules adapting them in real time to changes in demand, energy pricing and unforeseen events in the network. The radio network is composed of GE MDS-SD9, 900Mhz spread spectrum radios. The contractor/integrator shall write and execute PLC programming that will incorporate a "Central" mode and a "Derceto" mode for each pump or valve as indicated in the "Sequence of Operation" below. The PLC program shall be written, executed and tested utilizing EPWU established standards for program file

structure, control philosophy, ladder logic, data register mapping, graphic displays of HMI, etc. Sample documentation of above mentioned standards are included with this guideline to aid the contractor/integrator in providing the PLC program that will meet the intent of the project and to the satisfaction of the SCADA department programming procedures and standards. Contractor/integrator shall work in close cooperation with the SCADA department to ensure that the PLC programming will meet all their requirements and expectations prior to facility start-up.

Contractor/Integrator shall furnish PLC programming software and license to Owner at the end of project.

C. "Central" and "Decerto" mode Control Philosophy:

1. When a pump or Valve is put into "Central" mode from Central Control, the pump will respond to pump "Start" and "Stop" or Valve "Open" and "Close" commands from the operator at central control. Any commands to Start/Stop or Open/Close from Decerto at central control will be ignored.
2. When a pump or Valve is put into "Decerto" mode from Central Control, the pump will respond to pump "Start" and "Stop" or Valve "Open" and "Close" commands from Decerto at central control. Any commands to Start/Stop or Open/Close from the Operator at central control will be ignored.
3. Refer to the "Manual" and "Decerto" mode Binary Logic Diagram at the end of this specification.

D. SEQUENCE OF OPERATION

Refer to "Pump Station Sequence of Operation" at the end of this specification.

E. OWNER PLC PROGRAMMING DOCUMENTATION

Refer to Owner's Sample PLC programming documentation at the end of this specification.

F. Successful Contractor/Integrator shall request the Owner's Data Mapping Table at the beginning of the construction phase of the project.

G. The facility's PLC based control system, commonly referred to as remote terminal units (RTU) or station control panels (SCP), will provide via equipped radio interface monitoring and control information to the Utility SCADA system.

H. Each facility will be designed to utilize a programmable logic controller (PLC) with an HMI in order to autonomously control and locally monitor the facility's equipment unless otherwise specified.

I. Typical points monitored and controlled by the PLC but not limited to are control power source availabilities, motor drive status and actuation, inlet pressures, discharge pressures, intrusion alarms, fire alarms, emergency power generation, skid mounted equipment, ancillary equipment, tank or reservoir suction level alarms, discharge tank or reservoir level alarms, power transformer conditions, room temperature conditions, hydraulic oil system conditions, and control override functions

J. All available input/output (I/O) points shall be wired to the RTU; even if they are not to be used immediately they should be left connected and ready for future use. This will hold true unless the cost of wiring the future use I/O points outweighs the benefits.

## 21.3 DESIGN REQUIREMENTS

### A. Standards

Numerous standards are applicable to the various facets of instrumentation and control (I&C) work. Listed below are major standards and recommended practices that the Engineer shall be familiar with and follow in the design of the I&C system.

<u>REFERENCE</u>	<u>TITLE</u>
API RP550	Manual on Installation of Refinery Instruments and Control Systems
IEEE 100	Dictionary of Electrical and Electronic Terms
IEEE 472	Guide to Surge Withstand Capability (SWC) Tests
ISA S5.1	Instrumentation Symbols and Identification
ISA S5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems
ISA S5.4	Instrument Loop Diagrams
ISA RP7.3	Quality Standard for Instrument Air
ISA RP12.6	Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations
ISA S18.1	Annunciator Sequences and Specifications
ISA S20	Specification Forms for Process Measurement and Control Instruments, Primary Element and Control Valves
ISA S51.1	Process Instrumentation Terminology
NEMA 250	Enclosures for Industrial Controls and Systems
NEMA ICS	Industrial Control
NFPA 70	National Electrical Code (NEC)
NFPA 72	National Fire Alarm Code

- B. Process and instrumentation diagrams (P&ID) shall be developed to indicate each instrument, monitoring and control device, and communication device for the facility and subsystems. Loop diagrams from devices to terminal blocks and PLC I/O points shall be indicated.
- C. Electrical layout drawings shall show each field instrument that has electrical connections, and all instrument panels. Adequate space shall be reserved for instrument panels. Electrical signal cables and raceways will be installed by licensed electricians and shall be shown on the electrical layout drawings.
- D. Panel layout detail drawings are required for control panels. These drawings shall be included as part of the Engineer's design effort. Each face-mounted device will show a reference number which is coordinated with the instrument and input/output summary. Front-view drawings will show maximum cabinet dimensions. Nameplate and annunciator schedules will be shown on the drawings.
- E. Control panels shall be installed in enclosures that are environmentally suitable for the area. All control panels which require NEMA 4 or 12 rating will be provided with window kits to preserve panel integrity and allow operator viewing where internal devices have



displays. LED indicating lights on all control panels will be colored as determined by the Engineer.

- F. The I&C devices specified shall be industrial grade. Design emphasis shall be placed on safety, process control, reliability, maintainability, ease of access, and economics.
- G. SCP's or RTU's shall utilize Utility standardized manufacturer specific control and communication equipment. Other items, such as but not limited to power supplies, UPS's, terminal blocks, enclosures, cabling, and instrumentation shall follow the Utility's and Engineer's project specifications and drawings as well as industry standards for installation and application type unless otherwise specified.
- H. The Instrumentation and Control Contractor must have local tech support available to be on site within 24 hours.
- I. Uninterruptable power supply distribution shall be provided for all control and instrumentation devices. On-line system with a minimum of 60 min of battery time at full load.
- J. SCADA radio antenna mast supported either from building, structure, or separate tower depending on application and to minimize antenna movement for continuous signal reliability. Mast shall be grounded directly to an external ground rod and bonded to facility grounding system. Provide air terminal on top of mast or tower connected to grounding system. Path and spectral analysis shall be performed by the contractor/integrator to confirm antenna height and location for adequate signal strength and reliable performance.
- K. Design engineer shall submit a list of a minimum of three (3) proposed manufacturers and model numbers of equipment and instrumentation devices related to instrumentation and control systems for owner review at the 30% design submittal.
- L. Provide a loop testing of all I/O from devices to station PLC and radio and confirmation of signals to and from Central Control. Notify EPWU SCADA when loop testing and confirmation of signals to Central Control is to be performed.
- M. Refer to EPWU standard details for RTU panel layout guidelines and additional instrumentation mounting details.

#### END OF CHAPTER