



DALLAS
FORT WORTH
INTERNATIONAL
AIRPORT

DESIGN CRITERIA MANUAL

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PREFACE

Introduction

The Dallas/Fort Worth International Airport (hereinafter referred to as "DFW Airport") Design Criteria Manual has been developed to ensure a unified approach to the design of the renovation of existing facilities or the construction of new facilities throughout the DFW Airport complex.

Scope and Purpose

This Manual establishes specific design criteria for all public infrastructure, terminal buildings and other public facilities owned, operated or maintained by the Dallas/Fort Worth International Airport Board (hereinafter referred to as "Board"). It also serves as a design guide for all other facilities constructed within the boundaries of the DFW Airport. The Design Criteria manual is not intended to limit or dismiss the experience, knowledge or talent of the Designer. The Board encourages Designers to recommend alternates when deviations from the guidelines would be beneficial. However, adherence to these guidelines should result in project development that conforms to the goals and objectives of the Board.

Maintenance

Proposed changes to this manual should be submitted to the Building Official for consideration.

Request for Variances and/or Interpretation Statement

It is recognized that this Manual may not identify criteria for all possible types of Projects or all technologies possible for the design.

Proposed changes or additions to this Manual should be submitted to DFW Airport Code Enforcement for consideration. Requests for such change or addition shall include a complete description of the change proposed and shall be accompanied by sufficient technical analyses to support the change or addition and identified as a design improvement, public safety improvement, construction cost/schedule improvement, operation or maintenance improvements, life cycle cost benefit, or other improvement.

Airport Contact

References in this document to "Airport Contact" shall be defined as follows:

1. For Board Projects, "Airport Contact" shall be the Project Manager
2. For Tenant Projects, "Airport Contact" shall be the Building Official or his designee.

Acronyms, Abbreviations and Definitions

A/E	Architects and Engineers
AACS	Automatic Access Control System
AASHTO	American Association of State Highway and Transportation Officials
AC	Advisory Circular
AC	alternating current
ACI	American Concrete Institute
ACM	Asbestos Containing Material
ACS	Announcement Control System
ADA	Americans with Disabilities Act
ADE	Airport Development and Engineering
ADG	Airplane Design Group
AHJ	Authorities Having Jurisdiction
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ALP	Airport Layout Plan
AOA	Aircraft Operation Area
AOC	Airport Operations Center
ALS	Approach Lighting System
ANSI	American National Standards Institute
APM	Automated People Mover
ARFF	Aircraft Rescue and Fire Fighting
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	International (formerly American Society for Testing and Materials)
ATC	Air Traffic Control
AWG	American wire gauge
AWWA	American Water Works Association
BAS	Building Automation System
BHS	Baggage Handling System
BIM	Building Information Management
BTU	British thermal unit
CADD	Computer Aided Design and Drafting
CCTV	Closed Circuit Television
CCU	Cluster Control Unit

CDA	Critical Design Aircraft
CFAS	Central Fire Alarm System
CFM	cubic feet per minute
CFR	Code of Federal Regulations
CBP	Customs and Border Patrol
CPS	cathodic protection system
CPU	central processing unit
CPVC	chlorinated polyvinyl chloride
CRCP	Continuously Reinforced Concrete Pavement
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DART	Dallas Area Rapid Transit
DDC	direct digital control
DIP	ductile iron pipe
DIPS	ductile iron pipe size
DFW	Dallas/Fort Worth International Airport
EMT	electrical metallic tubing
ETAM	Airport Energy, Transportation and Asset Management
DPS	Department of Public Safety
EAD	Environmental Affairs Department
EP	Energy Plaza
EPA	U.S. Environmental Protection Agency
EPDM	ethylene propylene diene terpolymer
ESP	East Side Plant
EVAC/MN/PA	Emergency Voice Alarm Communication/ Mass Notification/ Public Address
FAA	Federal Aviation Administration
FARs	Federal Aviation Regulations
FAS	Fire Alarm System
FCU	fan coil unit
FDC	Fire Department Connection
FM	Factory Mutual Global
FIS	Federal Inspection Services
fps	feet per second
GFI	ground fault interrupter
gpm	gallons per minute

HDPE	high density polyethylene pipe
HID	high intensity discharge
HMAC	hot mix asphalt concrete
HOA	Hand-Off-Auto
HSLA	High Strength Low Alloy
IBC	International Building Code
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IES	Illumination Engineering Society
IESNA	Illuminating Engineering Society of North America
ILS	Instrument Landing System
IMC	intermediate metal conduit
IPS	iron pipe size
iSWM	Integrated Storm Water Management Design Criteria
IT	Information Technology
ITE	Institute of Transportation Engineers
kV	kilovolts
kVA	kilovolt amps
LCD	liquid crystal display
LED	light-emitting diode
LP	liquid petroleum
LPI	Lightning Protection Institute
LRFD	Load and Resistance Factor Design
MC	metal clad
MEP	Mechanical/Electrical/Plumbing
mph	miles per hour
MSS	Manufacturer's Standardization Society
NAVAIDS	Navigational Aids
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NRCA	National Roofing Contractors Association
O&M	Operation and Maintenance
O.D.	outside diameter

OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PCC	Portland Cement Concrete
POV	privately-owned vehicle
psf	pounds per square foot
psi	pounds per square inch
psig	pounds per square inch gauge
PTI	Post Tensioning Institute
PTWS	Pre-Treatment Waste System
PVC	polyvinyl chloride
PWS	Potable Water System
RAM	random access memory
RCCP	reinforced concrete cylinder pipe
RMC	rigid metal conduit
rpm	rotations per minute
SEER	Seasonal Energy Efficiency Ratio
SIDA	Security Identification Display Area
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPDT	single pole-double throw
SPRI	Single Ply Roofing Industry
SRD	Signal Receiving Device
SSI	Security Sensitive Information
SSS	Sanitary Sewer System
TAS	Texas Accessibility Standard
TCAS	Courtesy Announcement System
TCEQ	Texas Commission on Environmental Quality
TIA	Traffic Impact Analysis
TMUTCD	Texas Manual on Uniform Traffic Control Devices
TRACON	Terminal Radar Approach Control
TRE	Trinity Railway Express
TRIP	Terminal Renewal and Improvement Program
TSA	Transportation Safety Administration
TxDOT	Texas Department of Transportation
UL	Underwriters Laboratory
UPS	uninterruptible power supply

UST	underground storage tank
VAV	variable air volume
VFD	variable frequency drive

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References

Additional design criteria are contained in the following manuals for projects of specific scope and location on airport property:

[Airline Relocation Signage Requirements](#)

[Airport Image Elements](#)

[CADD Standards Manual](#)

[CADD Standard Detail Cell Library](#)

[Construction and Fire Prevention Standards Resolution & Amendments to the Codes](#)

[Founders' Plaza Center Development Criteria](#)

[DFW Airport Terminal Development Program](#)

[DFW Roadway Signage Protocol Standards](#)

[DFW Screening Criteria for Natural Gas Exploration](#)

[Leasehold Development Criteria for International Commerce Park](#)

[Measurement Standards for Structures](#)

[Office Space Standards](#)

[Rental Car Design Criteria Manual](#)

[South Gate Plaza Development Criteria](#)

[Signage Manual Volume 1 - Terminals](#)

[Signage Manual Volume 2 – Curbside](#)

[Signage Manual Volume 3 – Parking](#)

[Signage Manual Volume 4 – Roadway](#)

[Surface Transportation Corridor Standards](#)

[Tenant Design Manual for TRIP Related Projects, Terminals A, B, C, and E](#)

[Tenant Design Manual for Non-TRIP Related Projects, Terminals A, B, C, and E](#)

[Tenant Design Manual for Terminal D](#)

[Toilet Standards](#)

DIVISION 01

General Requirements

Design of new construction, renovation, remodel and demolition activities requires various environmental regulations and DFW Airport specific requirements. Please incorporate, address and abide by the following environmental and Wildlife requirements when designing specifications and drawings.

Not incorporating these items in specifications and drawings prior to building permit application phase may cause a delay in start of construction or unexpected cost increases during resolution of the issue.

SECTION 011 PROHIBITED ITEMS

11.1 Asbestos
No Asbestos Containing Material (ACM) shall be installed on Dallas Fort Worth International Airport (DFW) property.

11.2 Polychlorinated Biphenyls
No Polychlorinated Biphenyls (PCB)-containing products shall be installed on DFW property.

SECTION 012 FAA VEGETATION COVER REQUIREMENTS

12.1 Construction projects within the boundary of the Airport Operations Area must follow the FAA requirement of establishing vegetation cover of 97% with no individual bare area larger than 1 square foot and an aggregate for bare areas of not more than 3% of the total vegetated area. For more information, refer to the FAA Advisory Circular 150/5200-33A for Hazardous Wildlife Attractants on or Near Airports and FAA Advisory Circular 150/5370-1OG (or most recent version), Standards for Specifying Construction of Airports (specifically Part 10, Turfing).

SECTION 013 ALLOWED VEGETATION SEED AND SOD TYPES

13.1 In order to prevent bird attractants as required by the FAA and promote a consistent vegetation coverage on airport property, the following seed and sod types are to be incorporated into the design of specifications and drawings. This is not intended to replace landscape designer plans for developed sites where decorative landscaping involving trees, shrubs, mulch, hardscapes, planting beds and decorative grasses are used.

13.2 Deviations or changes to the listed types or the use of any native flowering plants such as naturalization with wildflower attempts must pre-approved by the airport's Wildlife Administrator before receiving a building permit. For more information, refer to FAA Advisory Circular 150/5200-33B (or most recent version), *Hazardous Wildlife Attractants on or Near Airports* and FAA Advisory Circular 150/5370-1OG (or most recent version), *Standards for Specifying Construction of Airports* (specifically Part 10, Turfing), and the airport's Seed and Sod Specifications (32 92 19).

13.3 For the purposes of DFW Airport, the following definitions describing use and mowing frequency shall control what vegetation, seed or sod is allowed.

- **Airside:** The airside consists of all areas within the AOA fence at the completion of the project, all areas extending 20 ft from the AOA fence, and all Runway Protection Zones (RPZ)
- **Public areas:** All non-Airside areas within 30 feet of a leased area, mowed, or landscaped.
- **Non-Public areas:** All non-Airside areas greater than 30 feet from a leased area, not mowed, and not landscaped
- **Cool Season, Temporary Type:** October 1 through March 31
- **Warm Season, Permanent Type:** April 1 through September 30

13.3.1 Airside- Warm Season Permanent

- Sod only, Bermuda Grass *Cynadon dactylon*

13.3.2 Public- Warm Season Permanent

(select one option):

- Unhulled Bermuda Cynadon dactylon
- Hulled Bermuda Cynadon dactylon
- Zoysia Grass *Zoysia japonica*

13.3.3 Non-Public -Warm Season

Permanent (select one option)

- Bermuda Grass *Cynadon dactylon*
- Buffalo Grass *Bouteloua dactyloides* (AKA *Buchloe dactyloides*) and Blue Grama Grass *Bouteloua gracillis*
- Buffalo Grass *Bouteloua dactyloides* (AKA *Buchloe dactyloides*) and Sand drop Seed *Sporobolus cryptandrus*
- Buffalo Grass *Bouteloua dactyloides* (AKA *Buchloe dactyloides*) and Hooded Windmill Grass *Chloris cucullate*
- Blue Gramma Grass (native) *Bouteloua gracillis*
- TXDOT Permanent Urban Seed Mix (District 18 Clay Soils) Green Sprangletop- *leptochloa dubia*, Sideoats Grama (El Reno)- *Boutelous curtipendula*, Buffalo Grass (Texoka) – *Bouteloua dactyloides*, Bermuda Grass – *Cyando Dactylon*

13.3.4 Airside- Cool Season Permanent

- Sod only, Bermuda Grass *Cynadon dactylon*

13.3.5 Public - Cool Season Permanent

- Sod only, Bermuda Grass *Cynadon dactylon*

13.3.6 Non Public - Cool Season

Permanent

- Sod only, Bermuda Grass *Cynadon dactylon*
- Sod only, *Zoysia japonica*

13.3.7 Non Public - Warm Season

Temporary

- Teff Grass *Eragrostis tef*

13.3.8 Non Public - Cool Season

Temporary

- Teff Grass *Eragrostis tef*
- Creeping Red Fescue *Festuca rubra*
- Western Wheatgrass *Passcopyrum smithii*

13.3.8 Special Conditions: Shade or Partial Shade Areas

Sod Types:

- *Zoysia 'Palisades'*

Ground Covers:

- Asian Jasmine
- Horseherb

13.3.9 Special Conditions: Landscaping

For a list of approved landscape plants, refer to Landscape Plant List, available through your Airport Contact.

SECTION 014 ADOPTED STANDARDS

2015 International Building Code

2015 International Fire Code

2015 International Plumbing Code

2015 International Mechanical

Code 2015 International Fuel Gas
Code

2015 International Energy Conservation
Code

2014 National Electrical Code

DIVISION 02

Existing Conditions

SECTION 021 PLAN ASSESSMENT

21.1 Airport Layout Plan

The Airport Layout Plan (ALP) is a scaled graphic presentation of existing and ultimate airport facilities, as approved by the Federal Aviation Administration (FAA). Reference is made to FAA Advisory Circular (AC) 150/5070-6B for ALP requirements. The ALP is a public document, which serves as a record of land and facility requirements, both present and future, as well as a source document for land use proposals. All proposed capital improvements must comply with the ALP. Any such project must be submitted through the Building Official to the FAA to determine if the project is in compliance with the ALP or if the ALP can be changed to accommodate the proposed project. Refer to Division 1 for airspace application. For detailed information concerning the most current ALP, consult the Airport Contact.

21.1.1 Radio/Wireless/Radar or similar installations are classified as a "Permanent" change to the ALP and require an FAA Air Space Application and Study Determination for possible interference with FAA or DFW Airport Board operations.

21.2 Site Plans

A site plan shall be prepared for all new and site projects. The site plan shall delineate all existing and proposed facilities and features. The site plan shall provide a clear schematic of the intended land use, project or building layout, site and project dimensions, access points, proximity to existing structures, etc. This plan will be used to initiate coordination among the Airport departments, the FAA, and tenants adjacent to the site. The site plan is also used to initiate changes to the ALP and to address potential line-of-sight issues.

21.2.1 The maximum building or equipment heights shall be indicated on the site plan prior to determining line-of-sight acceptability. A

traffic impact analysis will be required for all landside development projects that will generate and distribute vehicular traffic along the Airport's roadway network. A Level of Service "C" or better is required for all of the airport's roadways and intersections.

21.2.2 A landscape plan for each site shall be submitted with the site plan.

DIVISION 03 Concrete

SECTION 031 CONCRETE REINFORCING

31.1 Reinforcing Steel Clear Cover

For clear cover or protection, comply with the latest editions of American Concrete Institute and Concrete Reinforcing Steel Institute guidance.

31.2 Stressing Tendons

Stressing tendons shall be per Post Tensioning Institute (PTI) standards.

SECTION 032 CAST-IN-PLACE CONCRETE

32.1 Structural Concrete

32.1.1 Non Prestressed Concrete. Non prestressed concrete for structural elements shall be designed for a minimum 28-day compressive strength (f_c') of 4,000 pounds per square inch (psi), as dictated by design requirements.

Exception: Pier concrete may be 3,000 psi.

32.1.2 Cold Weather Concrete. Cold weather placement parameters shall be subject to design of the Engineer of Record.

SECTION 033 PRECAST CONCRETE

033.1 Precast Structural Concrete

Prestressed concrete for structural elements shall be designed for a minimum 28-day compressive strength (f_c') of 4,000 psi.

SECTION 034 STRUCTURAL FOUNDATION SYSTEMS

34.1 Foundations

Allowable foundation capacities shall be determined from geotechnical investigations under the direction of a professional structural engineer registered in the State of Texas.

34.1.1 Foundations shall be designed to prevent uplift and differential settlement, as well as load bearing requirements.

34.1.2 Minimum ground cover over footings shall be 12 inches.

SECTION 035 PIERS

35.1 Pier Shafts

Pier shafts shall be a straight shaft design. Bell shaped piers will not be allowed.

35.2 Structural Piers

Structural piers used in buildings and bridges, Major structures should extend into the shale rock to minimize the potential for lateral movement.

35.3 Rebar Cages

The rebar cages for all piers shall extend full length of the pier shaft.

SECTION 036 PAVEMENT UTILITIES

36.1 General

All cast-in-place and precast concrete utility structures shall be reinforced.

36.2 Paving Blockouts

Manhole and inlet-throat paving blockouts shall be separated from the surrounding paving section with expansion material and connected to the concrete paving section with smooth dowels with expansion caps. The smooth dowel size, length, and spacing shall conform to ACI 302.1R-11 Code. The reinforcing rebar size shall match the longitudinal reinforcing of the surrounding pavement.

36.3 Grated Inlets

Grated inlets placed in pavement shall be separated from the surrounding pavement section with expansion material and will not be doweled.

36.4 Curb and Gutter Reinforcement

Curb and gutter reinforcing shall match the surrounding pavement.

36.5 Transverse Construction Joints

There shall be no laps within 10 feet on either side of a transverse direction continuously reinforced concrete pavement (CRCP) paving joint.

36.5.1 All transverse construction joints across the paving lanes, between existing pavement and new pavement, shall be doweled with smooth dowels and shall conform to ACI 302.1R-11 Code.

36.5.2 Transverse construction joints must line up and extend across all the paving lanes at the same location without staggers.

36.5.3 In the absence of tie-bars, all longitudinal construction joints between the paving lanes shall be connected with rebar dowels, #6 rebar, 3 feet long at 12-inch centers, with 12 feet embed and epoxied into the existing paving lane.

SECTION 037 Anchor Bolt Assemblies

037.1 General

All anchor bolt assemblies placed in the tops of piers and columns shall incorporate embedded anchor plate rings to maintain vertical alignment of the anchor bolts.

DIVISION 05

Metals

SECTION 051

DESIGN CRITERIA

51.1 Loads

The following loading criteria shall exceed the requirements in the current Building Code for the special cases mentioned, unless the loads required in the Building Code (IBC 2015) are more restrictive.

51.1.1 Live Loads. Live loads shall not be less than the values in the currently adopted International Building Code (IBC 2015), be approved by the DFW Building Official and shall be stated on plans. Live loads shall be increased as necessary based on Project requirements. Consideration shall be given to account for the use of material handling equipment such as forklifts, floor cleaning equipment, and other portable or movable equipment within the building and specifically on the pedestrian bridges.

51.2 Wind Loads

Basic Wind Velocity per ASCE 7-10 (IBC 2015): 150 miles per hour (mph) 150 mph Exceeds Risk Category III & IV Basic Wind Speed Map 120 mph. Gust factors shall be determined by the Engineer of Record and included as appropriate.

51.2.2 IBC 2015 Exposure Category: C. Wind load for Terminal buildings at the airside face only shall be not less than 50 pounds per square foot (psf) applied to any 15-square-foot area for components and cladding, per FAA AC 150/5300-13, Chapter 8, "The Effects and Treatment of Jet Blast: (most current edition). Exception: This load need not apply at inset penthouse structures 40 feet above the apron level. This load is a result of aircraft jet blast plus meteorological conditions.

51.3 Roof Loads

Roof levels designated as future floors shall be designed for a live load of 100 psf minimum and a dead load of 25 psf minimum.

SECTION 052

STRUCTURAL METAL FRAMING

52.1 Structural Steel Detailing

Detailing for structural steel shall comply with the latest edition of American Institute of Steel Construction (AISC) "Detailing for Steel Construction." All loads shall be identified on the plans.

52.2 Connections

Steel moment connections shall be designed using Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings; Refer to American National Standards Institute (ANSI)/AISC 360-05). Design specification used and design loads shall be identified on the plans.

052.2.1 All connections shall be designed and sealed by a professional structural engineer registered in the State of Texas.

52.3 Structural Steel Framing

Structural steel be atmospheric corrosion resistance and conform to the latest publications for structural steel framing, to include but is not limited to the following:

- W, WT Shapes: ASTM International (ASTM) A992.
- S,M, HP, and Channels: ASTM A36, A572 Grade 50.
- Angles and Plates: ASTM A36 A572 Grade 50
- Pipes: ASTM A53, Grade B.
- Tubes: ASTM A500. Grade B.
- Erection Bolts: ASTM A 307.
- High Strength Low Alloy (HSLA) Steel: ASTM A588 steel will be allowed with prior approval for high-mast light poles and base plates. HSLA steel shall not be used in areas of high moisture or water unless a proper surface treatment is utilized. Concrete pier pedestals for high-mast light poles shall be at least 36 inches above finish grade.

52.4 Floor Framing Systems

Floor systems at Terminal buildings shall be designed to eliminate excessive vibrations from pedestrian and automated people mover (APM) car traffic.

SECTION 071 GENERAL

071.1 Energy Conservation

The currently adopted edition of the International Energy Conservation Code shall be fully complied with (IBC 2015).

Section 072 ROOFING SYSTEMS

72.1 General

Many different types of roofing systems have been utilized at the Airport. The acceptable choice and application of a particular roofing system will depend on the type, use, location, and configuration of the building. Roof systems meeting the minimum criteria outlined below may be specified on new construction or as roof replacement on existing buildings.

72.1.1 Acceptable roof systems for consideration include, but are not limited to: on low slopes (up to 1 ½ inches per foot); 2-Ply Modified Bitumen (MFR: Siplast, Soprema with maximum roof slope approved); Standing Seam Metal 22 ga minimum (MFR: McElroy 238T Panels with minimum slope 1/2 inch per foot); Single Ply PVC/KEE 50 mil minimum – fully adhered (MFR: Fibertite, Carlisle); Coatings (MFR: Hydro-Stop, Siplast, SIKA).

72.1.2 For steep slopes (over 1 1/2 inches per foot), properly designed and fastened: Standing Seam Metal 22 ga minimum (MFR: McElroy 238T Panels with minimum slope 1/2 inch per foot); PVC - KEE 50 mil minimum – fully adhered (MFR: Fibertite, Carlisle); Coatings (MFR: Hydro-Stop, Siplast, SIKA).

72.1.3 Standing seam metal roof systems may be selected with prior approval from the Airport Contact.

72.2 Roof Load

The roofing assembly and its components must be capable of withstanding and accommodating all of the airport service conditions to which they will be exposed, including rain, snow, hail, ice, wind, sun, thermal shock, service traffic and applied loads. The roof system components must provide optimum thermal resistance to heat gain or loss within the building, consistent with good roofing practices.

72.3 Drainage

Ponding is defined as standing water on roofs for more than 24 hours. Ponding is the frequent source of leaks and the cause of premature failure of roof systems. Roof system manufacturers recognize the seriousness of this common problem and generally exclude leaks or failure caused by ponding water from their warranties. Ponding water is not acceptable.

Minimum drainage to roof drains shall be not less than ¼ inch per foot roof surface slope in accordance with the currently adopted edition of the IBC 2015.

72.4 Minimum Standards and Recommendations Included by Reference

Roof system selection, design detailing, and specification shall, at a minimum, comply with the requirements and recommendations of the following standards:

- National Roofing Contractors Association (NRCA), Roofing and Waterproofing Manual, latest Edition (low slope and steep manuals).
- Architectural Sheet Metal Manual, Latest Edition, Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

SECTION 073

ROOF SYSTEM DESIGN CRITERIA

73.1 Roof Replacement on Existing Building.

73.1.1 Guidelines. Roofs adjacent to aircraft ramps (terminals, cargo and hanger structures, electrical vaults, etc.) shall be smooth surfaced or smooth coated. Gravel, rock or paver ballasted roof surfaces are not permitted because high winds may displace gravel, rock or paver material onto operational surfaces, causing damage to aircraft and aircraft engines.

Roof attachment shall equal or exceed FM Global 1-120 (based on ASCE 7 - 05) wind uplift rating for high exposed roofs or roofs subject to jet blast must be calculated from FMG Loss Prevention Data Sheets.

Roof materials and assemblies shall be listed by Underwriter Laboratories as a Class A and by Factory Mutual as a Class 1 roofing material or roof assembly.

Roof coping and metal edge materials assemblies and securement shall equal or exceed the current edition of the ANSI/Single Ply Roofing Industry (SPRI) ES-1 (all roof slopes) and FMG 4435 wind design standards for all roof slopes.

Provide above roof deck rigid board insulation thickness in multiple staggered layers to achieve thermal resistance of R-25 minimum, but in no case less than that required by the currently adopted edition of the IECC. Cover fastener plates/fasteners with cover boards/insulation to prevent thermal bridging of fasteners.

Where different roof types join together, provide proper seams, parapets, area dividers, or expansion joints.

Provide roof traffic protection at all parapets, around equipment and at all areas subject to frequent wear.

Minimum flashing heights shall be 8 inches above roof surface to the extent possible by existing design conditions, but in no case shall flashing height be less than required by the roof system manufacturer for the applicable warranty. Roof surface is defined as the surface of the roof membrane that is exposed to the elements on the exterior side.

73.1.2 Internal Gutters. Internal gutters are not allowed.

73.1.3 Warranties and Guaranties for Airport Maintained Roofs. Require Roof Manufacturer's "Total System, No Dollar Limit (NDL)" warranty for maximum time limited available (15-year for liquid applied roofing systems and 20- to 30- year for all other acceptable roof systems, depending on roof system).

- Warranty shall cover wind speeds up to 100 mph for peak gusts measured 10 meters above ground level.
- Warranty shall cover related sheet metal copings, edge strips and metal edges.
- Warranty shall also include 36 man hours of labor per year throughout the term of the warranty for puncture repair work.

Roofing Contractor shall provide 5-year guarantee/warranty against leaks and defects in workmanship in the installed roofing system.

Roof related sheet metal, copings, edge strips and metal edges: Contractor shall provide 5-year guarantee against leaks and defects in materials and workmanship. Sheet metal exposed to public view shall have a factory-applied finish with a 20-year warranty covering fading, discoloration, peeling or other defects.

73.1.4 Energy Rating, Preference is given to "Energy Star" roofing materials (i.e., white in color, solar radiation reflective). Reflective roof system finishes must comply with FAA guidelines.

73.2 New Construction

73.2.1 Slope. Provide a minimum ¼ inch per foot slope designed and built into the structure of the facility. Where the minimum ¼ inch per foot slope is not designed nor built into the structure of the facility, the ¼ inch slope shall be achieved using a fully tapered insulation system and/or crickets, saddles, or tapered insulation system.

73.2.2 Drains. Size and quantity is as required by the greater requirements of the currently adopted edition of the International Plumbing Code (IBC 2015) or this Design Criteria Manual.

Locate drains a minimum of 36 inches from equipment and perimeters to allow proper sump and flashing details.

airport contact. In addition, any new or reconfigured roof drains from terminal, hangar and air cargo building roofs shall not be allowed to drain on the ramp.

73.3.4 Roof Mounted Equipment. Accurately locate, size, and measure existing flashing height above roof surface as defined above.

As designated by the AOR, all obsolete equipment shall be removed, and penetrations through the deck shall be properly framed, infilled and sealed.

Penetrations less than or equal to 6 inches in least dimension shall be covered with 10-gauge galvanized sheet metal extending 6 inches beyond the opening in each direction. Fasten metal sheet over penetration to deck with approved fasteners 6 inches on center, minimum two per side.

Penetrations larger than 6 inches in both directions shall be capped with a prefabricated metal curb, the opening covered by an approved deck material, the curb opening infilled the insulation in the required thickness to achieve a thermal resistance of R-25 and the curb and curb opening flashing with a minimum 60 mil High Temperature Modified Bitumen membrane, and covered with 24-gauge galvanized metal cap, sloped to drain ¼ inch per foot.

All equipment with flashing height of less than 8 inches above the new roof surface shall be raised to a flashing height of 8 inches minimum.

Limit shutdown of roof mounted equipment to hours specified by AOR.

Metal counter flashing covering the top flashing edge by 4 inches minimum must protect all curb-mounted equipment flashing.

Walkway pads shall be placed at around all roof access hatches, roof-mounted equipment requiring periodic service and at all areas subject to frequent wear.

Antennas mounted on the roof shall be mounted to bases (non-penetrating where practical) designed for this purpose or to roofing system penetration support post(s) securely anchored to the building's structure below and properly flashing to the roofing system.

Antennas attached to piping or other equipment shall be removed.

073.3.5 Roof Penetrations. All pipe and conduit penetrations shall be securely anchored to the structure below the roofing system. All single pipe and conduit penetrations shall be flashed to the roofing system with roofing system manufacturer approved penetration materials and details. All multi-pipe and conduit penetrations shall be through covered metal pipe enclosures similar to SMACNA Figure 4-15A.

For membrane roofing systems: roofing manufacturer's prefabricated multi-pipe penetration flashings of the proper size and configuration for the specific condition may be used. Manufacturer approved fluid applied penetration flashing may be used only with approval of the AOR. Metal penetration dams (pitch/sealant pans) will be permitted only with the approval of the AOR and must have minimum 24-gauge galvanized metal umbrella counter flashing covers.

Lightning protection down leads shall be flashed with polyvinyl chloride (PVC) pipe enclosures and capped with PVC domed caps.

DIVISION 08

Openings

made by the Board's Energy Transportation and Asset Management Department.

SECTION 081 ENTRANCES, STOREFRONTS AND CURTAIN WALLS

81.1 Entrances

Automatic sliding doors at two-way traffic areas where the public is carrying baggage or boxes shall be used. Automatic swinging doors are acceptable in one-way traffic areas.

81.1.1 Turnstiles. Turnstiles should not be used except where required for security purposes.

81.1.2 Vestibules. Entries and openings into the building should be sealed by the use of vestibules or other means to be reviewed by the Airport Contact.

81.1.3 Curtains. Openings for baggage carriers, service openings, etc., shall be provided with curtains to prevent loss of conditioned air. A double row is suggested, with a minimum 5-foot separation.

SECTION 082 HARDWARE

82.1 Door Hardware

Door locks for all DFW Airport-owned buildings shall have standard core (refer to Appendix B for specific manufacturer). Coordinate hardware schedule with Energy Transportation & Asset Management.

82.2 Lock Sets

Locksets to be installed on doors in permanent buildings or semi-permanent portable buildings, to include Department of Public Safety (DPS) Security Guard Houses, must be capable of accepting a seven pin inter-changeable core. Temporary construction cores (refer to Appendix B for specific manufacturer) will be utilized until the project is complete and is accepted by the Board. Final lock cores will be specific Manufacturer listed in Appendix B. Installation of the final core will be

DIVISION 09

Finishes

SECTION 091 BUILDING FINISHES

91.1 General

Guidelines for building finishes are also specified elsewhere. Refer to Division 1 for other references containing additional design criteria.

91.1.1 No custom finishes shall be used to ensure future availability of materials/colors unless approved by Airport Contact.

91.1.2 Use materials that allow for future replacement orders to be of manageable quantity.

91.2 Paint

No flat sheens of paint are allowed. Corner guards shall be installed for any painted surfaces in high traffic areas.

91.3 Cove Base

Where cove base is used, a dark color shall be used unless approved by Airport Contact.

91.4 Terrazzo

Where terrazzo is installed, the terrazzo shall be polished to a 3000 grit and shall not be wax-coated.

91.5 Carpet

Where carpet is installed, carpet tile shall be used instead of rolled carpeting so that areas can be replaced as necessary. Prefer dark/patterned/ textured carpet that will more effectively hide stains.

91.6 Tile

Where tile is installed, prefer that dark colored grout be used.

91.7 Wall Covering

Where a wall covering is installed, use solid surface as opposed to laminates unless approved by Airport Contact.

91.8 Door Finishes

Doors in high traffic areas shall have a stainless steel kick plate and shall be powder coated, not painted.

91.9 Protective Covering

Halls in high traffic areas shall have protective covering installed from the floor to wainscot height.

DIVISION 10

Specialties

SECTION 101 PUBLIC RESTROOMS IN TERMINALS

101.1 Location

Restroom facilities should be evenly and conveniently distributed throughout the concourse areas. A maximum walking distance of 150 feet to a restroom should be used as a guideline; therefore, restrooms should be spaced approximately 300 feet apart.

101.1.1 Each location should include men, women, and unisex (family) toilet rooms. These three rooms should always be grouped together; the entries should be adjacent to each other so that they are visible to the passengers. The unisex toilet room should be signed with the men's, women's, accessibility symbols and labeled "toilet."

101.1.2 Comply with accessibility standards in the adopted IBC and the Texas Accessibility Standards.

101.2 Entry

Entries should be designed to prevent line-of-sight from the public areas. Entries to the men's and women's rooms should not have doors, but switch-back or "T" access halls that are wide enough for two people to pass. The "T" access is preferred for rooms with larger number of fixtures because of the improved circulation. Switch-back is acceptable for rooms with smaller number of fixtures. The materials used on the walls of the switch-back shall be capable of being cleaned; carpeting is not an acceptable material.

101.3 Circulation

Circulation in rooms with larger number of fixtures should be arranged in a loop to avoid dead-end conditions.

101.4 Fixtures

The fixture counts within each room should be calculated based on the function and occupancy of the area/function the restroom

supports in accordance with the International Plumbing Code and the IBC, as adopted with amendments by DFW.

101.4.1 The unisex toilet room will always contain one lavatory counter, one toilet, a diaper changing station, and a bench/shelf for nursing mothers or an attendant to wait (this will also satisfy the baggage shelf requirement).

101.4.2 All new restrooms shall have fully accessible plumbing chases when using back-to-back fixture assemblies. Wall sill/floor plates shall have minimum 36 inches, measured between the interior plates. Access door to chase shall be metal framed with opening dimensions of 2 feet width by 6 feet 8 inch height minimum.

101.4.3 Toilets and urinals shall have automatic flush with manual flush button.

101.4.4 Lavatory faucets shall be automatic with pre-set warm water. Hot water temperature shall not exceed 110 degrees Fahrenheit or in accordance with adopted IECC.

101.4.5 Sinks shall be monolithic units with fixtures spaced at 42 inches on center to allow adequate counter surface. The countertops shall be designed in such a way to minimize the ponding of water on the countertops.

101.4.6 Toilets shall have elongated bowl and non-contouring seat. The supports for the toilets shall be of sufficient strength to keep the fixture from rocking.

101.4.7 For urinals, provide extended bowl wall-mounted units.

101.4.8 Locate electric water coolers in conjunction with restrooms.

101.5 Accessories

Countertops shall be solid surface material to match backsplash on all walls.

101.5.1 Backsplash shall be a minimum of 4 inches high.

101.5.2 When possible, air type hand dryers in lieu of paper towels should be used. Locate center pull paper towel dispensers on the mirror wall above the trash holes with clear visibility. Provide an additional sidewall unit if this location is not Americans with Disabilities Act (ADA) compliance. Refer to Appendix B for specific manufacturer.

101.5.3 Provide stainless steel accessories: coreless roll toilet tissue and feminine product receptacles.

101.5.4 A 6-inch diameter trash hole should be located in the countertop between the sinks, with a trash receptacle located in a lockable under-counter cabinet.

101.5.5 A semi-recessed wall trash receptacle shall be located at the exits.

101.5.6 Provide large wall mirrors in front of lavatories. Provide a full-height dressing mirror out of the main circulation path.

101.5.7 Provide hooks adjacent to lavatory for hanging bags, purses, and briefcases. Provide a 12-inch-deep purse shelf at back of counter and/or on sidewalls.

101.5.8 Provide easily operated access panels to conceal pipes and water shut off valves under each sink.

101.5.9 Provide foam soap pump push style dispenser. Each refill bottle shall come with a sanitary-sealed refill and new pump. The dispenser shall be mounted such that the spout drips into the sink.

101.5.10 Provide one ground fault interruption (GFI) duplex receptacle at the least trafficked end of the counter.

101.6 Toilet Partitions

Partitions should be stainless steel or solid surface material. Partitions should be ceiling hung with extension to the floor every third compartment and at the end corner to stabilize the panels. There shall be sufficient framing support above the ceiling to ensure that the partitions do not shift. The partitions shall be supported to withstand the weight of carry-on luggage being hung on the doors.

Partition shall be 12 inches above floor and extend up to 78 inches for privacy. Latches should be easy sliding bars (ADA compliance). Stainless steel grab bars shall be installed within accessible stalls.

101.6.1 Cubicle shall have minimum clear dimensions of 38 inches wide and 66 inches deep, to provide enough room in front of the toilet to maneuver the door and carry-on.

101.6.2 Purse/coat hook on partition side panel behind door shall be 60 inches above floor level. The hook shall be heavy duty to be capable of supporting carry-on luggage. The hook shall be mounted closer to the hinge side of the door to reduce the torque on the door.

101.6.3 Provide a 12-inch deep baggage wall shelf behind toilets and urinal bank. The wall behind the shelf shall be tile (hard surface).

101.6.4 Provide privacy partitions between each urinal.

101.7 Flooring Materials

Flooring shall be porcelain tile rated for heavy duty use. Reference the Floor Management Program guide for flooring material/ installation recommendations. Any semi-porous material such as terrazzo shall not be used in restrooms. Tiles should be large; 18 inches by 18 inches minimum to reduce grout lines. Accent tiles may be smaller.

Joints should be tight; (1/8 inch) maximum. Grout shall be a dark color.

Square edge tile shall be used to minimize joint expression. Rustic or heavy cushioned edges shall not be used.

Tile shall be type with multiple colors, veining, mottling, or specks. Solids should not be used. Very light or dark tones should not be used. Tile with textured glossy finish should be used in lieu of flat matte finish. Colors of tile and floor pattern should be carefully selected to reduce spotting and support a clean appearance.

101.7.1 Grout shall be an epoxy grout that shall be sealed.

101.7.2 Base should be a minimum height of 6 inches and shall be the same material and color as floor.

101.7.3 Provide a floor drain(s) for maintenance of spills in the toilet areas. Floor drains are to be located equidistant from wall to wall. Slope interior floors to floor drain at 0.5 percent grade.

101.8 Other Materials

Walls shall be non-porous materials (ceramic tile, solid surface, hard stone, etc.) from floor to 84 inches minimum. Above 84 inches, paint is acceptable.

Color, patterns, and finish of wall tile should maximize a clean-looking, well-lighted appearance. Use glossy/polished wall tile that appear cleaner than matt finish.

All restrooms shall be finished with the same materials, colors, and patterns. If a distinction between men and women is provided, it should be in the transition area.

101.8.1 The entries from the terminal should reinforce “way finding” by expressing a “restroom” cue. Materials should be coordinated with the terminal finishes and shall not be the same as the restroom materials.

Inside the “T” access corridor shall be a transition area between the terminal and the toilet room. These transition walls shall be durable, cleanable materials that can tolerate rolling bags and provide acoustical treatment.

In this transition area at eye level, the finishes should reinforce the overhead signage package to confirm a passenger is headed into the correct room.

101.8.2 Ceilings must be accessible gypsum board type with appropriate regular edge, 2 by 2 acoustical lay-in features.

101.8.3 A “trim” or molding feature above 84 inches, such as crown molding or wall molding element, is preferred.

101.9 Lighting

Rooms should be well lighted, especially at the lavatories. Refer to Illuminating Engineering Society of North America (IESNA) Lighting Handbook (most recent edition) and ANSI Standard 90.1 (most recent edition) for recommended lighting levels and allowable lighting power density. Provide interior lighting with switch at door entrance; spacing of lighting fixtures at 6-foot intervals. Provide 120- Volt electrical service outlet (GFI) adjacent to light switch for servicing of equipment.

101.9.1 Provide a wall sconce fixture on lavatory mirror wall for lighting of faces. Provide warm white lamp.

101.9.2 Use light-emitting diode (LED) lamps in concealed lighting coves, down lights and accent fixtures. The light level should be even throughout the room to reinforce the clean/airy appearance.

101.9.3 Emergency lighting shall be provided.

101.10 Other Amenities

Provide amenities in accordance with the specification section of the Design Criteria Manual.

101.10.1 Provide a built-in stainless steel diaper changing station, 42 inches long by 24 inches deep in every men, women, and family room. Install in a remote, recessed but visible location. Provide a trash receptacle with lid and a paper towel dispenser at this location. Provide a raised lip (approximately 2 inches high) at the open edge as a stop.

101.10.2 Provide potable water spigot, using ball valve with service hose attachment. Locate between 12 to 24 inches above finished floor (AFF). Locate cleanout for battery of fixtures at door entrance and slope drain piping to clean this out.

101.10.3 Provide music system speakers in the restrooms.

101.10.4 Toilet room exhaust and ventilation shall meet or exceed International Mechanical Code.

101.10.5 Provide fragrance dispensers.

SECTION 102 EXTERIOR SPECIALTIES

102.1 Flagpoles

Flagpoles shall be cone tapered aluminum, with all standard fittings. Flagpoles shall be adequately supported and provided with lightning protection.

102.2 Trash Handling

Space shall be provided for trash handling devices and containers depending on the size, location, and type of trash that is to be disposed of. Design plans shall indicate the proposed method(s) for trash disposal. All equipment used for handling, storage, or compaction of trash that may be in the public view, shall be screened. Equipment shall be finished in a color to match other painted building equipment.

Dumpster-type containers shall be oriented for ease of approach by truck.

All trash containers shall be covered or otherwise enclosed to prevent access by wildlife and high winds.

No open topped trash containers are permitted within the Air Operations Area, unless thoroughly protected from jet blast and high winds.

DIVISION 14

Conveying Equipment

SECTION 141 BAGGAGE HANDLING SYSTEM

141.1 General

The BHS system should have a recirculation point to reintroduce bags to the system in the event of a failure.

141.1.1 BHS ladders should be safety ladders with self-closing gates.

141.1.2 Baggage control rooms shall have independent and or redundant cooling systems.

141.2 Clearances

141.2.1 A minimum clearance of 6 feet above the catwalk is required.

141.2.2 A minimum clearance of 8 feet from ramp to any obstructions above is required.

141.2.3 Ensure that no pipes containing any type of liquid other than life safety systems are installed above the control room or motor control panels.

141.2.4 BHS system elements should have sufficient maintenance clearance.

141.2.5 Install belly/catch pans underneath conveyors above common work areas to minimize risk to workers.

141.3 Size of conveyors

Size of standard beds should be a minimum width of 39 inches.

Size of oversized beds should be a minimum width of 46 inches.

Minimize the use of 90 degree turns.

DIVISION 21

Fire Suppression

SECTION 211 GENERAL INFORMATION

211.1 General

This Division defines general criteria that apply to the design of fire protection systems and fire detection systems at DFW. Division 1 should be consulted for specific Airport regulations and standards that also apply.

All designs shall conform to the adopted Fire Code, National Standards, and Local Amendments.

211.2 Design Requirements

The fire sprinkler system in airport passenger terminals and Board occupied, operated and maintained buildings shall be designed for a minimum ordinary hazard type occupancy. All equipment and materials shall be Underwriters' Laboratories (UL) or Factory Mutual (FM) approved and listed, and shall bear the appropriate stamp or label.

211.2.1 Sprinkler systems shall be designed and built to facilitate the capture of fire sprinkler water and drained into the facility's sanitary sewer system as permitted by the DFW Environmental Affairs Department (EAD). All fire sprinkler water not plumbed to a sanitary drain shall be tested, collected and disposed of properly per DFW Environmental requirements.

211.2.2 All sprinkler systems shall be constructed to allow for water quality sampling. Except for an activated discharge, the system should have a means to drain directly to sanitary sewer. The rate of discharge must be compatible with capacities at the point of entry into the sewer system. Sprinkler systems must be constructed as to facilitate the collection of the entire volume of water generated during testing, expansion, modification, or repair. Discharge to anything other than sanitary sewer is not allowed.

211.2.3 Implement MIC monitoring program according to current National Fire Protection

Association (NFPA) 13, Installation of Sprinkler Systems.

211.2.4 All sprinkler pipes that penetrate masonry or concrete walls or floors shall be sleeved with steel pipe.

211.2.5 The inspector test valves shall terminate to the exterior of the building. Discharge shall not be near any pits.

211.2.6 Provide a bypass around the check valve in the fire department connection line with a control valve in the normally closed position. The bypass is required for the performance of a full flow test of the system demand through the back flow preventer. Exception: If the main drain can achieve the flow demand of the system, no bypass is required.

SECTION 212 WATER-BASED FIRE SUPPRESSION SYSTEMS

212.1 Facility Fire Department Connections
All Fire Department Connections (FDC) shall be equipped with a 5-inch quick connect fitting with a 30 degree down angle. Refer to Appendix B for specific manufacturer.

212.2 Fire Suppression Sprinkler Freeze Protection
UL Listed Sprinkler Head Trace is permitted.

212.3 Dry-Pipe Sprinkler System
Dry pipe systems shall meet one of the following options:

Option 1: Dry sprinkler systems shall consist of Schedule 10 galvanized for 3-inch pipe and larger, Schedule 40 for 2.5-inch pipe and smaller, and the sprinkler system attached to a nitrogen generator.

Option 2: Dry sprinkler systems not connected to a nitrogen generator shall consist of Schedule 40 piping.

Each dry-pipe system shall have its own air pressure supervisory switch to monitor and report both high and low air pressure conditions. The switch shall be located between the air supply check valve and sprinkler alarm valve.

A manual shut-off valve shall be provided between the hi/low switch and the main air supply line leading to the compressor. The air compressor shall be hardwired directly to a lockable disconnect box or to a dedicated branch circuit.

212.3.1 Sprinkler pipes shall be thoroughly flushed each time the system is expanded or modified.

212.3.2 All concealed low point drains shall be visually identified and provided with a sign to identify system.

212.3.3 Dry pipe sprinkler systems with air compressors shall be connected to the existing piping system via stainless steel mesh connectors and installed with no bends. All air compressors shall be installed on spring vibration isolation pads.

212.4 "D" Stand Pipe Systems
Terminal Buildings shall have a looped standpipe system that allows for fire department support from any FDC.

212.5 Preaction Sprinkler System
System piping may be supervised with air or nitrogen. Piping shall be galvanized. Pre-action valve assemblies shall not to be installed in public areas or ceiling plenums. All pre-action system drains shall terminate to a suitable drain that can accommodate removal of system water.

SECTION 213 SPECIAL CONSIDERATIONS

213.1 Floor Penetrations for Conveyors
Where conveyors penetrate rated assemblies or floors, provide closely spaced sprinklers in combination with draft stops as follows:

213.1.1 Draft Stop. The draft stops shall be located immediately adjacent to the opening, shall be at least 18 inches deep, and shall be of noncombustible material that will stay in place before and during sprinkler operation. Sprinklers shall be spaced approximately 6 feet apart and placed 6 to 12 inches from the draft stop on the side away from the opening. An area smoke detector shall be placed in the ceiling above the floor opening and wired to the fire alarm system.

213.1.2 Shutters. Conveyor openings may be provided with fire/smoke shutters that can be manually closed or automatically closed by smoke detectors installed in accordance with NFPA 72 in lieu of method described above. The preferred method is to use a fire rated "dog house" consisting of sheetrock walls and roof with combination fire/security door that drops through the conveyor. This provides security between ramp and concourse levels, and reduces outside air infiltration into the concourse.

213.1.3 Baggage Conveyor Systems in Terminal Buildings. Baggage conveyor belts shall be protected with sprinklers spaced no closer than 6 feet and no farther than 8 feet on centers in above ceiling areas. Sprinkler heads shall clear baggage and other items. Sprinkler head guards shall be installed.

213.2 Safe-Type Box and Lock System
A "safe" type box shall be provided for all facilities and buildings, and located as directed by the Fire Marshal. Refer to Appendix B for manufacturer.

213.2.1 A "safe" type lock shall be provided for all facility and building fire department standpipes and FDC.

DIVISION 22 Plumbing

SECTION 221 GENERAL

221.1 Energy Conservation

The Plumbing System Designer shall consider using such techniques as controlling hot water temperatures and water pressures, and providing faucets with flow restrictors. To provide maximum energy efficiency, the system should consider the following measures: economic use of thermal insulation, automatic shutdown of water heating and circulating systems, use of waste heat from air conditioning systems, use of off-peak power, occupancy sensor for automatic flushing, use of automatic closing faucets, and use of minimum energy consuming equipment. The Plumbing Engineer shall employ sustainable strategies that in aggregate use less water than the water use baseline calculated for a building.

SECTION 222 COMMON WORK RESULTS FOR PLUMBING

222.1 Hangers and Supports for Plumbing Piping and Equipment

All pipes must be adequately supported throughout and shall withstand the effect of gravity loads and stresses. Generally, hangers shall be split ring or clevis type. However, trapeze hangers constructed of steel channels with welded spacers and steel rods may be used. An engineered system may use pre-engineered hangers and supports. All hangers and supports shall comply with Manufacturer's Standardization Society (MSS) standards. Vertical pipes must be supported at each floor with pipe clamps.

Provide pipe saddles fabricated from galvanized metal (for insulated pipe) extending at least 12 inches in length and covering a minimum of half-pipe circumference.

Generally, the gauge shall be as follows:

Avenir LT Std 35 Light	Avenir LT Std 35 Light
Up to 3 inches	No. 22
3"-6"	No. 16
>6"	No. 12

222.2 Vibration and Seismic Controls for Plumbing Piping and Equipment

222.2.1 Vibration Isolation

To prevent excessive noise or transmission of vibration to the building structure due to the operation of machinery or equipment, or due to interconnected piping, ductwork, or conduit, proper vibration isolation shall be provided.

Static deflection of vibration isolators generally shall conform to minimum design criteria recommended in the latest American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Guide and Data Book for the actual floor spans involved.

A single vibration isolation manufacturer shall supply vibration isolation equipment for any one project.

The vibration isolation manufacturer and his representative shall have been engaged in the business of vibration isolation for no less than 5 years.

The design shall include lateral bracing with pipe hangers and supports to prevent swaying.

222.2.2 Shock Absorbers

Provide 18-inch air chamber at each hot and cold water outlet adjacent to fixture outlet. Diameter of chamber shall be a minimum of 1½ times that of the service line to the fixture device.

Chamber and cap shall be of the same material as supply piping.

Hydraulic shock absorbers may be used in accordance with Water Hammer Arresters Standard, PDI-WH-201, latest revision.

222.3 Identification for Plumbing Piping and Equipment

All piping in buildings shall be identified by the use of pipe marker bands with direction of flow arrows at (10-foot intervals in concealed spaces; 20-foot intervals in exposed areas and on each side of any penetrated wall, ceiling, or floor. Pipe marker color coding shall follow industry practice ANSI/ American Society of Mechanical Engineers (ASME) A13.1 "Scheme for Identification of Piping Systems."

SECTION 223 PLUMBING INSULATION

223.1 Minimum Thickness

Follow DFW Energy Code for pipe insulation requirements.

223.2 Insulating Unions and Adapters

Provide dielectric insulating unions or adapters as required between copper and steel pipe, and equipment. Dielectric insulators/adapters shall contain nylon insulation.

223.3 Pipe Sleeves

Provide pipe sleeves for all pipes passing through masonry and concrete construction. The annular space between pipes and sleeves must be permanently sealed and sleeves below grade must be watertight.

Pipe joints should not be made closer than 12 inches to a wall, ceiling, or floor penetration, unless such pipe is welded.

223.4 Heat Tracing

Plumbing Piping Insulation shall not contain asbestos, lead mercury or mercury compounds and must conform to ASTM standards.

Heat tracing for freeze protection and grease waste temperature maintenance shall use electric heating cables that are self-regulating and parallel resistance.

SECTION 224 PLUMBING PIPING

224.1 Domestic Cold Water

Domestic cold water (inside) – Type K or L copper with silver solder (95-5); no lead. Copper systems using mechanical joining, such as "ProPress" by Rigid/Viega may be used in lieu of "silver solder joining method. Chlorinated polyvinyl chloride (CPVC) may also be used to meet return air plenum restrictions. Domestic cold water (outside) – ductile iron mechanical joint Class 150 fittings and American Water Works Association (AWWA) C900, DR18 PVC piping.

224.2 Domestic Hot Water

Domestic hot water (inside and outside above ground) – Type K or L copper with silver solder (95-5); no lead.

SECTION 225 PLUMBING SPECIALTIES

225.1 Backflow Preventers

Provide double check backflow preventer when domestic service is connected to service water main. A backflow preventer shall be installed on any domestic water line serving other closed or chemically treated systems that could foreseeably contaminate the potable water line. All backflow preventers shall be installed in a readily accessible location, not more than 4 feet above the floor.

225.2 Domestic Water Pumps

Pumps shall be close-coupled, horizontally mounted, in-line centrifugal domestic water pumps.

Pumps shall be all bronze or stainless steel for domestic water service. Provide a line size ball valve on suction and discharge side of pump. Provide unions or bolted flange connection on each side of pump. Pressure taps and thermometer wells are not required on in-line circulators. Sleeve type bearings are acceptable for in-line pumps.

The plumbing system designer shall study water usage periods and shall operate pumps

just prior to usage periods and limit operation of pumps as much as possible. A 7-day, 12-hour timer should be installed to control such pump operation, especially during peak demand periods as an energy reduction measure.

SECTION 226 FACILITY DRAINAGE

226.1 Sanitary Drains

Sanitary sewer (inside) – non-service weight cast iron above grade, cast iron service weight underground and within a building, which also including cathodic protection, Schedule 40 PVC below grade.

Sanitary sewer (outside) – Schedule 40 PVC.

226.2 Grease Removal Devices

Waste water from disposers, sinks, dishwashers, floor drains, mop sinks, and floor sinks in food service facilities shall drain to a grease collection system or through a grease trap or grease interceptor serving one or more facilities. Installation shall comply with the Plumbing Code. The grease waste piping shall have electrical heat trace of sufficient capacity to prevent the coagulation of grease in the piping prior to entering the trap. All grease waste piping shall be insulated; additionally, exposed piping shall have an outer metal jacket.

226.3 Submersible Sewerage Pumps

Sewer ejector pump design and selection design criteria are the same as those listed for "Sump Pumps" except sewer ejector pumps shall be of the standard 3-inch, non-clog type specifically designed and installed for their purpose intended.

226.4 Roof Drains

Roof drains shall be compatible with roof system. The Designer shall use 6 inches per hour as a minimum rainfall intensity guideline for sizing roof drains.

226.5 Floor Drains

All toilet rooms shall be equipped with at least one floor drain, or the minimum number as

required by code. Trap guards are acceptable trap primers. All floor drains must be readily accessible.

226.6 Wet Pit Mounted, Vertical Sump Pumps

Generally, duplex sump pumps are required when located in a mechanical/electrical equipment room containing high voltage switchgear or motor control panels. A simplex pump may be used if an area does not contain critical equipment.

Provide a mechanical alternator on duplex pumps and provide a separate circuit and circuit breaker for each pump. Provide check valves, and bypass pipe work and valves as required (in-line check valves are not recommended). Pumps shall be complete with automatic float switch with rod, rod guide, and copper float.

Pumps shall be of the wet-pit type complete with gas tight sump cover, curb ring, and grease lubricated, including alemite fittings extended to the pump base plate.

Pumps shall be heavy-duty, explosion-proof if underground wet pit type, vertical centrifugal, open non-corrosive impeller type with vertical drip-proof type motor with anti-friction grease lubricated bearings.

Where sump pumps are installed to provide protection for mechanical/electrical equipment, a high water alarm bell shall be provided in the area and alarm contacts shall be provided for a central monitoring system.

226.7 Submersible Sump Pumps

Generally, submersible pumps are avoided where possible except electric power manholes where high voltage switches or tap boxes are installed. Diaphragm actuated pumps are preferred rather than float actuated pumps.

226.8 Discharge of Sump Pumps

Discharge of sump pumps to the storm sewer system is prohibited without written approval from Environmental Affairs.

SECTION 227 GENERAL SERVICE PACKAGED AIR SYSTEMS

227.1 General Service Packaged Air Compressors and Receivers

House service should not be taken from the instrument or control air distribution line or instrument or control air receiver unless specifically approved, except for doors and dry system fire sprinklers in Terminal buildings.

Provide an ASME pressure rated receiver and pressure relief assembly for the working pressure involved. Provide a non-cycling refrigerated air dryer when required. Provide an automatic drain on receiver with drain line piped to floor drain or hub drain. Air compressor assembly shall be provided with adequate vibration isolation. Adequate sound isolation shall also be provided. Generally, a horizontal tank-mounted type unit, with motor and compressor arranged for V-belt drive and mounted on a common steel base supported for the receiver is preferred.

Compressors that are equipped with cylinder unloading devices that will unload compressor on stopping and prevent cylinders from loading or starting until the rated motor speed is attained are preferred.

SECTION 228 PLUMBING EQUIPMENT

228.1 Electric Domestic Water Heaters

- Water heaters shall be glass lined, storage type.
- Electric water heaters shall be UL listed and FM approved when possible.
- All standard water heaters shall have a 10-year limited warranty.

- All energy saver water heaters shall meet ASHRAE Standards for Energy Efficiencies, latest edition.
- Water heater drains shall have valves and shall be plumbed to a floor drain with copper piping.
- All water heaters shall be readily accessible.
- Electric water heaters located in ceiling/attic spaces shall be accessible through an access door or by removing ceiling tile. No ACM shall be used.
- Expansion tank required.

228.2 Commercial Gas Domestic Water Heaters

Water heaters shall adhere to the following requirements:

- Water heaters shall be glass-lined, storage type.
- Gas water heaters shall have automatic gas shut-off device and be equipped with an American Gas Association certified draft hood. Water heaters shall utilize electric ignition devices.
- All standard water heaters shall have a 10-year limited warranty.
- All energy saver water heaters shall meet ASHRAE Standards for Energy Efficiencies, latest edition.
- Water heater drains shall have valves and shall be plumbed to a floor drain with copper piping.
- All water heaters shall be readily accessible by access panel or removable ceiling tile.
- Expansion tank required.

228.3 Domestic Water Heat Exchangers Shall adhere to the following requirements:

- Water heaters shall be completely copper lined.
- Heads shall be cast bronze, coiled tubes shall be copper, and all other internal parts shall be copper and bronze. Heat exchanger tubes shall be double-wall type.
- The tank shall be ASME stamped at or above the scheduled working pressure.

- Factory furnished and approved accessories, including ASME temperature and pressure relief valve, shall be used.

SECTION 229 PLUMBING FIXTURES

229.1 General Information

In general, the plumbing designer shall use high-efficiency fixtures and valves, such as automatic sensors, aerators on lavatories, and WaterSense™-certified fixtures. Fixture fittings should be used where available.

All exposed metal work at fixtures shall be brass with chromium plate. All faucets, fittings, supply stops for fixtures, and similar devices shall be from one manufacturer unless otherwise required. Each fixture shall contain standardized interchangeable operating units made up of separate renewable stem, seat, washer retainer, and nut. All faucets and fittings must close with the water pressure. All fixtures shall be installed with supply stops/valves accessible at the fixtures.

All fixtures and accessories listed apply to Board owned, operated, or maintained buildings. Some fixture and accessory preferences may change over time depending upon current maintenance warehouse stocking. Tenants may have different preferences and shall be consulted.

On renovation projects, an effort shall be made to match existing fixtures and trim. On renovation projects where fixtures and trim cannot be matched and on new projects, fixtures shall be water conserving American Standard or an approved equal.

229.2 Commercial Water Closets

Wall-hung water closets are preferred. Water closets shall be white, vitreous china, siphon jet, elongated bowl, with white open-front seat without cover.

Flush valves for water closets in Terminal buildings shall be as follows:

- For specified flush valve system, see Appendix B.
- Toilet shall have concealed rough brass hydraulically operated flush valve, 1-inch wheel handle back-check stops, adjustable tailpiece, solenoid motor operator, sensor, vacuum breaker, elbow flush connection and spud coupling for 1.5-inch concealed back spud.
- Automatic sensor for operation of each water closet, with required transformers, controls, and complete wiring diagrams for separate operation in each toilet, all as recommended and approved by flush valve manufacturers, are required.
- Flush valves as described above are approved, or an approved equal may be used.
- For specified flush valves, see Appendix B.

229.3 Commercial Urinals

Wall-hung urinals are preferred. Urinals shall be white, vitreous china, wash-out type.

Flush valves for urinals in Terminal buildings shall be as follows:

- For specified flush valve system, see Appendix B.
- Urinal shall have concealed rough brass hydraulically operated flush valve, ¾ inch wheel handle back-check stops, adjustable tailpiece, solenoid motor operator, sensor, vacuum breaker, elbow flush connection and coupling for ¾ inch concealed back spud, wall and spud flanges for each urinal.
 - Automatic sensor for operation of each urinal with required transformers, controls and complete wiring diagrams for separate operation in each toilet, all as recommended and approved by flush valve manufacturers, are required.
 - Flush valves as described above are approved, or an approved equal may be used.
 - For specified flush valves, see Appendix B.
 - Meet accessibility requirements.

- Make provisions for dispersion of chemical treatment for public banks of urinals.

229.4 Commercial Lavatories

Commercial Lavatories in Terminal buildings shall be as follows:

- For specified faucets, see Appendix B.
- Lavatories wall be wall-hung white enameled cast iron or white enameled cast iron self-rimming lavatories with 20-inch by 18-inch rectangular basin with splash back are preferred. For specified manufacturer, see Appendix B.

229.5 Mop Basins

Mop basins shall be one-piece mop service basin, size 24 square inches by 12 inches high outside, with Type 304 stainless steel, 20-gauge cap, continuous on all sides.

Basins shall have wall flashing on back and sides as required. Provide silicone base for full seal at floor. Grout entire installation level.

Service faucet shall be chrome plated with vacuum breaker, integral stops, adjustable wall brace, pail hook, and 0.75inch hose thread on spout, 8-inch spread. Hose and hose bracket shall be 30 inches long flexible, heavy-duty 0.75-inch rubber hose, cloth reinforced, with 0.75-inch chrome coupling at one end. Five- inch long bracket by 3-inch wide, with rubber grip. See Appendix B for specified manufacturer.

Mop hanger shall be 24 inches long by 3 inches wide, 18 gauge No. 302 stainless steel attached with flat head, slotted machine screws.

229.6 Service Sinks

Service sinks shall be white enameled cast iron, 20 inches by 22 inches, blank back with wall hanger supports. See Appendix B for specified manufacturer.

Trap shall be adjustable standard for 3-inch pipe connection with cleanout plug and strainer, enameled inside.

Rim guard shall be 9 inches and 12 inches stainless steel rim guard, front and sides.

229.7 Electric Water Coolers (EWC)

Wall hung water coolers are preferred. Electric water coolers shall meet accessibility requirements. Some Terminal buildings have a central water cooling system. The Designer shall investigate the possibility of connecting to this system where it is available.

DIVISION 23

Heating, Ventilating, Air-Conditioning

SECTION 231 GENERAL INFORMATION

231.1 Scope

This Division defines general design criteria that apply to the design of heating, ventilation, air conditioning (HVAC) at DFW, as well as those HVAC systems to be served by the Energy Plaza (EP). Division 1 should be consulted for specific Airport regulations and standards that also apply.

It shall be the Designer's responsibility to verify locations or the adequacy of record information prior to design and construction of HVAC systems. The Designer shall coordinate the development of the design at all stages with DFW / Energy and Transportation Department.

All areas used primarily to accommodate people-oriented activities such as offices, concessions, concourses, cafeterias, etc., shall be air conditioned and heated. Areas classified as storage or manufacturing shall be mechanically ventilated and heated to minimum requirements of the Building Code. The criteria for a particular HVAC system will vary somewhat from building type to building type, or project to project, which may change certain parameters of initial design considerations.

231.2 Restrictions

No U.S. Environmental Protection Agency (EPA) Class I or Class II refrigerants may be used in any HVAC equipment.

A table of substitute refrigerants is available from the Environmental Protection Agency (EPA) at <http://www.epa.gov/ozone/snap> or may contact the Environmental Affairs Department for more information.

Renovation of HVAC systems still using a Class I or Class II refrigerant shall incorporate into

design and specifications the replacement of the refrigerant with a suitable substitute.

231.3 System Types

231.3.1 Terminal Buildings

System design for new Terminal facilities should conform to the basic design parameters and equipment and material criteria described herein. Heat pumps, roof top units, and plenum-mounted condensing units are not desired and require approval from DFW's Energy Transportation & Asset Management Department.

231.3.2 Buildings Other Than Terminals

Building use and DFW/stakeholder recommendations shall be used as guides in selecting the type of HVAC system for buildings other than terminals or not served by the EP. In many instances, rooftop direct expansion packaged systems are satisfactory. When packaged systems are used, the control system supplied by the manufacturer is acceptable. Thermostatic zoning must not be compromised when using packaged equipment. Split systems are preferred to roof top units.

All curb-mounted units shall be furnished with appropriate enclosed engineered curbs to provide for level unit mounting with minimum 16-inch curb height above top of the roof deck surface.

The following criteria shall apply where applicable:

- Chilled water systems are required for 50 tons and above.
- Air cooled chilled water systems can be used to 100-ton unit capacities.
- Water cooled chilled water systems are required above 00- ton unit capacities.

If available, natural gas is preferred as a source of heating. Otherwise, heat pumps shall be used.

**SECTION 232
COMMON WORK RESULTS FOR HVAC**

232.1 Expansion Fittings and Loops for HVAC Piping

A pipe stress analysis shall be performed to ensure the system has adequate flexibility and to determine support and equipment reaction forces and support spacing. Expansion loops and/or expansion joints shall be provided where necessary to limit pipe stress or reaction forces in accordance with the applicable ASME B31 piping code. Where possible, the use of engineered expansion loops is preferred to expansion joints.

Joints shall be piston-ring, internally guided, double-expansion joint or a packless expansion joint.

Expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors. All chilled and hot water piping joints shall be welded; therefore, special consideration must be given to pipe layout for expansion and contraction.

A pipe stress analysis shall be performed to determine proper pipe anchor locations.

232.2 Meters and Gages for HVAC Piping
British thermal unit (BTU) metering is required for all chilled and hot water applications served by the EP or the East Side Plant (ESP). Metering must provide flow, temperature, and BTU per hour values to the respective energy management system.

232.2.1 Non-Board facilities must be metered using revenue-grade metering devices.

232.3 Hangers and Supports for HVAC Piping and Equipment

A pipe stress analysis shall be performed to determine pipe hanger support system and spacing requirements. All hangers and supports shall comply with MSS standards.

Vertical pipes must be supported at each floor with pipe clamps.

Pipe saddles shall be galvanized metal (for insulated pipe) extending at least 12 inches in length and covering a minimum of half-pipe circumference. Protection shields shall be provided for all insulated pipe. Generally, the gauge shall be as follows:

Pipe Diameter (inches)	USS Gauge
Up to 3	No. 22
3 to 6	No. 16
Above 6	No.12

232.4 Vibration Controls for HVAC

To prevent excessive noise or transmission of vibration to the building structure due to the operation of machinery or equipment, or due to interconnected piping, ductwork, or conduit, engineered vibration isolation shall be provided.

Static deflection of vibration isolators shall conform to minimum guidelines recommended in the latest ASHRAE handbooks for the actual floor spans involved, and NFPA 90A. Consideration shall be given to sound transmission by following ASHRAE Guidelines in Design.

The vibration isolation system shall consist of foundation, base, spring isolators, and rubber and shear pads, as necessary to provide maximum isolation conforming to ASHRAE guidelines and standards.

232.5 Noise Control

Mechanical noise levels shall be controlled by proper design of the noise producing mechanical and electrical equipment such as fans, mixing boxes, diffusers, pumps, transformers, emergency generators, etc., so as to not exceed acceptable levels as set forth by industry standard criteria. The acceptable noise level shall be described in terms of Noise Criteria as defined by the ASHRAE Handbook, Systems Volume, (Sound and Vibration Control Chapter) latest edition).

232.6 Identification for HVAC Piping and Equipment

All piping in buildings shall be identified by the use of pipe marker bands or pipe insulation sleeving, with direction of flow arrows. Pipe marker and sleeving color coding shall follow standard industry practice ANSI/ASME A13.1 "Scheme for Identification of Piping Systems."

232.7 Testing, Adjusting and Balancing for HVAC

The balancing, testing, and adjusting of the heating, ventilating and air conditioning systems shall be performed by an independent technical firm or balancing agency not involved in the design. Balancing firm shall be Associated Air Balance Council- or National Environmental Balancing Bureau-certified. All tests shall comply with certification agencies standards and practices.

SECTION 233 HVAC INSULATION

233.1 Ductwork Insulation

Generally, all ductwork except exhaust ductwork shall be externally insulated in accordance with temperatures involved and current IECC and International Fire Code. Ductwork insulation materials shall be selected for the function involved, considering sound absorption coefficients, velocities, etc. See Appendix B for specified manufacturer.

Where external rectangular ductwork insulation is required, particular attention shall be given to joints, terminating edges, operation of air control devices, etc.

External duct wrap may be used where insulation is not exposed to abuse. Where insulation may be subject to abuse, insulation shall be 2 inches thick, 3-pound density glass fiber rigid board duct insulation complete with reinforced foil-kraft integral heavy vapor proof covering on the outside surface. Insulation shall have a minimum compressive strength of 140 psf at 10 percent deformation. Securely fasten all edges, joints, etc., to provide a vapor proof duct. Rigid insulation shall be mechanically fastened to the duct.

Generally, high velocity ductwork requiring external insulation shall be insulated with blanket wrap fiberglass insulation, 2 inches thick, 1-pound density, complete with scrim kraft jacket. Facing overlapping joints shall be at least 2 inches and held in place with outward clinching staples on approximately 4-inch centers.

Underside of ducts exceeding 24 inches in diameter shall be mechanically fastened.

This ductwork shall be UL 181, Class I, with rating to meet or exceed NFPA 90A-90B and reinforced with a perforated sheet metal inner jacket. Maximum length of flexible duct shall be 5 feet. Flexible duct shall be composed of an inner duct of woven and coated fiberglass permanently bonded to a spring steel helix with 6.0 R-value fiberglass insulation and fiberglass reinforced metalized film outer jacket.

233.2 HVAC Piping Insulation

All insulations, jackets, adhesives, coatings, vapor barrier mastics, etc., shall meet the requirements of NFPA Bulletin 90-A, ASTM E 84 and UL 723, and shall have a flame spread of 25 or less and smoke developed rating of 50 or less. For all piping systems except steam, fiberglass insulation and cellular glass insulation are required. Use of flexible cellular insulation must be approved by Airport Contact.

All piping and vessels with a surface temperature less than ambient temperature shall have a vapor barrier covering. The vapor seal shall be continuous, unbroken, and adhere to surface so that the insulation is airtight in order to minimize the possibility of vapor draining into the insulation material.

Form fitted polyurethane insulation shall be used on all coil header piping to the extent necessary to include all valves, including flow control valves, and other appurtenances utilized to evaluate the performance of the coil.

233.2.1 Chilled Water Piping. Chilled water pipes shall be covered with minimum 2-inch thick fiberglass or cellular glass insulation. ASHRAE Standard 189.1 shall be followed if greater than 2-inch thickness occurs. Fittings shall be insulated with 2-inch thick pre-molded or shop-fabricated fiberglass, or cellular glass insulation with PVC fitting covers. Insulation on lines in concealed areas shall be jacketed with white reinforced foil-kraft vapor barrier. Insulation on lines exposed in equipment rooms or in occupied areas shall be jacketed with pre-sized glass cloth vapor barrier jacket. Jacket laps and butt strips should be adhered with vapor barrier adhesive or position sealing system. Fittings shall be vapor sealed with vapor barrier mastic.

Higher density insulating materials should be used at pipe supports, if required to prevent crushing/ cutting of insulation.

All exterior exposed pipes shall have aluminum metal jacket as specified below. Direct buried chilled water piping shall be pre-insulated with urethane foam, 2 inches thick.

233.2.2 Hot Water Piping. Follow description above for chilled water piping except that vapor barrier is required on direct buried pipe only.

233.2.3 Drain, Refrigeration Suction and Chilled Water Piping 2 Inches and Smaller. Follow description above for chilled water piping except thickness shall be 1 inch.

233.2.4 Steam and Condensate Piping. The insulation for 100-pounds per square inch gauge (psig) steam condensate piping shall be minimum 2.5 inches thick. High pressure steam piping greater than 100 psig) shall be covered with calcium silicate, 3 to 5 inches thick, depending on fluid temperature and pipe diameter as required in ASHRAE Standard 189.1. Calcium silicate insulation shall be used as required for surface temperatures of 500°F and above. Fittings for calcium silicate insulation pipe shall be performed or shop fabricated calcium silicate of same thickness of pipe insulation.

233.2.5 Tunnel Piping. All steam, chilled water and hot water piping, in tunnels or exposed, shall have a smooth finish aluminum metal jacket on polyurethane insulation or small rib texture aluminum metal jacket on calcium silicate. Minimum jacket thickness shall be .016 inch.

233.3 Chilled and Hot Water Pump Insulation

Chilled and hot water pumps shall be insulated. Provide removable insulated enclosure over pump casing to facilitate pump maintenance.

SECTION 234 INSTRUMENTATION AND CONTROL FORHVAC

234.1 DDC Control System for HVAC
BACnet compatible direct digital control (DDC) controls shall be used to control all HVAC equipment in facilities with a total cooling capacity greater than 20 tons. The controls shall be interfaced with the Building Automation System (BAS) front-end system that is already in use at the Airport and must interface with the Airport's Enterprise Control System. Design of the DDC system must be coordinated with the Airport's BAS Administrator. Cooling systems that are dedicated to data or communications rooms will be connected to the HVAC control system for monitoring, alarms, and control.

234.2 Sequence of Operations for HVAC Controls

A clear Sequence of Operations shall be provided by the design team in the design submittal. The record drawings shall reflect any changes made during construction and startup.

In addition to industry best practices and code requirements, the following key points shall be included in the Sequence of Operations for HVAC controls:

234.2.1 Supply air temperature and pressure reset schedule according to outside air temperature.

234.2.2 System response to humidity conditions exceeding 60 percent relative humidity.

234.2.3 Nighttime and weekend setup/setback schedule shall be patterned to match the building usage for both terminal boxes and air-handler units.

234.2.4 Coordination of the use of return fans. Turning the fan off when supply air pressure can be effectively maintained by the supply air fan only.

234.2.5 Areas that require dedicated cooling support, such as data or communications rooms, must provide constant (24/7/365) cooling.

234.3 Individual Space Control System for HVAC

Individual space control is desired for each individual totally enclosed office space or room. Individual variable air volume (VAV) units or a two-position damper may be utilized which shall have independent controls.

SECTION 235 HVAC PIPING AND PUMPS

235.1 Hydronic Hot Water Piping
Hot water piping shall be black steel pipe ASTM A53 Grade B, seamless or welded, Schedule 40 with welded joints and must be in accordance with ASTM B 36.10M or ASTM B88 Type L. For pipe diameters greater than 12 inches, standard wall piping is acceptable.

235.1.1 Hot Water Piping – Inside. Hot water (inside) piping shall be steel or K copper.

235.1.2 Hot Water Piping – Underground. Underground hot water piping is not allowed without the approval of the Energy Transportation & Asset Management Department.

235.2 Chilled Water Piping
Chilled piping shall be black steel pipe ASTM A53 Grade B, seamless or welded, Schedule 40

with welded joints and must be in accordance with ASTM B 36.10M or ASTM B88 Type L. For pipe diameters greater than 12 inches, standard wall piping is acceptable.

235.2.1 Chilled Water Piping – Inside. Chilled water (inside) piping shall be steel or K or L copper.

235.2.2 Chilled Water Piping – Underground. Underground chilled water piping is not allowed without the approval of the Energy Transportation & Asset Management Department.

235.2.3 Chilled Water from Central Plant. All control valves shall be two-way valves. For design purposes of new connections to the secondary loop, a supply and return pressures must be obtained from the EP Utilities Manager. Facilities requiring greater than this value will need to include booster pumps for the chilled water.

Heat exchangers will not be used on the chilled water service from the Energy Plaza secondary loop without prior approval of DFW Energy and Transportation Management. All components of the system cooling load shall be designed to return 62°F water when the supply water temperature is 38°F and the load is operating at design flow rates. All loads shall be provided with design flow rate control. See Appendix B for specified manufacturer of flow rate control device.

235.2.4 Chilled Water from ESP. Design for additional facilities attached to this system must include consideration of existing plant pressures and capacities. Modifications to the plant pumping system must be included in the design to maintain necessary flow rates to existing facilities. See Appendix B for specified manufacturer of maximum flow control device.

The chilled water supply temperature is reset on ambient air temperature ranging from 40°F to 53°F. Design loads should be based on this range of water temperature. Spaces with high loading,

such as computer rooms, will require special design considerations for adequate cooling with 53°F chilled water supply temperatures. In certain instances, supplemental cooling for interior high load density areas may be necessary. All control valves shall be two-way valves and all cooling coils shall be provided with a design flow rate control device.

Any new facilities planned for construction adjacent to East Airfield Dr. should be considered for chilled water service from the ESP. Conceptual design development must be coordinated with DFW stakeholders.

235.3 Hydronic Pumps

"Stand-by" pumps are required on most facilities, especially for facilities containing computer rooms.

Pumps that are connected to the EP or ESP chilled water loops must be outfitted with suction and discharge pressure transmitters that will tie into the respective control system. The control system must be interfaced to the pump controls to provide full control and visibility of the pump operation.

Booster pumps for chilled and hot water systems shall be controlled via tie-in to the EP Distributed Control System or the Airport enterprise control system. All requirements must be verified and approved by the BAS Administrator.

Impellers shall be one piece, hydraulically and statically balanced, and keyed to the shaft. Impeller size shall not be more than 90 percent of the maximum impeller size allowed for the pump casing.

Pumps shall be of a premium efficiency design. The pump motor assembly shall be mounted on a common steel or cast iron base.

Pump and motor bearings shall be grease-lubricated, complete with alemite fittings.

Variable volume pumping systems with variable frequency electric drives are desired.

235.3.1 Provide pressure gauge taps with stop cocks and gauges on suction and discharge sides of pump. Provide thermometer wells on suction and discharge sides of pumps.

235.4 Aboveground Steam and Condensate Piping General Requirements

Any new service extension of the HSS shall consist of 300-psig rated components. To prevent water logging problems, all future expansions shall be the diaphragm type.

Existing system capacity must be checked before each addition to the load and new heat exchanger capacity must be added as required. The location of heating water pump rooms must be considered when adding new heating units at the terminal buildings.

Hot water coil sizing shall be based on a minimum 60°F delta temperature at 180°F supply. An exception to this requirement shall be side pocket VAV boxes where commercial availability limits water side differentials to 20°F at 160°F supply.

New heating water systems shall be variable pumping. Work in adjacent areas shall consider increasing existing coil capacity to minimize pumping requirements.

235.4.1 Steam Piping. Steam piping shall be ASTM A 106, Grade B, seamless, Schedule 40, in accordance with ANSI B3610.M, and with welded joints.

235.4.2 Steam Fittings. Steam fittings shall be ASTM A 234/A 234M WPM(W), seamless or welded, butt-weld, Schedule 40 in accordance with ANSI B 16.9 or ASTM A 105/A 105M, and forged, socket weld, 3,000 pounds in accordance with ANSI B 16.11.

235.4.3 Steam Flanges. Steam flanges shall be ASTM A 105/A 105M forged weld neck, 300 pounds, flat raised faced, bored to Schedule 40, in accordance with ANSI B16.5. Flat face is allowed to match existing equipment.

235.4.4 Condensate Steam Piping (Steam Trap System). Condensate steam piping shall be

ASTM A 106, Grade B, seamless Schedule 80 in accordance with ANSI B36 10M, and with welded joints.

235.4.5 Condensate Piping. Condensate piping shall be ASTM A 106, Grade B, seamless Schedule 80 in accordance with ANSI B36.10M, and with welded or threaded joints.

235.4.6 Condensate Fittings. Condensate fittings shall be ASTM A234/A 234 M WPB(W), seamless or welded, butt-weld schedule 80 steel in accordance with ANSI B 16.9 or ASTM A 105/A 105M, and forged, socket weld, 3,000 pounds, in accordance with ANSI B16.11.

235.4.7 Condensate Flanges. Condensate flanges shall be ASTM A 105/A 105 M, forged, weld neck 150 pounds flat or raised faced, bored to Schedule 80, in accordance with ANSI B16.5.

235.5 Steam Condensate Pumps
Pumps are required to meet the following criteria:

235.5.1 Horizontal split case constructed such that removal of pump shaft impeller, seal, bearings, etc., may be possible without the removal of the pump casing from the line or disconnecting either suction or discharge connection.

235.5.2 Mechanical seal assembly will have replaceable seats.

235.5.3 Connection shall be flanged or union connection (type depending on size, pipe, and work space restrictions).

235.6 Condensate Pumps and Receivers
Condensate units shall be of the duplex type with two bronze, fitted, close coupled centrifugal pumps with pressure gauge taps with stop cocks on both suction and discharge sides. Maximum pump speed shall be 1,750 rotations per minute (rpm).

The receiver tank will be fabricated of cast iron or steel, as applicable, and equipped with required float switches and alternator to

provide automatic alteration of pumps. The receiver shall be provided with condensate return, vent, overflow, and valved drain connections.

235.7 Refrigerant Piping
Refrigerant piping shall be Type ACR copper, capped and cleaned. Joints shall be made with silfoss, and purged with nitrogen.

SECTION 236 HYDRONIC PIPING TESTING AND CLEANING PROCEDURES

236.1 Hydronic Pipe Testing
All hydronic piping shall be hydrostatically tested prior to placing in service. The Contractor shall fill the system with water and hydrostatically test to a pressure 150 percent of the operating working pressure. During this process, all major equipment such as air handling units (AHU)s and pumps shall be isolated. Once the test pressure is achieved, it must maintain the test pressure for a duration of 4 hours after the hydrostatic pump is removed. The test is successful with a zero pressure drop for the duration of the test.

236.2 Hydronic Pipe Cleaning and Flushing
At the successful completion of the hydrostatic testing process, the system shall be flushed for approximately 2 hours at a rate of 7 feet per second to remove any construction debris. During the flushing process, make-up water shall be added at a rate equal to the flush water. A temporary trash pump shall be used and all system pumps and major equipment such as AHU's shall be isolated and bypassed.

Once the system is flushed, the Contractor shall refill, circulate, and add an approved chemical cleaner to the system at a concentration recommended by the chemical manufacturer. The system shall be allowed to circulate at a minimum rate of 7 feet per second for a duration of 24 hours. At the completion of the 24 hours, the Contractor shall flush the system with potable water. The Energy Transportation & Asset Management department's Water Treatment Specialist or his/her designee shall deem the test

satisfactory, when the flush water has reached the water quality standards to that of the potable water. If the test fails, the Contractor will be required to repeat the chemical cleaning process until required results are achieved. The potable water parameters will be measured at the beginning of the test.

The Operator shall submit documents detailing the design criteria utilized to ensure effluent from fire suppression systems can either be released into sanitary sewer systems or easily collected and not discharged into the storm water collection system during required maintenance and flushing activities.

SECTION 237 HVAC AIR DISTRIBUTION

237.1 Terminal Building HVAC System

The Terminal buildings shall be served by VAVAHUs with fan powered VAV terminals and hot water heating.

237.2 Metal Ducts

All ductwork systems shall be constructed and installed in accordance with SMACNA and ASHRAE Standards and Guidelines.

Duct material shall be zinc-coated sheet steel or aluminum of the thickness of the metal and stiffeners as indicated in the SMACNA Manual. All ductwork installations shall meet SMACNA Class A duct sealing requirements. All medium pressure ductwork (equal to or greater than 2-inch w.g. design static pressure) shall be pressure tested in accordance with SMACNA standards, with measured leakage not to exceed 1 percent of design flow rate.

Wherever ductwork is connected to fans, AHUs, or other equipment that may cause vibration in the duct, the connection to the equipment shall be by means of a flexible connection constructed of fire resistant flexible canvas or other approved material. The connection shall be suitable for the pressures at the point of installation.

All ducts, except general exhaust ducts, shall be externally insulated. Internal duct liner of any type shall not be used for any duct system.

All ductwork installed below the floor in crawl spaces or below grade shall be constructed with watertight joints and shall be tested and proved tight before floors are poured. The under-floor duct system shall be constructed of fiberglass, PVC, or other approved non-metallic material.

Flexible ductwork shall comply with UL 181 Class 1, and shall meet or exceed NFPA 90A-90B rating. Flexible duct shall be composed of an inner duct of woven and coated fiberglass permanently bonded to a spring steel helix with 6.0 R-value fiberglass insulation and fiberglass reinforced metalized film outer jacket. Maximum length of flexible duct shall be 5 feet.

All flexible duct connections to grilles and registers shall have a radius forming brace installed at the connection.

237.2 Variable Air Volume Units

The preferred system in the Terminal buildings is the use of fan-powered Variable Air Volume (VAV) box with a hot water coil. VAV boxes shall be double wall construction, exposed internal insulation shall not be allowed. The cold air damper will be closed to 0°F or to a minimum position to maintain ventilation rates when cooling is no longer required. However, total air supply shall not be less than that required by currently adopted International Mechanical Code. The wall-mounted thermostat/sensor (all thermostats/sensors should be mounted on the walls) will control the volume damper and a floating or modulating hot water valve in sequence. For heating, the fan motor shall start and operate to satisfy the thermostat/sensor setting; upon a further need for heating, the floating or modulating hot water valve will open to satisfy the thermostat/sensor setting. When the thermostat/sensor is satisfied, the floating or modulating valve will close and the fan motor will cycle off in sequence. There is a 2°F dead band between closing of cold air damper and the starting of the fan motor and another 2°F dead band before opening of

control valve. A filter will be included on the inlet to the fan powered box to protect the heating coil and fan from dirt. Consideration should be given to static pressure drop. Static pressure controls should be sufficient to allow boxes to operate with stability. The effect of the box addition on the remainder of the ducted system must be evaluated to ensure the required static pressure from the AHU is not impacted. All variable volume terminal units shall be equipped with at least a 5 diameter length of straight rigid duct immediately upstream of the volume control devices.

Terminal boxes located above finished ceilings will have adequate ceiling access panels or other means of access to box for maintenance and removal. Except for lift out ceiling installation, all access panels will be hinged.

237.3 Equipment connected to Energy Plaza

The EP operating conditions will have a significant influence on the design of new or modified HVAC systems for buildings served by the EP. Variable seasonal Chilled Water System operating supply temperatures will have a significant influence on mechanical design of new HVAC systems.

237.4 Equipment connected to East Side Plant

All buildings served with chilled water from the ESP should use a locally based boiler system. The boiler should be natural gas fired and meet the requirements of the currently adopted energy code. Boiler configuration and sizing should be such that the failure of one boiler will provide no less than 85% of the design peak load. The smaller of the boilers should be capable of a high turn-down ratio to permit efficient operation during short periods of light loading.

237.5 Heat Exchangers for HVAC

Horizontal Stainless Steel Plate type heat exchangers shall be used, except for steam-to-hot water service. Locate the units such that tube bundle may be removed/repaired with minimum removal of pipe work, walls, etc.

Heat exchangers to be installed in the Energy Plaza utility tunnel vaults shall be of shell and U-tube type, steam in shell, 300 psig steam working pressure, in accordance with ASME Code for Unified Pressure Vessels. Present operating pressure is 110 to 125 psig. Provide unit with steam inlet, condensate outlet, vent, water inlet and outlet, and other connections as required.

Any steam-to-hot water heat exchanger installed in a separate facility outside of the EP utility tunnel, but supplied steam from it, may be rated for less than 300 psig steam working pressure. Such an installation, however, will require a pressure relief and reducing station for protection of any downstream low pressure-rated heat exchangers and supporting equipment.

SECTION 238 CENTRAL HVAC EQUIPMENT

238.1 Indoor Central-Station Air-Handling Units
AHUs shall adhere to the following requirements:

238.1.1 Provide Variable Frequency Drive (VFD) with a hand operated Hand-Off-Auto (HOA) switch and remote control terminations at each air handler location. VFD shall be provided with integral bypass. Provide a fused disconnect switch at each location.

Fan array type configuration shall be used for all VAV-type AHU in excess of 5,000 cubic feet per minute (CFM).

238.1.2 Provide a double-wall insulated stainless steel drain pan sloped in two or more planes to eliminate stagnant water with a drain line not less than $\frac{3}{4}$ inch in diameter or size of tap on drain pan. Use a plugged tee for all changes in direction rather than a 90-degree ell. Condensate shall be drained to the sanitary sewer.

238.1.3 AHU casings shall be double-wall construction, galvanized steel with insulation between the walls. Under no circumstances will

it be acceptable to have insulating material exposed to the air stream. The casing leakage shall not exceed 1 percent of total airflow at design static pressure.

238.1.4 Air handling equipment should be equipped with filters. High efficiency filters shall be provided on equipment over 152,000 CFM. High efficiency filters shall be MERV 13 rated cartridge type with MERV 7 rated, 2-inch thick prefilters.

238.1.5 Field lubricated ball bearing equipment is preferred over sleeve bearings. All air handling equipment shall be selected and installed such that bearings can be replaced with minimum demolition of equipment or surrounding structures. Bearing lubrication points shall be extended to a central external accessible point and fitted with alemite fittings.

238.1.6 Electric motor speeds in excess of 1,800 rpm are discouraged. Fans shall be selected for the highest efficiency, airfoil type is preferred. Fan wall technology should be considered and evaluated.

238.1.7 Chilled water and hot water coils shall be of the continuous copper tube type with copper or aluminum fins. Tubes shall be a minimum 0.5-inch outside diameter (O.D.) and a minimum 0.025-inch wall thickness. All coils shall be of the cleanable and drainable type. Each tube shall be accessible without piping disconnect. Headers shall be removable at the opposite end. All water coils shall have maximum flow rate control devices in the return line.

Coil design shall be based on the following criteria:

238.1.8.1 64°F minimum L.W.T. Cooling, 40°F supply

238.1.8.2 60°F minimum delta T heating, 160°F supply

238.1.8.3 Air friction loss across coil shall not exceed 0.7 inch W.C. (Faces velocities below 450 feet per minute are desired).

238.1.8 Access covers to water coils on the AHU housing shall be readily removed for access without piping disconnect or demolition of surrounding structures.

238.1.9 Provide hinged access doors with gaskets to AHU sections with view windows. Provide marine lights in each AHU section with timer-driven light switches on outside of unit.

238.1.10 Air handling units with a 7.5-horsepower motor or larger shall be selected with a key way shaft and keyed fan hub. Standard size key and key way are preferred.

238.1.11 Chilled water and hot water control valves shall be pressure independent type with flanged or set in unions for easy removal.

SECTION 239 DECENTRALIZED HVAC EQUIPMENT

239.1 Packaged Air Conditioners

Where building use, type, and DFW stakeholders review justifies the use of package equipment, the following shall apply:

239.1.1 Roof Top System

Rooftop systems shall be completely self-contained, with factory wired controls and factory assembled components and piping. Equipment shall have 2-inch thick pleated replaceable media filters. Compressors shall have 5-year warranty, including parts and labor (5 tons and under). All curb mounted units shall be furnished with appropriate enclosed engineered curbs to provide for level unit mounting with minimum 16-inch curb height above top of the roof deck surface. An alternative is a structural steel support frame with minimum 40-inch clearance above finished roof. All rooftop systems require approval from Airport Contact.

239.1.2 Split System Air-Conditioners

Split systems shall consist of furnace, coiling section plenum with direct expansion cooling coil, air-cooled condensing unit or heat pump, piping, controls, etc. All components shall be factory wired and assembled. Furnaces shall have filter rack complete with 1-inch thick throw-away filters. Compressors shall have a 5-year warranty, including parts and labor (5 tons and under).

Split system air conditioners shall have a Seasonal Energy Efficiency Ratio (SEER) rating of 13 or meet the latest version of the IECC requirement, whichever is greater.

239.2 Fan Coil Units (Floor and Wall Mounted Equipment)

FCUs shall have a high-medium-low-off switch where adjustment can be made without removal of the access door or unit housing. This switch shall be easily accessible for room or area occupant's personal adjustment. FCUs shall be double-wall construction as described for Modular Indoor Central-Station AHUs.

FCUs shall be equipped with replaceable pleated filters, minimum MERV 7. The use of FCUs shall be limited to sizes below 2,000 CFM and have prior approval from Airport Contact.

DIVISION 26

Electrical

SECTION 261 GENERAL INFORMATION

261.1 Scope

This Division defines general design criteria that apply to the design of electrical systems at DFW. Division 1 should be consulted for specific Airport regulations and standards that also apply. The electrical design criteria in this section are organized into three distinct divisions: interior electrical, exterior electrical, and airfield electrical. Electrical design should comply with the 2008 National Electrical Code (NEC) as amended by the Airport Board.

261.2 Short Circuit Study

The maximum available short-circuit current should be calculated for the different system configurations (including open and closed transition, from normal and alternative power sources) at each bus, and the results used to verify the interrupting ratings of the overcurrent protective devices, complying with Institute of Electrical and Electronics Engineers (IEEE) guidance IEEE241 and IEEE242. Summarize the results from the calculations in the Equipment Evaluation Report. The results of the study are to be implemented within the design.

261.3 Protective Devices Coordination Study

Perform coordination study for all the protective devices in the scope of the project, using the results of the fault study, and complying with IEEE399. Prepare a written report with all findings and recommendations. Complete a table with the recommended settings for the all protective devices within the scope of work.

261.4 Arc Flash Study

Perform an arc flash analysis per the requirements of the IEEE 1584 equations that are presented in NFPA70E 2009. The Arc-Flash Hazard Analysis shall include all significant locations in 240-volt and 208-volt systems fed from transformers equal to or greater than 125 kilovolt amps (kVA) where work could be performed on energized parts. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios

must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. Use the worst-case scenario for the equipment labeling. The labels shall include the following information at a minimum: Location Designation, Nominal Voltage, Flash Protection Boundary, Hazard Risk Category, Incident Energy, Working Distance, Required Personal Protective Equipment (PPE), and Issued Date.

261.5 Preservation of Power Quality

All low voltage power and distribution system designs of facilities with computers and other sensitive electronic loads shall comply with IEEE 1100.

261.6 Harmonic Current Limits

The harmonic current distortion of any individual device or piece of equipment specified in the design documents shall not exceed values given in IEEE519.

261.7 Utilities

The Airport's 25-kilovolt (kV), three-phase, medium voltage distribution system is owned and maintained by Oncor Electric. The Designer shall confer with the Airport Contact and Oncor Electric to determine service arrangement for each project.

261.8 Redundant Services

Two independent electrical power sources shall be used for all critical use facilities.

Redundant services are available from the Airport electrical distribution system and are normally provided for terminal buildings, FAA buildings, emergency facilities, crash/fire/ rescue stations, APM, the Central Plant, and other critical use facilities. Other alternate emergency sources may be considered for true uninterruptible power supply. Terminal building service entrance switchgear is double-ended drawout-air-circuit-breaker-type. Transformers, main breakers, and bus on each side of the tie breaker are to be sized to

serve the total service load. The Airport utility service provider provides the main services switches and transfer switch (circuit breakers). The Airport provides all distribution switchgear from this point to the building electrical systems.

Buildings not consisting of critical loads shall be served with single radial feed. The Designer should verify service type with Airport Maintenance Engineering.

261.8.1 Uninterruptible Power System. A single or three-phase UPS shall be provided where it is required, to provide continuous, regulated alternating current (AC) power to the critical loads under normal and abnormal conditions, including loss of the utility AC power. The UPS shall contain a full rated input rectifier, output inverter, battery charger, bypass static switch, maintenance free battery plant, liquid crystal display (LCD) interface and controls, options for remote monitoring, and maintenance bypass circuit to isolate UPS for safety maintenance, without disruptions to the critical loads. Comply with the current editions of UL1778(UPS Standard) and NFPA 70(NEC).

261.8.2 Generators. Where standby generators are provided, they shall comply with Construction Specifications Institute (CSI) standards. Provide automatic transfer switch as part of design. Manual transfer switches shall be approved by Airport Contact.

261.9 Electrical Distribution
All electrical distribution shall be underground unless otherwise authorized by DFW.

261.10 Enclosures
Provide all ductwork, equipment pads, and metering enclosures in accordance with Onkor Electric specifications and standards. Provide issued address label on all meter enclosures.

SECTION 262

COMMON WORK RESULTS FOR ELECTRICAL

262.1 Interior Conduit for Electrical Systems

262.1.1 Conduit shall be galvanized rigid metal conduit (RMC) or intermediate metal conduit (IMC) steel, except as outlined below.

All RMC and IMC conduit couplings shall be threaded type only.

Minimum conduit size shall be ¾ inch for home runs and feeders and ½ inch for branch runs.

262.1.2 Electrical Metallic Tubing

EMT may be used where permitted by NEC. Use RMC or IMC where subject to severe mechanical or physical damage 6 feet or less above floor, if exposed. EMT fittings shall be steel compression or steel set screw type.

262.1.3 Direct Buried Metallic Conduit

Direct buried metallic conduits require PVC coating or approved equal coating to protect against corrosion.

262.1.4 PVC Conduit

PVC conduit shall be minimum Schedule 40 or thicker, and may be used underground, direct buried, or concrete encased. Conduit bends shall be IMC, PVC coated.

Exception: 2 inches or less, with runs less than 150 feet long, installed with two or fewer 90° bends.

262.1.5 Flex Conduit

Steel flex or liquid-tight flex (for damp or wet locations) shall be used for connection to all movable, rotating, or vibrating equipment, including dry type transformers. Flex connection shall not be used as equipment grounding conductor.

Flex metal or metal clad (MC) type cable, where concealed by walls, floors, or ceilings is acceptable wiring method installed per NEC 330 requirements.

MC Cable shall be installed in a neat and workmanship like manner per NEC 110.12

MC cable is not permitted as an exposed wiring method.

When crossing building expansion joints, seal-tite (2-foot minimum), may be used to span the expansion joint. Pre-approved seal-tite design is used in all parking garages to allow for vertical and horizontal movement. Flex will not be allowed because of its ease of slipping from connectors.

262.2 Low Voltage Cables (0 Volts to 600 Volts)

262.2.1 Low Voltage Open Conductors

Copper shall be used for all wiring, aluminum wire 1/0 and larger may be used for temporary service conductors. Exception [see 267.3-5] for exterior pole mounted fixtures.

Minimum size #12 American wire gauge (AWG). All conductors #10 AWG and smaller shall be solid or stranded construction. Wire sizes #8 AWG and larger shall be stranded construction installed per NEC Chapter 2 requirements.

Total voltage drop shall be less than 5% percent. Limit feeder drop to less than 2 percent and branch circuit drop to less than 3 percent.

262.2.2 Control wiring shall be stranded.

262.2.3 All exterior lighting circuits serving high intensity discharge (HID) lighting fixtures shall be limited to a loading of 60 percent or less of the "Full Load" capacity of the circuit (including circuit breakers, switches, relays, etc.). HID fixtures include high pressure sodium, metal halide, and mercury vapor lamps.

262.2.4 All direct buried counterpoise group wire used at the Airport shall be #6 or stranded, tinned, soft drawn, copper wire conforming to ASTM #B-33.

262.2.5 Interior power wiring for power and lighting shall be color coded as follows:

480Y/277V, 3Ø, 4W	208Y/120V, 3Ø, 4W	240Y/120V, 1Ø, 3W
AØ - Brown	AØ- Black	AØ - Black
BØ - Orange	BØ- Red	CØ - Red
CØ - Yellow	CØ- Blue	N - White
N – Gray	N – White	Grnd – Green
Grnd – Green	Grnd – Green	Iso. Grnd – Green/Yellow
Iso. Grnd – Green/Yellow	Iso Grnd – Green/Yellow	

262.3 Grounding and Bonding for Electrical Systems

Consideration shall be given to local conditions affecting grounding methods. Ground resistance shall not exceed limits as established by IEEE Standard 142 for type of facility. Ground rods shall be ¾ inch by 10 feet copper clad minimum. Exception: All ground rods on DFW Airfield Operations Area shall be ¾ inch by 10 foot stainless steel.

262.3.1 Ground Connections

All ground connections shall be bolted (where accessible) or by the exothermic process. Exothermic welds shall be coated against corrosion where direct buried.

An equipment grounding conductor shall be routed with all conduit runs and shall be sized per NEC. Conduit shall not be used as a ground path.

262.4 Underground Ducts and Raceways for Electrical Systems

Underground electrical circuits shall be installed in Schedule 40 PVC. Service entrance conduits shall be encased in concrete.

SECTION 263

MEDIUM VOLTAGE ELECTRICAL DISTRIBUTION (600 VOLTS to 5000 VOLTS)

263.1 Manholes and Handholes

Manholes and handholes shall be provided with heavy duty traffic covers. All circuits shall be labeled with stamped brass tags. See Appendix B for specified manufacturer of heat sealing tags.

SECTION 264

LOW-VOLTAGE ELECTRICAL DISTRIBUTION (0 VOLTS to 600 VOLTS)

264.1 Switchboards and Panel Boards

Panel main bus may be copper or aluminum. Panels shall have conductor color code identification. Panel circuit breakers shall be bolt on type.

Fused switches shall utilize current limiting fuses with "rejection" type pins where applicable. A spare fuse panel and a set of three spare fuses of each size used on a project will be furnished.

Freestanding switchboard construction shall be specified for bus sizes larger than 1,200 amp. Freestanding equipment shall be installed on a concrete pad.

264.2 Light Fixtures

Light fixtures shall include interior, exterior attached to buildings, exterior steps, stairways, and parking structures.

The Designer shall obtain a list of lamps from Airport Procurement Warehouse that are in stock and limit design to lamps that are currently being used for interior lighting. Requirement may be waived if special design warrants, subject to DFW Contact approval.

All exit lights shall be LED types with a minimum 20-year warranty.

Occupancy sensor controls and dimming for energy management shall be used throughout the facilities. Use double twin tube type compact florescent lamps in lieu of incandescent where low level down-lighting is required. Dimming of compact fluorescent fixtures is not required, unless specified in Design Requirements.

264.2.1 Ballasts that are manufactured exclusively for a particular fixture, or fixtures that require a particular ballast, shall not be specified. Use of non-standard configurations, voltages, or types shall require approval from Airport Contact.

264.2.2 Lighting system shall be designed in accordance with Illumination Engineering Society (IES) recommendations to provide an energy efficient system with minimum maintenance. Refer to IESNA Lighting Handbook, 9th Edition.

264.2.3 Long-term lamp and fixture maintenance should be considered in location of all fixtures. Use very long life lamps in areas difficult to re-lamp and areas along roadways.

264.3 Metering

Revenue metering is provided by Oncor. Provide a metering equipment enclosure in accordance with Oncor requirements. Provide a voltmeter and ammeter for incoming services 1,200 amp and larger.

264.4 Distribution Transformers

Distribution transformers will be three-phase, 120/208 volt or 277/480 volt, provided by Oncor. Furnish equipment pads in accordance with Oncor requirements.

264.5 Identification for Electrical Systems

264.5.1 Nameplates and Labels: Follow Terminal Renewal and Improvement Program (TRIP) Basis of Design requirements for the terminal in which the work is occurring for labeling of the switchboards, panelboards, transformers, transfer switches, and safety switches.

264.5.2 Wire Markers: Follow TRIP requirements for labeling and color coding of power and control wires.

264.5.3 Conduit Markers: Follow TRIP requirements for identifications of the conduits.

SECTION 265

ONCOR/DFW Duct Bank and Service Entrance Requirements

265.1 Service Entrance

Unprotected service entrance (secondary) duct bank shall be concrete-encased and shall meet all of the following duct bank requirements to the building footprint edge, or to the first means of over-current protection. Concrete encasement may be waived where the secondary duct bank is a short and direct path to the building or first means of over-current protection.

265.2 Primary (25kv) Duct Bank

All 25-kV duct bank is owned and maintained by DFW; 25-kV cabling system and controls are owned and maintained by ONCOR Electric.

Duct bank shall be constructed as follows:

265.2.1 All conduit shall be Schedule 40 PVC, solid wall (not cellular core), concrete-encased with a minimum of 4 inches of concrete on all sides, with a minimum of 6-inch coverage on top.

265.2.2 All concrete shall have a pattern finish and be red in color.

265.2.3 Schedule 40 PVC bends are allowed with a minimum 36-inch radius.

265.2.4 Spacers shall be installed every 5 feet and shall provide 3 inches of vertical and

horizontal separation between conduits. Install #3 steel reinforcing rods through the internal channels in both outer edges of spacers and drive into earth to anchor the assembly. See Appendix B for specified manufacturer of spacers.

265.2.5 Install #3 steel reinforcing rods horizontally in each corner of the duct spacers along the top and bottom of the entire length of the encasement. Tie all horizontal and vertical rebar together with #16 steel tie wire.

265.2.6 When entering flat surfaces of pull boxes and manholes, dowel rebar ends a minimum of 3 inches if possible, into sides to prevent shear points. ONCOR will perform all coring into pull boxes and manholes.

265.2.7 Duct banks shall be sloped to manholes for drainage throughout its entire length.

265.2.8 For continuation of duct banks, provide a 45-degree slope for the cold joint to prevent shear points. Leave a minimum of 12 inches of rebar for overlapping.

265.2.9 Conduit joints shall be staggered and constructed so that a mandrel can be pulled through its entire length.

265.2.10 Allow a minimum of 12 hours before backfilling concrete encased duct banks allowing for adequate cure time to prevent fracturing.

265.3 Electrical Manholes, Junction Boxes, and Pull Boxes

These structures shall be located outside of runway and taxiway safety areas (as defined in AC 150/5300-13) where DFW Maintenance personnel can service them without closing runways or taxiways. Structures shall sufficiently be raised above the surrounding grade to prevent ponding water on the structure and the top cover sloped to drain. A concrete apron shall be constructed around all electrical manholes located in turfed areas. Particular attention shall be given to stormwater drainage plans to prevent placement of electrical structures in areas channeled for drainage. These structures shall have all joints and openings completely sealed and vermin-proof with secure covers with bolts. Structures, covers, and frames in the runway and taxiway safety areas shall be heavy

duty designed for aircraft at 250 psi tire pressures and wheel loads of at least 40,000 pounds. Homerun manholes and pull boxes shall be located at a maximum spacing of 600 feet.

SECTION 266 ELECTRICAL AND CATHODIC PROTECTION

266.1 Certification

Specify that upon completion of construction, the Prime Contractor is required to transmit on his letterhead an affidavit bearing the notarized signature of the Lightning Protection Institute (LPI) Certified Master Installer that the lightning protection system complies with NFPA 780 and, in building additions, that it has been bonded to the existing system. Installation shall be made under the direct supervision of a Certified Master Installer, whose certification has been granted by the LPI.

266.2 Lightning Protection for Buildings

A Lightning Protection System shall be provided for all building structures on the Airport. The lightning protection system shall comply with the 1995 edition of NFPA 780, Standard for the Installation of Lightning Protection Systems of the National Fire Protection Association. Except for cable fasteners, all components of the lightning protection system shall be listed and labeled by Underwriters Laboratories, Inc.

266.3 Lightning Protection for Building Additions

For additions to buildings already having a lightning protection system, provide lightning protection in the new construction only, and properly bond to the existing system.

SECTION 267 LIGHTING

267.1 Apron Lighting

Apron lighting shall be in accordance with IES Recommended Practice RP-14 "Airport Service Area Lighting."

Exceptions:

- General lighting near the Terminal buildings is specified at approximately two maintained foot-candles.
- In the service areas, approximately 50 feet to 300 feet from Terminal buildings, average illumination levels, at 5 feet above the apron

are specified at 3- to 4-foot candles horizontal and 7- to 9-foot candles vertical. The uniformity ratio is in the range of 3:1 (average/minimum) and 6:1 (maximum/ minimum). The fixtures have a specified cutoff at 400 feet from the Terminal building to prevent direct spill onto the taxiways. In addition, internal louvers shall be provided for maximum bare lamp shielding.

- The Designer shall call for submittals of the manufacturer's lighting analysis to include point by point foot-candle calculations to demonstrate the proposal meets the design criteria.
- Prior to the final acceptance, the Contractor must submit a report, of testing accomplished by an IES-certified agency, showing that the installation complies with the specified criteria and the proposal calculated values. These tests shall indicate areas of unacceptable glare as indicated by FAA air traffic controllers or pilots. All testing shall comply with IES recommendations. All adjustments in fixture aiming shall be accomplished by the Contractor at no additional cost to the Airport.

267.2 Airfield Lighting

Runway and taxiway lighting and visual aids shall be designed based on the design standards and requirements of the most current FAA Advisory Circulars, as appropriately supplemented by the NEC as it pertains to vault work and the commercial power side of the vault equipment.

System layout configuration and fixture utilization and design shall be specified by all current applicable FAA Advisory Circulars.

Airport operated lighting systems shall be designed for the most critical operational criteria (CAT II/III).

267.2.1 Standard Lock Out Procedures

Designer shall instruct Contractor that no construction or maintenance shall be allowed on Airfield lighting circuits while the circuits are energized. The published circuit "Lock-out and Lock-in" procedures will be required to be followed for all work performed on the airfield. Designer shall instruct contractor to confirm with DFW Operations Department the need for temporary circuits for extended outages (more than one work period, 8 to 12 hours).

Standard electrical circuit lockout procedures are available from Airport Energy, Transportation and Asset Management (ETAM) Electrical Shop.

267.2.2 Medium Voltage Open Conductors. Conductors shall be copper with insulation suitable for wet locations, sized based on NEC recommended maximum allowable voltage drops.

267.2.3 Medium Voltage, Single and Multi Conductor Cables. Direct burial cable is not permitted. All cables shall be placed in conduit (PVC Schedule 40 as minimum). Bends in underground conduit system are not permitted without a junction box. All cables shall be tagged in manholes with heat sealing tags, Scotch HB-21 or approved equal, imprinted with the circuit number on each side of L-823 connectors. 5-KV series circuit cables shall be color coded as to circuit type (i.e., Runway CKT, Taxiway CKT, Sign CKT, etc.). Verify color coding requirements with the Airport ETAM Department.

267.2.4 Fixtures. In all specifications for lighting and electrical equipment, the item and manufacturer must be listed as approved for use by the FAA. In some instances, requirements above those required for FAA approval will be stipulated. These must be specified precisely; for example "Signs (L-858) - To withstand high wind velocity up to 200 mph regardless of location."

Fixtures and lamps shall be specified to match existing equipment whenever possible. Fixtures shall be installed on deep bases (cans) housing the isolation transformers. Inset (shallow) bases shall not be. Runway Distance Remaining Signs and Taxiway Guidance Signs shall be internally lighted to match existing equipment.

Minimum coverage for wet and dry bores for duct bank installation is 10 feet under taxiways and runways.

267.2.5 Saw Kerfs. Saw kerfs are discouraged. However, where saw kerfs are required, only 1-inch PVC coated RMC or IMC conduit per saw kerf is allowed. Saw kerfs shall not exceed 5-inch depth. Minimum coverage of 3 inches above conduit is required.

267.3 Exterior Lighting Systems

All airport light sources shall be aimed in a manner that will not interfere with FAA Air Traffic Control Tower operations or piloting activities. Where lighting sources are directed toward runway ends or FAA towers, they shall be shielded as necessary to deflect the light source down and away from those areas. Lighting systems shall be designed in accordance with IES recommendations to provide an energy efficient system with minimum maintenance.

Refer to the latest edition of the IESNA Lighting Handbook.

267.3.1 Lighting Poles. Poles shall be located to provide adequate working clearance for maintenance without disrupting roadway traffic. Poles required to be installed in areas not accessible with bucket truck shall be equipped with mechanical fixture lifting device in accordance with Airport Standards. All high poles modified with fixture lowering devices shall be inspected by the manufacturer of the device. This manufacturer shall issue a certificate as to the proper installation to factory specification with a 5-year warranty period to cover installation and factory defects.

267.3.2 Mounted Fixtures. The Designer shall obtain a list of acceptable lamps from DFW Airport Energy Manager approval.

267.3.3 New Underground Lighting Systems. New underground lighting systems shall be installed in direct buried Schedule 40 PVC. Splices shall be made in pole base or concrete splice box with heavy duty traffic cover.

267.3.4 Ballasts. Do not specify ballasts that are manufactured exclusively for a particular fixture, or fixtures that require a particular ballast. Ballasts shall be located at the base of high poles rather than at fixture. Avoid use of unusual fixtures, tubes, voltages, etc.

267.3.5 Conductors. For exterior pole-mounted fixtures only, conductor shall be aluminum and sized based on NEC recommended maximum allowable voltage drop.

267.3.6 Fixture and System Voltage. Fixture and system voltage shall match existing for maintenance purposes.

267.3.7 Anchor Bolts and Poles – Design Standards

- ACI 318, most current edition.
- AISC, most current edition.
- AASHTO, Specification for Design and Construction of Structural Supports for Highway Luminaries

267.4.8 Corrosion Protection. The top 10 inches of anchor bolts and their associated nuts shall be hot dipped galvanized. All base plates shall be exposed to air, no grout allowed.

267.4.9 Anchorage. Anchor bolts shall have full embedment as required by ACI. Specify nut torque requirement.

267.5 Roadway Lighting

The roadway lighting system is 480-volt, single-phase, with power extending to pole bases underground in Schedule 40 PVC duct. Sleeves shall be installed for future Airport growth.

Roadway lighting shall be per IES Type II or Type III with distribution obtained by reflectors or in some cases by refractors if approved by Airport Contact. Roadway lighting systems shall be controlled.

267.5.1 Lighting and Sign Base Grounding. High mast pole bases shall be provided with a ground directly connected to both the pier cages and a single ground rod located adjacent to the pole base. Size per NEC. Both ground conductors shall be routed into the center of the pole for connection. The ground conductor from the

ground rod shall be installed in Schedule 40 PVC to the center of the pole for connection.

267.5 Interior Lighting

The most currently released edition of the IES NA Lighting Handbook should be used to determine design lighting levels. The following light conditions should be used as design levels during the area's predominate period of occupancy:

describe the intended ballast factor of the ballast to be used. Fluorescent ballasts should be Program Rapid Start type ballasts with a power factor greater than 90 percent.

267.5.2 LED Lighting. LED sourced lighting is acceptable where economically and aesthetically acceptable.

LED can lights with less than 8 inch aperture installed in gyp-board or inaccessible ceilings, all components and wire connections shall be accessible per NEC110.26 and 300.14.

267.5.3 Lighting Controls. Lighting controls shall be installed to meet the Airport-adopted energy code as well as the Airport's goals of energy conservation. Strategies that should be considered and implemented include:

Terminal waiting areas	20 Hfc
Terminal Concourse	10 Hfc
Private office area (maximum level)	50 Hfc at the work surface (Task lighting is encouraged)
Common office area (cubicle)	40 Hfc at the work surface
Corridors in office area	25 fc
Ticket counters and TSA Documentation review	30 Hfc
Baggage claim	15 Hfc
Jet Bridge	10 Hfc
Rest Rooms	10 Hfc, 5 Vfc
Equipment maintenance	50-75 Hfc on task plane
Storage	30 Vfc on shelf
Parking garage	5 Hfc, 3Vfc, 10:1 Max/min uniformity
Surface parking	0.5 Hfc, 0.25 Vfc, 15:1 max/min uniformity

Occupancy sensing	<ul style="list-style-type: none"> In all areas that have a non-predictable usage pattern, or otherwise have no automatic controls. Equipment and electrical rooms shall employ the use of occupancy sensors to control at least 75 percent of the lighting. Rooms with fewer than four fixtures will use Occupancy sensors automatically control two of the fixtures. In large open areas such as equipment floors, storage areas, etc., occupancy sensors may be included on a fixture-by-fixture basis to provide on/off control as appropriate.
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Apron: see Design Criteria Manual section 267.1

267.5.1 Fluorescent lighting. Linear fluorescent lighting All linear fluorescent lighting will be 4,100[8K in color temperature with a color rendering index of 82 or greater.

267.5.1.1 Fluorescent lighting fixtures shall be selected using a balance of fixture efficiency and aesthetic acceptability. The number of fixtures should be minimized to provide long term sustainability of the lighting system.

267.5.1.2 Ballasts. For fluorescent lighting, the specifications and/or drawings should clearly

Daylight Harvesting	<ul style="list-style-type: none"> Offices and areas with glass exposure should apply daylight harvesting sensors and dimming equipment to all fixtures within two times the height of the window.
Individual light level control	<ul style="list-style-type: none"> Private offices shall have the opportunity to dim the lighting in the office to meet personal preferences. A maximum level should be set according to the section above regarding Interior Design Lighting Levels.
Fire Stations	<ul style="list-style-type: none"> Lighting controls in fire stations should be interfaced to the local notification system to provide appropriate lighting levels when necessary. Nighttime lighting levels that are lower than daytime levels need to be considered to allow for the adaptive compensation capabilities of the responder's eyes.

Lighting controls can be stand-alone in an area-by-area configuration, centrally coordinated via a control system front end, or a hybrid of both. Any centralized approach must conform to the Airport's standard interconnection approach to provide visibility to the system via the Airport's Enterprise Control System.

267.5.4 Energy Code. Lighting systems shall follow, at a minimum, the energy code that has most currently been adopted by the Airport. Improvements from the energy code should be applied as economically feasible.

267.5.5 Night Lighting vs. Emergency Lighting. Night lighting should be kept to a minimum and applied only when required by code or logical application. Emergency lighting that also serves as ambient lighting shall not also serve as night lighting (to reduce burn time and premature lamp failure of the emergency fixture). It shall be wired in a switched configuration, allowing manual or automatic controls to turn the lights off, but causing the lights to turn on automatically in the event of a power failure.

DIVISION 27 Communications

SECTION 271 GROUNDING AND BONDING

Grounding and Bonding Infrastructure			
Requirements for the J-STD-607-A and Miscellaneous Entrance Facility Grounding Components			
Panduit Part #	Description	Notes	Use
GB4B0612TPI-1	Telecommunications Main Grounding Busbar (TMGB) 1/4" x 4" x 12" , Solid Copper, Tin Plated,		TMGB
GB4B0624TPI-1	Telecommunications Main Grounding Busbar (TMGB) 1/4" x 4" x 20" , Solid Copper, Tin Plated,		TMGB
GB2B0304TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 10", Solid Copper, Tin Plated.		TGB
GB2B0306TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 12", Solid Copper, Tin Plated.		TGB
GB2B0312TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 12", Solid Copper, Tin Plated.		TGB
LCC4/0-38DW	Two-hole, long barrel lug w/window, 4/0 AWG, 3/8" stud hole, 1" spacing	Other sizes available	Connections To TMGB and TGB
LCC3/0-38DW	Two-hole, long barrel lug w/window, 3/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC2/0-38DW	Two-hole, long barrel lug w/window, 2/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC1/0-38DW	Two-hole, long barrel lug w/window, 1/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC1-38DW	Two-hole, long barrel lug w/window, 1 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC2-38DW	Two-hole, long barrel lug w/window, 2 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC4-38DW	Two-hole, long barrel lug w/window, 4 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC6-14AW	Two-hole, long barrel lug w/window, 6 AWG, 1/4" stud hole, 1" spacing		Connections To TMGB and TGB

Grounding and Bonding Infrastructure			
Requirements for the J-STD-607-A and Miscellaneous Entrance Facility Grounding Components			
Panduit Part #	Description	Notes	Use
	hole, 5/8" spacing		
SSNTS1420-C	Stainless Steel Bolts, 1/4", 100 pack		Attaching lugs to busbars
SSCW14-C	Stainless Steel Belleville Washers(locking), 1/4", 100 pack		Attaching lugs to busbars
SSFW14-C	Stainless Steel Flat Washers, 1/4", 100 pack		Attaching lugs to busbars
SSN1420-C	Stainless Steel Nuts, 1/4", 100 pack		Attaching lugs to busbars
SSNTS3816-C	Stainless Steel Bolts, 3/8", 100 pack		Attaching lugs to busbars
SSCW38-C	Stainless Steel Belleville Washers(locking), 3/8", 100 pack		Attaching lugs to busbars
SSFW38-C	Stainless Steel Flat Washers, 3/8", 100 pack		Attaching lugs to busbars
SSN3816-C	Stainless Steel Nuts, 3/8", 100 pack		Attaching lugs to busbars
HTWC250-250-1	H-Tap w/Cover Kit: Run 250kcmil - #2 AWG, Tap 250kcmil - #2 AWG	Other sizes available	To Tap from TBB to TGB, Access floor grid to TGB
HTWC2-2-2	H-Tap w/Cover Kit: Run #2 - #6 AWG, Tap #2 - #6 AWG		To Tap from TBB to TGB or TBB to conduit w/ 6 AWG
HTWC250-2-1	H-Tap w/Cover Kit: Run 250kcmil - #2 AWG, Tap #2 - #6 AWG		TBB to conduit w/ 6 AWG
HTCT250-250-1	H-Tap ONLY Kit: Run 250kcmil - #2 AWG, Tap 250kcmil - #2 AWG	Other sizes available	In cases where an H-tap cover is not necessary
HTCT2-2-1	H-Tap Only Kit: Run #2 - #6 AWG, Tap #2 - #6 AWG		In cases where an H-tap cover is not necessary
HTCT250-2-1	H-Tap Only Kit: Run 250kcmil - #2 AWG, Tap #2 - #6 AWG		In cases where an H-tap cover is not necessary
GUBC500-6	Universal Beam Grounding Clamp		To attach to building steel
GPL-8	Grounding Clamp, U-Bolt. 1/2 or 3/4" pipe. #8AWG to #4 AWG	Other sizes available	TBB to conduit w/ 6 AWG
GPL-14	Grounding Clamp, U-Bolt. 1" pipe. #8AWG to #4 AWG		TBB to conduit w/ 6 AWG
LTYK	Telecommunications Grounding and Bonding Label Kit		For tagging cables, Do not disconnect

Data Center Access Floor Grounding Grid (Mesh Common Bonding Network)			
Requirements for TIA-942 and IEEE-1100			
Panduit Part #	Description	Notes	Use
GPQC07-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: 3/4"- 7/8" round	4 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC10-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: 7/8" SQUARE & 1"-1 1/8" round	5 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC12-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: Up to 1 1/4" round	6 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC15-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: Up to 1 1/2" round	7 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
CTAPF1/0-12	Code Conductor C-Tap: Run #2 AWG, Tap #2 AWG	8 ft x 4 ft grid, 2 AWG bare code recommended	Compression connector to tie in grid to perimeter if required
SBC3	Split bolt connector	one bond per every 60' of wire basket	Use to bond wire basket to grid. Not required for Panduits GridRunner.

Data Center Rack and Cabinet Grounding			
Requirements for TIA-942			
Panduit Part #	Description	Notes	Use
RGCBNJ660P22	Common Bonding Network Jumper Kit	All Cabinets/Racks in the data center. 6 AWG jumper, taps to 2 AWG.	For bonding Cabinets/Racks to the access floor grounding grid or other grounding infrastructure above or below the cabinet/rack.
RGS134-1Y	Grounding Strip Kit, threaded equipment mounting rails	Determine Type of mounting rails	Vertical Grounding Strip. Used to land equipment jumpers from active equipment
RGS134B-1	Grounding Strip Kit, Cage Nut equipment mounting rails	Determine Type of mounting rails	Vertical Grounding Strip. Used to land equipment jumpers from active equipment
RGRB19U	Grounding Bus Bar kit, threaded equipment mounting rails	Determine Type of mounting rails	Horizontal Bus bar. Used to land equipment jumpers from active equipment
RGRB19CN	Grounding Bus Bar Kit, Cage Nut equipment mounting rails	Determine Type of mounting rails	Horizontal Bus bar. Used to land equipment jumpers from active equipment
RGESD2-1	ESD Port, #12-24 threaded rail	Determine Type of mounting rails	cabinets with #12-24 mounting rails, use front and back
RGESDB-1	ESD Port, Cage Nut Rails	Determine Type of mounting rails	cabinets with cage nut mounting rails, use front and back
RGESDWS	ESD Wrist Strap	All Cabinets/Racks	Install Front and Back
RGW-100-1Y	Paint Piercing Grounding Washers, pack of 100	available in packs of 12, 24, 32 & 100	For bonding two-post rack members together during assembly of rack.

272 Pathways

272.1 Hangers and Supports for Communication Systems

J-hooks shall be used to route all exposed cables (cables not in conduit or cable tray) in open access environments as well as in communications closets. All J-Hooks shall be the Panduit J-Pro Cable Support System.

		Max. Bundle Capacity		Max. Cable Capacity*			Material**	Max. Static Load	
Part Number	Part Description	In.	mm	Cat 5e (.187")	Cat 6 (.250")	Cat 6A (.289")		Lbs.	kg
Wall Mount	J Hook for wall mount applications. One 1/4" (M6) mounting hole for user supplied screw.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP75W-L20^		1.31	33.3	31	17	13		25	11.30
JP131W-L20		2.00	50.8	56	31	23		30	13.61
JP2W-L20^†***		4.00	101.6	228	127	95		100	45.37
JP4W-X20^†***									
Wall Mount with Bracket									
JP75WP-L20^	J Hook for powder actuated installation on walls. One 5/32" (M4) mounting hole for user supplied fasteners.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131WP-L20		1.31	33.3	31	17	13		25	11.30
JP2WP-L20^		2.00	50.8	56	31	23		30	13.61
JP4WP-X20		4.00	101.6	228	127	95		100	45.37
Ceiling Mount									
JP75CM-L20^	J Hook with ceiling mount bracket that has one 3/16" (M5), 1/4" (M6) and 3/8" (M10) mounting hole.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131CM-L20		1.31	33.3	31	17	13		25	11.30
JP2CM-L20^		2.00	50.8	56	31	23		30	13.61
JP4CM-X20		4.00	101.6	228	127	95		100	45.37
Drop Wire and Threaded Rod Clip									
JP75DW-L20^	J Hook with clip for use with #12 wire, threaded rod up to 1/4" in diameter, or 1/8" – 1/4" thick flanges.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	10	4.53
JP131DW-L20		1.31	33.3	31	17	13		10	4.53
JP2DW-L20^†		2.00	50.8	56	31	23		10	4.53
Screw-On Beam Clamp									
JP75SBC50-L20	J Hook with screw-on beam clamp for use with flanges up to 1/2" thick. Rotates 360°.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131SBC50-L20		1.31	33.3	31	17	13		25	11.30
JP2SBC50-L20		2.00	50.8	56	31	23		30	13.61
JP4SBC50-X20		4.00	101.6	228	127	95		25	11.30
JP75SBC50R-L20^***		0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131SBC50R-L20^***		1.31	33.3	31	17	13		25	11.30
JP2SBC50R-L20^***		2.00	50.8	56	31	23		30	13.61
JP4SBC50R-X20		4.00	101.6	228	127	95		100	45.37

attachments

		Max. Bundle Capacity		Max. Cable Capacity*			Material**	Max. Static Load	
Part Number	Part Description	In.	mm	Cat 5e (.187")	Cat 6 (.250")	Cat 6A (.289")		Lbs.	kg
JP75SBC87-L20	J Hook with screw-on beam clamp for use with flanges up to 3/4" thick.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131SBC87-L20		1.31	33.3	31	17	13		25	11.30
JP2SBC87-L20		2.00	50.8	56	31	23		30	13.61
JP4SBC87-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
JP75SBC87R-L20	J Hook with screw-on beam clamp for use with flanges up to 3/4" thick.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131SBC87R-L20		1.31	33.3	31	17	13		25	11.30
JP2SBC87R-L20		2.00	50.8	56	31	23		30	13.61
JP4SBC87R-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
Purlin Clips									
JP75ZP-L20	J Hook with Z-purlin clip for use with angled flanges up to 1/4" thick.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131ZP-L20		1.31	33.3	31	17	13		25	11.30
JP2ZP-L20		2.00	50.8	56	31	23		30	13.61
JP4ZP-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
JP75CP-L20	J Hook with c-purlin clip for use with vertical flanges up to 1/4" thick.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131CP-L20		1.31	33.3	31	17	13		25	11.30
JP2CP-L20		2.00	50.8	56	31	23		30	13.61
JP4CP-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
Hammer-On Beam Clamp									
JP75HBC25R-L20	J Hook with hammer-on beam clamp for use with flanges 1/8" – 1/4" thick.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131HBC25R-L20		1.31	33.3	31	17	13		25	11.30
JP2HBC25R-L20		2.00	50.8	56	31	23		30	13.61
JP4HBC25R-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
JP75HBC50R-L20	hammer-on use with flanges 5/16" – 1/2" thick. Rotates 360°.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131HBC50R-L20		1.31	33.3	31	17	13		25	11.30
JP2HBC50R-L20		2.00	50.8	56	31	23		30	13.61
JP4HBC50R-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
JP75HBC75R-L20	J Hook with hammer-on beam clamp for use with flanges 9/16" – 3/4" thick. Rotates 360°.	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131HBC75R-L20		1.31	33.3	31	17	13		25	11.30
JP2HBC75R-L20		2.00	50.8	56	31	23		30	13.61
JP4HBC75R-X20	Rotates 360°.	4.00	101.6	228	127	95		100	45.37
Under Floor Pedestal Clamp									
JP75UF100-L20	J Hook with under floor clamp for use	0.75	19.0	11	6	4	Nylon 6.6 J Hook with metal attachments	15	6.81
JP131UF100-L20		1.31	33.3	31	17	13		25	11.30
JP2UF100-L20		2.00	50.8	56	31	23		30	13.61

		Max. Bundle Capacity		Max. Cable Capacity*			Material** attachments	Max. Static Load	
Part Number	Part Description	In.	mm	Cat 5e (.187")	Cat 6 (.250")	Cat 6A (.289")		Lbs.	kg
JP4UF100-X20	with pedestal support 7/8" square or 1 1/8" – 1 3/8" in diameter.	4.00	101.6	228	127	95		100	45.37

272.2 Cable Trays for Communications Systems

Panduit FiberRunner-	Shall be used for overheard distribution of fiber cable Please note more sizes available are offered by Panduit
Part Number	Description
FR6X4YL6	6x4 FiberRunner Channel
FRHC6YL6	6x4 FiberRunner Snap-On Hinged Cover
FRBC6X4YL	6x4 FiberRunner QuikLock Barbed Coupler
FRSPYL	Spill-Over Junction with 2x2 Exit
FRSP6CYL	Spill-Over Junction with 2x2 Exit Cover
FREC6X4YL	6x4 FiberRunner End Cap
FRIDT2X2YL	1 Port ID Spill-Out to 1.5" ID CLT
FBC2X2YL	2x2 FiberRunner QuikLock Barbed Coupler
FREC6X4YL	6x4 FiberRunner End Cap
CLT150F-X20	Slit Corrugated Loom Tubing (10 ft roll)
FRT6X4YL	6x4 FiberRunner Horizontal Tee
FRTSC6YL	6x4 FiberRunner Horizontal Tee Cover
FRVT6X4YL	6x4 FiberRunner Vertical Tee
FRT4X4YL	4x4 Fiber-Duct Bend Radius Control Trumpet
FR6LRB	Ladder Rack Bracket
FR4X4YL6	4X4 FiberRunner Channel
FRHC4YL6	4X4 FiberRunner Snap-On Hinged Cover
FRBC4X4YL	4X4 FiberRunner QuikLock Barbed Coupler
FRSPYL	Spill-Over Junction with 2x2 Exit
FRSP4CYL	Spill-Over Junction with 2x2 Exit Cover
FREC4X4YL	4X4 FiberRunner End Cap
FRIDT2X2YL	1 Port ID Spill-Out to 1.5" ID CLT
FBC2X2YL	2x2 FiberRunner QuikLock Barbed Coupler
FREC4X4YL	4X4 FiberRunner End Cap
CLT150F-X20	Slit Corrugated Loom Tubing (10 ft roll)
FRT6X4YL	6x4 FiberRunner Horizontal Tee
FRTSC6YL	6x4 FiberRunner Horizontal Tee Cover
FRVT4X4YL	4x4 FiberRunner Vertical Tee
FRT4X4YL	4x4 Fiber-Duct Bend Radius Control Trumpet
FR6LRB	Ladder Rack Bracket

GridRunner	Shall be used for all raised floor cable requirements (i.e. data center)
Part Number	Description
GR21X6X24PG	21" W x 6" D x 24" L Wire Basket Section
GR21X6X48PG	21" W x 6" D x 48" L Wire Basket Section
GRFWC21PG	Universal Intersection Section
GRPBPG	Pedestal Support Bracket
GRCLAMPPG-X	Pedestal Clamp
GR21X4X24PG	21" W x 4" D x 24" L Wire Basket Section
GR21X4X48PG	21" W x 4" D x 48" L Wire Basket Section
GR12X4X24PG	12" W x 6" D x 24" L Wire Basket Section
GR12X4X48PG	12" W x 6" D x 48" L Wire Basket Section
GRBRC6PG	Bend Radius Control Corner
GRLC21X6PG	21" W x 6" D level Change Section

272.3. Surface Raceway for Communication Systems

DFW Airport shall use Panduit Surface Raceway Solutions for office or warehouse environments as needed. Panduit's Pan-Way Surface Raceway Systems offer a wide variety of metal and non-metallic surface raceway solutions; all that provide routing, protecting, and concealing high performance copper, voice, video, fiber optic, and power cabling. Specific requirements and product selection will be provided by DFW ITS Department.

272.4. Identification labeling Communication systems

All labels shall be Panduit TIA/EIA-606-A compliant labeling products. All cables, faceplates, patch panels, 110 blocks, boxes and patch cords shall be labeled as to TIA/EIA-606-A standards, and as designed by Panduit to be used for the specific Product. All conduits and inner-duct shall be labeled as well.

Reference	Description	Part Number		
		LS8	Laser	Desktop Thermal
Sec.270553,Part2,Para.5	Outlet Labels, 2 Port Adhesive	C125X030FJC	C125X030FJJ	C125X030YPT
Sec.270553,Part2,Para.5	Outlet Labels, 2 Port Non-Adhesive	C195X040Y1C	C195X040Y1J	C195X040Y1T
Sec.270553,Part2,Para.5	Outlet Labels, 4 Port Adhesive	C252X030FJC	C252X030FJJ	C252X030YPT
Sec.270553,Part2,Para.5	Outlet Labels, 4 Port Non-Adhesive	C261X035Y1C	C261X035Y1J	-
Sec.270553,Part2,Para.2	HDA Cable Labels	S100X150VAC	S100X150YAJ	S100X150VAT
Sec.270553,Part2,Para.2	Fiber Cable Labels 2mm and 3mm dia	S100X160VAC	S100X160YAJ	-

Reference	Description	Part Number		
		LS8	Laser	Desktop Thermal
Sec.270553, Part2, Para.2	Fiber Cable Labels Duplex and Ribbon Cable	S100X220VAC	S100X220YAJ	-
Sec.270553, Part2, Para.2	Copper Riser Cable Labels	S100X225VAC	S100X225YAJ	S100X225VAT
Sec.270553, Part2, Para.2	Patch Cord Labels	S100X150VAC	S100X150YAJ	S100X150VAT
Sec.270553, Part2, Para.3	Fiber Cable Label Carriers 2mm dia	NWSLC-2Y	NWSLC-2Y	NWSLC-2Y
Sec.270553, Part2, Para.3	Fiber Cable Label Carriers 3mm dia	NWSLC-3Y	NWSLC-3Y	NWSLC-3Y
Sec.270553, Part2, Para.3	Fiber Cable Label Carriers 7mm dia	NWSLC-7Y	NWSLC-7Y	NWSLC-7Y
Sec.270553, Part3, Para.5b,c	Fiber Patch Panel Port Labels	T100X000VPC-BK	C350X100YJJ	C350X100YJT
Sec.270553, Part3, Para.5b,c	Copper Patch Panel 4 Port Labels - Adhesive	C252X030FJC	C252X030FJJ	C252X030YPT
Sec.270553, Part3, Para.5b,c	Copper Patch Panel 4 Port Labels - Non-Adhesive	C261X035Y1C	C261X035Y1J	-
Sec.270553, Part3, Para.5b,c	Copper Patch Panel 6 Port Labels - Adhesive	C379X030FJC	C379X030FJJ	C379X030YPT
Sec.270553, Part3, Para.5b,c	Copper Patch Panel 6 Port Labels - Non-Adhesive	C390X030Y1C	C390X030Y1J	-
Sec.270553, Part2, Para.4	Termination Block Label Insert - 110 Block	C750X050Y1C	C750X050Y1J	C750X050Y1T
Sec.270553, Part2, Para.4	Termination Block Label Insert - Gigapunch Block	C788X050Y1C	C788X050Y1J	C788X050Y1T
Sec.270553, Part2, Para.1	Cabinet Labels - Adhesive	C200X100YPC	C200X100YJJ	C200X100YPT
Sec.270553, Part2, Para.1	Cabinet Labels - Diecut, Foam backed, Adhesive	-	-	C200X100APT
Sec.270553, Part2, Para.1	Rack Labels - Adhesive Label	C200X100YPC	C200X100YJJ	C200X100YPT
Sec.270553, Part2, Para.1	Rack Labels - Diecut, Foam backed, Adhesive	-	-	C200X100APT
Sec.270553, Part3, Para.5a	Cabinet Row End Labels - Adhesive	C200X100YPC	C400X400YJJ	C400X400YJT
Sec.270553, Part3, Para.5a	Cabinet Row End Labels - Diecut, Foam backed, Adhesive	-	-	C300X250APT
Sec.270553, Part2	Label Marking Machine	LS8E	-	TDP43MY
Sec.270553, Part2	Label Marking Software	PROG-EMCD3	PROG-EMCD3	PROG-EMCD3

273 DFW LABELING STANDARDS
 FN – numeric building identifier is unique across the campus

TR/ER/TC – Telecommunications Room (TR) where no servers or computers are installed such as for telephone cross-connects. An Equipment Room (ER) which is an environmentally controlled telecommunications room which may also serve as a TR. A Telecommunications Closet (TC) is a small closet for patching in phones or network outlets. An Entrance Facility (EF) is a room where outside plant cabling is terminated to a wall field or patch panel.

- A – Alpha only value
- X – Indicates alpha-numeric value
- Y – Indicates numeric only value

Figure 2 – Wall Area Outlet Faceplate Labeling.



Label as follows:
 Faceplate ID (Top & bottom label as shown above):
Destination TR/ER/TC – Faceplate # (e.g. TR2E-018)
 XXXX – YYY
 Note: Faceplate # starts with '001' to '999'.

Voice Jack ID (above each white jack as depicted):
Destination Wall Field – Row – Chassis section (e.g. AB-06-05)

AA - YY – YY

Note: Chassis section or port numbering starts with '01' to '05' which corresponds to one row on a wall field.

Data Jack ID (below each red jack as depicted):
Destination Cabinet/Rack#- Rack Unit – Port # (e.g. 01-38-05)
 YY – YY – YY

Note: Port numbering starts with '01' to '24' for a 24-port patch panel or '48' if connected to a 48-port patchpanel in the TR/ER/TC.

Figure 3 – Cabinet and Wall Field Identification. Each cabinet in the TR/ER must be labeled as follows: TR/ER/TC room ID then '01 – 99', e.g. TR2E-1. Rail Rack unit (RU) numbering in each cabinet starts at the bottom with '01'. Some rails are pre-numbered by the manufacturer. Each wall field chassis must be labeled starting with the TR/ER/TC ID then '- AA' to '- AZ' from left to right, e.g. TR2E-AA. Each wall field chassis row must be labeled starting with '01' at the top.

Figure 4 - Patch Panel and Wall Field Labeling (going to wall area outlets only).
Patch Panel and Data Port Labeling.

Ports are numbered from the left starting with '01 to 24' for a 24-port patch panel, and '01 to 48' for a 48-port patch panel.

Labeled as follows:
 Top Line – *Destination Faceplate ID* (e.g. TR2E - 018)
 XXXX - YYY
 2nd Line (Port label) – *Cabinet/Rack# - Rack Unit - Port#* (e.g. 01-38-01)
 YY - YY - YY

Wall Field Labeling.

There are five (5) Chassis Sections or Ports per row, labeled '01 – 05'.



Label each Chassis Section or Port as follows:
Destination Faceplate ID – Chassis# - Row# - Section or port# (e.g. TR2E-018-AB-05-01)

XXXX-YYY-AA-YY-YY



Figure 5 – Patch Panel to Patch Panel Labeling.

Note: One (1) 24-port copper patch panel will be installed in each Chatsworth cabinet in the 3rd rack unit from the top which will potentially house computers or other electronics needing data network access. Label as follows:

Top Line – *Destination Cabinet/Rack ID* (e.g. TR2E-06)

XXXX-YY

2nd Line – *Destination Rack Unit - Port #* (e.g.

38-01)

YY-YY-YY

Figure 6 - Horizontal Cable Labeling.

Label both ends of the cable the same as follows:
TE/ER/FC ID- Faceplate#- Rack#/Wall Field ID- Rack Unit/Row-Port#

Data Cable - XXXX-YYY-YY-YY-YY (e.g. TR2E-018-01-38-01)

Voice Cable – XXXX-YYY- AA-YY (e.g. TR2E-018-AA-01-01)

Figure 7 – Backbone Distribution Cable within a Building (fiber and copper).

Label both ends of the cable the same as follows:
Cabinet Rack/Wall field ID - Rack Unit/Row / Destination Cabinet/Rack/Wall field ID Rack Unit/Row

Data - XXXX-YY-YY / XXXX-YY-YY

Voice – XXXX-AA-YY / XXXX-AA-YY

e.g. Data – TR2E-06-07 / GHN1-03-06

Voice - TR2E-AA-01 / GHN1-AB-02

Figure 8 – Outside Plant Cable Label (fiber and copper).

Label each cable as follows:

FN-EF/TR-Cabinet/Rack # -Rack Unit / Destination

FN-EF/TR- Cabinet/Rack# -Rack Unit

YYYYY-XXXX-YY-YY/YYYYY-XXXX-YY-YY

e.g.: 33960-SN1D-03-38 / 34780-ERS1-03-18

Figure 9 – Conduit Labeling.

Label each end and at each J-Box as follows:

Origin / Destination

XXXX / XXXX

e.g, TR2E/MERS

Figure 10 – Fiber Optic Patch Cable Labeling.

Label each end as follows:

General Layout: Origin / Destination

Label Template: Comm. Rm. # - Cabinet# - Rack unit# - strand # or switch port

e.g. MCRS – 01 – 34 – 35/36

MCRN – 05 – 10 – 13/14

e.g. TR1W – 02 – 05 – 02

TR1W – 01 – 45 – 32/34

SECTION 274
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Communication Cabinets, Racks, Frames and Enclosures

Based on the specific IDF, MDF, or Data Center requirements, below are acceptable racks, cabinets, and wire managers:

1. *Active Zone Cabling Solutions*
 - a. Wall Mount Applications

Part Number	Description
PanZone Wall Mount Cabinets	
PZC12S	PanZone Wall Mount Cabinet, 12 RU, solid door
PZC12P	PanZone Wall Mount Cabinet, 12 RU, perforated door
PZC12W	PanZone Wall Mount Cabinet, 12 RU, windowed door
PZCHSM2	PanZone Horizontal Slack Manager, 2 RU
PZCFK	PanZone Fan Kit
PZCGK	PanZone Grounding and Bonding Kit
PanZone Active Wall Mount Enclosure	
PZAEWM3	PanZone Active Wall Mount Enclosure, 3 RU for active equipment & 3 RU for passive products
PZAELOCK	Optional keyed locks for PZAEWM3
PZAEFAN	PanZone Fan Kit for PZAEWM3, accepts up to 2 fan kits
PZCGK	PanZone Grounding and Bonding Kit for PZAEWM3

Part Number	Description
PanZone Wall Mount Cabinets	
PZC12S	PanZone Wall Mount Cabinet, 12 RU, solid door
PZC12P	PanZone Wall Mount Cabinet, 12 RU, perforated door
PZC12W	PanZone Wall Mount Cabinet, 12 RU, windowed door
PZCHSM2	PanZone Horizontal Slack Manager, 2 RU
PZCGK	PanZone Grounding and Bonding Kit
Punchdown Consolidation Point Enclosures	
WMCPE	Wall Mount Consolidation Point Enclosure accepts one punch down base
PanZone Wall Mount Consolidation Point Enclosure	
PZB4	PanZone Wall Mount Consolidation Point Enclosure accepts 4 Punch down bases
PZB4-HC	PanZone Hinged Cover for PZB4
PZB4-FC	PanZone Flat Cover for PZB4
PZBPPB	PanZone Patch Panel Bracket Kit; accommodates up to 2 RU of standard patch panels in PZB4
Raised Floor Applications	

Part Number	Description
PanZone Raised Floor Enclosure	
PZRFE4	PanZone Raised Floor Enclosure, 4 RU
PZRFE8	PanZone Raised Floor Enclosure, 8 RU
PZRFE12	PanZone Raised Floor Enclosure, 12 RU
PanZone Under Floor Enclosures	
PZCPE2F	PanZone Under Floor Consolidation Point Enclosure, accepts 2 FAPs/FMPs
PZCPE4F	PanZone Under Floor Consolidation Point Enclosure, accepts 4 FAPs/FMPs
PZCPE8F	PanZone Under Floor Consolidation Point Enclosure, accepts 8 FAPs/FMPs
Part Number	Description
Consolidation Point Boxes	
CUFMB24BL	24-port Mini-Com Consolidation Point Enclosure
CUFB48BL	48-port Mini-Com Consolidation Point Enclosure
CUFF-KIT	Optional fiber conversion kit
Punchdown Consolidation Point Enclosures	
WMCPE	Wall Mount Consolidation Point Enclosure; accepts one punch down base

2. Fiber Optic Rack Mount Enclosures

Part Number	Dimensions	Capacity
FRME1	1.74"H x 17.16"W x 11.08"D (44.2mm x 435.9mm x 299.7mm)	Three FAP or FMP adapter panels
FRME2	3.45"H x 17.16"W x 11.80"D (87.6mm x 433.3mm x 292.1mm)	Six FAP or FMP adapter panels
FRME3	5.00"H x 17.16"W x 11.80"D (127.0mm x 433.3mm x 292.1mm)	Nine FAP or FMP adapter panels
FRME4	6.62"H x 17.16"W x 11.80"D (168.1mm x 433.3mm x 292.1mm)	Twelve FAP or FMP adapter panels

Fiber Optic Rack Mount Cassette Enclosures

Part Number	Dimensions	Capacity
FCE1U	1.73"H x 17.60"W x 16.03"D (43.9mm x 447.0mm x 414.0mm)	Four QuickNet Cassettes, FAP adapter panels or FOSM splice modules
FCE2U	3.48"H x 17.60"W x 16.30"D (88.4mm x 447.0mm x 414.0mm)	Eight QuickNet Cassettes, FAP adapter panels or FOSM splice modules
FCE4U	6.98"H x 17.60"W x 16.30"D (177.0mm x 447.0mm x 414.0mm)	Twelve QuickNet Cassettes, FAP adapter panels or FOSM splice modules

Fiber Optic Wall Mount Enclosures

Part Number	Dimensions	Capacity
FWME2	10.18"H x 12.00"W x 2.32"D (258.6mm x 304.8mm x 59.1mm)	Wall Mount Fiber Enclosure (Holds 2 panels)
FWME4	12.25"H x 16.11"W x 3.52"D (311.0mm x 409.2mm x 89.4mm)	Wall Mount Fiber Enclosure (Holds 4 panels)

FMP6	Fiber Connector Panel
FST24S	Fiber Splice Tray
FSTHED	Fiber Splice Tray Holder
FMD1	Opticom Rack Mount Fiber Drawers - 48 fibers
FMD2	Opticom Rack Mount Fiber Drawers - 96 fibers
CFAPPBL1	Fiber Adapter Panel
CFAPPBL2	Fiber Adapter Panel
FRME72SBL	Opticom Fiber Splice Enclosure 72
FRME144SBL	Opticom Fiber Splice Enclosure 144

B. Communications Termination Blocks and Patch Panels

Panduit Part Number	Product Type	Description
UICMPPA24BLY	Modular Patch Panel for Cat 6 modules	Ultimate ID 24 port, 1RU angled Modular Patch Panel for Cat 6A, CAT 6 and CAT5e modules
UICMPPA48BLY	Modular Patch Panel for Cat 6 modules	Ultimate ID 48 port, 2RU angled Modular Patch Panel for Cat 6A, CAT 6 and CAT5e modules
UICMPP24BLY	Modular Patch Panel for Cat 6 modules	Ultimate ID 24 port, 1RU flat Modular Patch Panel for Cat 6A, CAT 6 and CAT5e modules
UICMPP48BLY	Modular Patch Panel for Cat 6 modules	Ultimate ID 48 port, 2RU flat Modular Patch Panel for Cat 6A, CAT 6 and CAT5e modules
CPPLA24WBLY	Modular Patch Panel with labels	24 Port 1 RU angled Modular Patch Panel with labels for Cat 6A, Cat 6, and Cat5e modules
CPPLA48WBLY	Modular Patch Panel with labels	48 Port 2 RU angled Modular Patch Panel with labels for Cat 6A, Cat 6, and Cat5e modules
CPPL24WBLY	Modular Patch Panel with labels	24 Port 1 RU flat Modular Patch Panel with labels for Cat 6A, Cat 6, and Cat5e modules
CPPL48WBLY	Modular Patch Panel with labels	48 Port 2 RU flat Modular Patch Panel with labels for Cat 6A, Cat 6, and Cat5e modules
GPKBW24Y	Wiring Block	Giga Punch wiring block kit (CAT 6)
P110KB1005Y	Wiring Block	PanPunch 110 wiring block kit
DPFP1	1 RU rack filler panel	
DPFP2	2 RU rack filler panel	
DPFP4	4 RU rack filler panel	
DPFP8	8 RU rack filler panel	

C. Communications Cable Management and Ladder Rack

Panduit Part Number	Description
PRV6	Patchrunner Vertical manager 6" wide front and rear
PRV8	Patchrunner Vertical manager 8" wide front and rear
PRV10	Patchrunner Vertical manager 10" wide front and rear
PRV12	Patchrunner Vertical manager 12" wide front and rear
PRV15	Patchrunner Vertical manager 15" wide front and rear
PRD6	Dual hinged metal door for PRV6
PRD8	Dual hinged metal door for PRV8
PRD10	Dual hinged metal door for PRV10
PRD12	Dual hinged metal door for PRV12
PRD15	Dual hinged metal door for PRV15
NM1	High Capacity NetManager horizontal 1RU front and rear
NM2	High Capacity NetManager horizontal 2RU front and rear
NM3	High Capacity NetManager horizontal 3RU front and rear
NM4	High Capacity NetManager horizontal 4RU front and rear
NMF1	High Capacity NetManager horizontal 1RU front only
NMF2	High Capacity NetManager horizontal 2RU front only
NMF3	High Capacity NetManager horizontal 3RU front only
NMF4	High Capacity NetManager horizontal 4RU front only
CWF400	Provides bend radius control for cable entering/exiting 4" conduit
CMW-KIT	Cable management waterfall kit that provides bend radius control when transferring cables from standard ladder rack
TRC18FR-X8	Used to protect cabling from threaded rod
CRS4-125-X	Four space stackable cable rack spacer for standard ladder rack
CRS1-125-X	One space stackable cable rack spacer for standard ladder rack
CRS6-X	Six space stackable cable rack spacer
CRS1-X	One space stackable cable rack spacer

SECTION 27.5
COMMUNICATIONS BACKBONE CABLING

A. Copper Backbone Cabling

1. Panduit (Plenum rated):

- Cat 5e, 25pair, CMP cable PUP5525IG-UY
- Cat 3, 50pair, CMP cable PUP3050IG-UG/N (offered as a NS...non-standard)
- Cat 3, 100pair CMP cable PUP30100IG-UG/N (offered as a NS...non-standard)
- Cat 3, 200pair, CMP CABLE PUP30200IG-UG/N (offered as a NS...non-standard)
- Refer to DFW ITS Infrastructure for recommended pair count during design buildout (972-973-9000).

B. Voice communications Horizontal Cabling
DFW Airport cable infrastructure projects require a PANDUIT TX6A 10GIG structured cabling system, NO EXCEPTIONS.

2 PANDUIT® *CERTIFICATION PLUS™* System Warranty

A *CERTIFICATION PLUS* System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of 25 years.

PANDUIT® PCI Contractor Agreement

A factory registered *PANDUIT* PCI contractor shall complete network installation. The contractor shall have completed standards based product and installation training. A copy of the PCI Contractor Registration shall be submitted in the proposal.

K Product Guarantee

All *PANDUIT PAN-NET®* non-consumable products have a 25-year guarantee. When installed per TIA or ISO/IEC standards, the *PANDUIT PAN-NET®* Network Cabling System will operate the application(s) for which the system was designed to support. Applications may include, but are not limited to:

- 10GBASE-T Ethernet (IEEE 802.3an)
- 10/100/1000 Mbps Ethernet (IEEE 802.3)
- 4/16 Mbps Token Ring (IEEE 802.5)
- 155, 622, 1.25 Gbps ATM
- SONET
- FDDI/CDDI
- IBM System 3x-AS/400
- Appletalk
- ISDN

In order to qualify for the guarantee, the structured cabling system must be installed per the following:

- Meet all TIA/EIA commercial building wiring standards
- *PANDUIT* categorized product must be used in conjunction with *PANDUIT TX6A™ 10GIG™* UTP Copper Cable.
- *PANDUIT* Products must be installed per Panduit instruction sheets.

Note: All Networks shall be installed per applicable standards and manufacturer's guidelines.

If any *PANDUIT PAN-NET®* product fails to perform as stated above, *PANDUIT* will provide new components at no charge.

THIS GUARANTEE IS MADE IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR USE ARE SPECIFICALLY EXCLUDED.

bK Cable Packaging

Neither seller nor manufacturer shall be liable for any other injury, loss or damage, whether direct or consequential.

The *TX6A™ 10GIG™* UTP Copper Cable with MaTriX Technology shall meet or exceed both channel and component compliant standards (ANSI/EIA/TIA-568-B.2-10, IEC/ISO 11801 Class E_A (channel) and IEC 61156-6 (component) standards). Augmented Category 6 UTP 4 pair copper cable shall be constructed of 23 AWG conductors. The insulated conductors shall be twisted in pairs and all four pairs shall be covered by a flame retardant PVC, FEP, or PE jacket depending on cable flame rating. The copper conductors shall be twisted in pairs and separated by a cross web. All four pairs shall be surrounded by Matrix Tape and flame retardant jacket. The patent pending Matrix Tape shall suppress the effects of alien crosstalk allowing 10Gb/s transmission. This innovative cable design shall provide installation flexibility as cables can be routed in tight bundles through pathways and spaces. The *TX6™ 10GIG™* UTP Copper Cable with MaTriX Technology must be installed as part of a complete *TX6™ 10GIG™* Copper Cabling System in order to achieve 10GBASE-T certified performance.

All cable shall conform to the requirements for communications circuits defined by the NEC (Article 800) and the Canadian Building Code. Cable listed to NEC Article 800-51(a) will be used for "Plenum" installations. Cable listed to NEC Article 800-51(b) shall be installed in vertical runs penetrating more than one floor.

Part number	Flame Rating	Category
PUR6A04**-UG	CMR	6A - UTP
PUP6A04**-UG	CMP	6A - UTP

** - designates color

** - To designates color, add BU (Blue), WH (White), YL (Yellow), GR (Green), BL (Black), RD (Red), VL (Violet), and OR (Orange).

aK Quality Control

Every Master Reel shall be tested for Attenuation, NEXT, Power Sum Crosstalk, Impedance, and RL. This testing shall be performed using a sweep test method and include frequencies from 0.772 MHz to 650MHz.

The cable shall be packaged in 1000 ft (305 meter) reels with descending length designation markings.

Specification	Value
Flame Rating	Riser – NEC type CMR (UL) and FT4 rated Plenum – NEC type CMP (UL) and FT4 rated
Installation Tension	25 lbs. (110N) maximum
Temperature Rating	32° to 140°F (0° to 60°C) during installation 14° to 167°F (-10° to 75°C) during operation
Mechanical Test	Requirement
Ultimate Breaking Strength	> 400 N (90 lb. ft.)
Minimum Bend Radius	25.4 mm (1.0 inch)
Electrical Test	Requirement
DC resistance	<90.38 Ohm per 100M (328 ft.)
DC Resistance Unbalance	<5% at 20°C per ASTM D 4566
Mutual Capacitance	<5.6 nF per 100M (328 ft.) at 1KHz and 20°C per ASTM D 4566
Characteristic Impedance	<5.6 nF per 100M (328 ft.) at 1 kHz and 20°C per ASTM D 4566
Propagation Velocity	>62.1 (at 250 MHz) CMR: 70% CMP: 72%

F. Date Communications Horizontal Cabling DFW Airport cable infrastructure projects require a PANDUIT TX6A 10GIG structured cabling system.

NK PANDUIT® CERTIFICATION PLUS™ System Warranty
A *CERTIFICATION PLUS* System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of 25 years.

OK PANDUIT® PCI Contractor Agreement
A factory registered *PANDUIT* PCI contractor shall complete network installation. The contractor shall have completed standards based product and installation training. A copy of the PCI Contractor Registration shall be submitted in the proposal.

PK *Product Guarantee*
All *PANDUIT PAN-NET®* non-consumable products have a 25-year guarantee. When installed per TIA or ISO/IEC standards, the *PANDUIT PAN-NET®* Network Cabling

System will operate the application(s) for which the system was designed to support. Applications may include, but are not limited to:

10GBASE-T Ethernet (IEEE 802.3an)
10/100/1000 Mbps Ethernet (IEEE 802.3)
4/16 Mbps Token Ring (IEEE 802.5)
155, 622, 1.25 Gbps ATM
SONET
FDDI/CDDI
IBM System 3x-AS/400
Appletalk
ISDN

In order to qualify for the guarantee, the structured cabling system must be installed per the following:

- Meet all TIA/EIA commercial building wiring standards
- *PANDUIT* categorized product must be used in conjunction with *PANDUIT TX6A™ 10GIG™* UTP Copper Cable.
- *PANDUIT* Products must be installed per Panduit instruction sheets.

Note: All Networks shall be installed per applicable standards and manufacturer's guidelines.

If any *PANDUIT PAN-NET*® product fails to perform as stated above, *PANDUIT* will provide new components at no charge.

THIS GUARANTEE IS MADE IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS

FOR A PARTICULAR USE ARE SPECIFICALLY EXCLUDED. Neither seller nor manufacturer shall be liable for any other injury, loss or damage, whether direct or consequential.

The *TX6A*™ *10GIG*™ UTP Copper Cable with MaTriX Technology shall meet or exceed both channel and component compliant standards (ANSI/EIA/TIA-568-B.2-10, IEC/ISO 11801 Class E_A (channel) and IEC 61156-6 (component) standards). Augmented Category 6 UTP 4 pair copper cable shall be constructed of 23 AWG conductors. The insulated conductors shall be twisted in pairs and all four pairs shall be covered by a flame retardant PVC, FEP, or PE jacket depending on cable flame rating. The copper conductors shall be twisted in pairs and separated by a cross web. All four pairs shall be surrounded by Matrix Tape and flame retardant jacket. The patent pending Matrix Tape shall suppress the effects of alien crosstalk allowing 10Gb/s transmission. This innovative cable design shall provide installation flexibility as cables can be routed in tight bundles through pathways and

spaces. The *TX6*™ *10GIG*™ UTP Copper Cable with MaTriX Technology must be installed as part of a complete *TX6*™ *10GIG*™ Copper Cabling System in order to achieve 10GBASE-T certified performance.

All cable shall conform to the requirements for communications circuits defined by the National Electrical Code (Article 800) and the Canadian Building Code. Cable listed to NEC Article 800- 51(a) will be used for “Plenum” installations. Cable listed to NEC Article 800-51(b) shall be installed in vertical runs penetrating more than one floor.

Part number	Flame Rating	Category
PUR6A04**-UG	CMR	6A - UTP
PUP6A04**-UG	CMP	6A - UTP

** - designates color

** - To designates color, add BU (Blue), WH (White), YL (Yellow), GR (Green), BL (Black), RD (Red), VL (Violet), and OR (Orange).

G. Quality Control

Every Master Reel shall be tested for Attenuation, NEXT, Power Sum Crosstalk, Impedance, and RL. This testing shall be performed using a sweep test method and include frequencies from 0.772 MHz to 650MHz.

H. Cable Packaging

The cable shall be packaged in 1000 ft (305 meter) reels with descending length designation markings.

Additional Specifications

Specification	Value
Flame Rating	Riser – NEC type CMR (UL) and FT4 rated Plenum – NEC type CMP (UL) and FT4 rated
Installation Tension	25 lbs. (110N) maximum
Temperature Rating	32° to 140°F (0° to 60°C) during installation 14° to 167°F (-10° to 75°C) during operation
Mechanical Test	Requirement
Ultimate Breaking Strength	> 400 N (90 lb. ft.)
Minimum Bed Radius	25.4 mm (1.0 inch)
	Electric Requirement
DC resistance	<90.38 Ohm per 100M (328 ft.)
DC Resistance Unbalance	<5% at 20°C per ASTM D 4566
Mutual Capacitance	<5.6 nF per 100M (328 ft.) at 1KHz and 20°C per ASTM D 4566
Characteristic Impedance	<5.6 nF per 100M (328 ft.) at 1 kHz and 20°C per ASTM D 4566
Propagation Velocity	>62.1 (at 250 MHz) CMR: 70% CMP: 72%

J. Grounding and Bonding for Communication Systems

Grounding and Bonding Infrastructure			
Requirements for the J-STD-607-A and Miscellaneous Entrance Facility Grounding Components			
Panduit Part #	Description	Notes	Use
GB4B0612TPI-1	Telecommunications Main Grounding Busbar (TMGB) 1/4" x 4" x 12", Solid Copper, Tin Plated,		TMGB
GB4B0624TPI-1	Telecommunications Main Grounding Busbar (TMGB) 1/4" x 4" x 20", Solid Copper, Tin Plated,		TMGB
GB2B0304TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 10", Solid Copper, Tin Plated.		TGB
GB2B0306TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 12", Solid Copper, Tin Plated.		TGB
GB2B0312TPI-1	Telecommunications Grounding Busbar (TGB) 1/4" x 2" x 12", Solid Copper, Tin Plated.		TGB
LCC4/0-38DW	Two-hole, long barrel lug w/window, 4/0 AWG, 3/8" stud hole, 1" spacing	Other sizes available	Connections To TMGB and TGB
LCC3/0-38DW	Two-hole, long barrel lug w/window, 3/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC2/0-38DW	Two-hole, long barrel lug w/window, 2/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC1/0-38DW	Two-hole, long barrel lug w/window, 1/0 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB

Grounding and Bonding Infrastructure

Requirements for the J-STD-607-A and Miscellaneous Entrance Facility Grounding Components

Panduit Part #	Description	Notes	Use
LCC1-38DW	Two-hole, long barrel lug w/window, 1 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC2-38DW	Two-hole, long barrel lug w/window, 2 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC4-38DW	Two-hole, long barrel lug w/window, 4 AWG, 3/8" stud hole, 1" spacing		Connections To TMGB and TGB
LCC6-14AW	Two-hole, long barrel lug w/window, 6 AWG, 1/4" stud hole, 5/8" spacing		Connections To TMGB and TGB
SSNTS1420-C	Stainless Steel Bolts, 1/4", 100 pack		Attaching lugstobusbars
SSCW14-C	Stainless Steel Belleville Washers(locking), 1/4", 100 pack		Attaching lugstobusbars
SSFW14-C	Stainless Steel Flat Washers, 1/4", 100 pack		Attaching lugstobusbars
SSN1420-C	Stainless Steel Nuts, 1/4", 100 pack		Attaching lugstobusbars
SSNTS3816-C	Stainless Steel Bolts, 3/8", 100 pack		Attaching lugstobusbars
SSCW38-C	Stainless Steel Belleville Washers(locking), 3/8", 100 pack		Attaching lugstobusbars
SSFW38-C	Stainless Steel Flat Washers, 3/8", 100 pack		Attaching lugstobusbars
SSN3816-C	Stainless Steel Nuts, 3/8", 100 pack		Attaching lugstobusbars
HTWC250-250-1	H-Tap w/Cover Kit: Run 250kcmil - #2 AWG, Tap 250kcmil - #2 AWG	Other sizes available	To Tap from TBB to TGB, Access floor grid to TGB
HTWC2-2-2	H-Tap w/Cover Kit: Run #2 - #6 AWG, Tap #2 - #6 AWG		To Tap from TBB to TGB or TBB to conduit w/ 6 AWG
HTWC250-2-1	H-Tap w/Cover Kit: Run 250kcmil - #2 AWG, Tap #2 - #6 AWG		TBB to conduit w/ 6 AWG
HTCT250-250-1	H-Tap ONLY Kit: Run 250kcmil - #2 AWG, Tap 250kcmil - #2 AWG	Other sizes available	In cases where an H-tap cover is not necessary
HTCT2-2-1	H-Tap Only Kit: Run #2 - #6 AWG, Tap #2 - #6 AWG		In cases where an H-tap cover is not necessary
HTCT250-2-1	H-Tap Only Kit: Run 250kcmil - #2 AWG, Tap #2 - #6 AWG		In cases where an H-tap cover is not necessary
GUBC500-6	Universal Beam Grounding Clamp		To attach to building steel
GPL-8	Grounding Clamp, U-Bolt. 1/2 or 3/4" pipe. #8AWG to #4 AWG	Other sizes available	TBB to conduit w/ 6 AWG
GPL-14	Grounding Clamp, U-Bolt. 1" pipe. #8AWG to #4 AWG		TBB to conduit w/ 6 AWG
LTYK	Telecommunications Grounding and Bonding Label Kit		For tagging cables, Do not disconnect

Data Center Access Floor Grounding Grid (Mesh Common Bonding Network)			
Requirements for TIA-942 and IEEE-1100			
Panduit Part #	Description	Notes	Use
GPQC07-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: 3/4" - 7/8" round	4 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC10-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: 7/8" SQUARE & 1"-1 1/8" round	5 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC12-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: Up to 1 1/4" round	6 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
GPQC15-1/0	Access Floor Grounding Clamp, #6 - 1/0 AWG. For Pedestal Sizes: Up to 1 1/2" round	7 ft x 4 ft grid, 2 AWG bare code recommended	Pedestal Clamp, for access floor grounding grid. Need to determine size of floor pedestals.
CTAPF1/0-12	Code Conductor C-Tap: Run #2 AWG, Tap #2 AWG	8 ft x 4 ft grid, 2 AWG bare code recommended	Compression connector to tie in grid to perimeter if required
SBC3	Split bolt connector	one bond per every 60' of wire basket	Use to bond wire basket to grid. Not required for Panduits GridRunner.

Data Center Rack and Cabinet Grounding			
Requirements for TIA-942			
Panduit Part #	Description	Notes	Use
RGCBNJ660P22	Common Bonding Network Jumper Kit	All Cabinets/Racks in the data center. 6 AWG jumper, taps to 2 AWG.	For bonding Cabinets/Racks to the access floor grounding grid or other grounding infrastructure above or below the cabinet/rack.
RGS134-1Y	Grounding Strip Kit, threaded equipment mounting rails	Determine Type of mounting rails	Vertical Grounding Strip. Used to land equipment jumpers from active equipment
RGS134B-1	Grounding Strip Kit, Cage Nut equipment mounting rails	Determine Type of mounting rails	Vertical Grounding Strip. Used to land equipment jumpers from active equipment
RGRB19U	Grounding Bus Bar kit, threaded equipment mounting rails	Determine Type of mounting rails	Horizontal Bus bar. Used to land equipment jumpers from active equipment
RGRB19CN	Grounding Bus Bar Kit, Cage Nut equipment mounting rails	Determine Type of mounting rails	Horizontal Bus bar. Used to land equipment jumpers from active equipment
RGESD2-1	ESD Port, #12-24 threaded rail	Determine Type of mounting rails	cabinets with #12-24 mounting rails, use front and back
RGESDB-1	ESD Port, Cage Nut Rails	Determine Type of mounting rails	cabinets with cage nut mounting rails, use front and back
RGESDWS	ESD Wrist Strap	All Cabinets/Racks	Install Front and Back
RGW-100-1Y	Paint Piercing Grounding Washers, pack of 100	available in packs of 12, 24, 32 & 100	For bonding two-post rack members together during assembly of rack.

K. Communications Faceplates and

Connectors

Part number	Style	Category	Colors
CJ6X88TG**	RJ-45	6A	11

1. Category 6A UTP Modular Jacks

MINI-COM® TX6A™ 10GIG™ UTP Jack Modules shall be Category 6A modules featuring MaTriX Technology. The eight position modules shall terminate unshielded twisted 4 pair, 22 – 26 AWG, 100 ohm cable and shall not require the use of a punch down tool. Jack module shall use Enhanced *Giga-TX™* termination technology with forward motion termination to optimize performance by maintaining cable pair geometry and eliminating conductor untwist. The termination cap shall provide strain relief on the cable jacket, ensure cable twists are maintained to within 1/8" (3.18 mm) and include a wiring scheme label. The module shall include a blue base to signify Category 6A performance. The blue termination cap shall be color coded for T568A and T568B wiring schemes. All terminations for this project shall use the T568B(A) wiring scheme. The *MINI-COM® TX6A™* Modules have MaTriX Tape on the external portion of the jack, which helps suppress Alien Crosstalk. The modules shall be universal in design, including complying with the intermateability standard IEC 60603-7 for backward compatibility. Category 6A jack modules shall have UL and CSA approval.

The modules shall have ETL verified ANSI/TIA/EIA Category 6A and IEC/ISO 11801 Class E_A channel performance. They shall be universal in design, accepting 2, 3, or 4 pair modular plugs without damage to the outer jack contacts. The modules shall be able to be re-terminated a minimum of 20 times and be available in 11 standard colors for color coding purposes. The jack shall snap into all *MINI-COM* outlets and patch panels. They shall snap into all *Mini-Com®* outlets and patch panels. The module shall include a blue base to signify Category 6A performance. The Jack Modules shall be RoHS compliant. The *MINI-COM® TX6A™ 10GIG™* Jack Module must be installed as

part of a complete *TX6A™ 10GIG™* Copper Cabling System with MaTriX Technology in order to achieve 10GBASE-T certified performance.

**To designate a color, add suffix IW (Off White), EI (Electric Ivory), IG (Int'l Gray), WH (White), BL (Black), OR (Orange), RD (Red), BU (Blue), GR (Green), YL (Yellow) or VL (Violet).

a. Modular Jack Reliability Requirements

Mechanical Test	Test Method	Measurement	Typical Test Results
Normal Force	—	Load (grams)	>100
Vibration	IEC 512-6d	Circuit Resistance (mOhms)	<40
Shock	IEC 512-6c	Contact Disturbance (microseconds)	<5
Durability	IEC 512-9a	Circuit Resistance (mOhms)	<40
Mating/Un-Mating	IEC 512-13b	Mating Force (N)	<20
		Un-Mating Force (N)	<20
Termination Cycles	IEC 352	Number of Cycles	>20

Electrical Test	Test Method	Measurement	Typical Test Results
Low Level Circuit Resistance	IEC 512-2a	Resistance (mOhms)	<20
Dielectric Withstand Voltage	IEC 512-4a	1000 V, 1 minute	Passed
Insulation Resistance	IEC 512-3a	Resistance (mOhms)	>500

Environmental Test	Test Method	Measurement	Typical Test Results
Temperature Life	IEC 512-9b	Circuit Resistance (mOhms)	<40
Humidity	IEC 512-11c	Circuit Resistance (mOhms)	<40
Thermal Shock	IEC 512-11d	Circuit Resistance (mOhms)	<40
Climatic Sequence	IEC 512-11a	Circuit Resistance (mOhms)	<40
Flowing Mixed Gas Corrosion	IEC 512-11g	Circuit Resistance (mOhms)	<40

b. Additional Copper Cabling Connectors

Additional *MINI-COM*® Modules for copper shall include the following:

- 50 and 75 Ohm BNC coax coupler modules, male-male
- F-Type coax coupler module, male-male threaded

- RCA connector modules with black, red, yellow, and white inserts
 - Solder, pass through and punchdown termination types
- S-Video connectors modules - coupler and punchdown termination types
- Blank module to reserve space for future additions

The connectors shall snap into all *MINI-COM* outlets and patch panels.

Part number	Style	Medium	Termination Style	Colors
CMBA**	BNC	Coax	Coupler	5
CMBA75**	BNC	Coax	Coupler	5
CMFBA**	F- Type	Copper	Coupler	5
CMFSR**	F-Type	Copper	Coupler	5
CJRR**	RCA - red	Copper	Punchdown	5
CJRY**	RCA - yellow	Copper	Punchdown	5
CJRW**	RCA - white	Copper	Punchdown	5
CMRPR**	RCA - red	Copper	Passthrough	5
CMRPY**	RCA - yellow	Copper	Passthrough	5
CMRPW**	RCA - white	Copper	Passthrough	5
CMRCA**	RCA - black	Copper	Solder	5
CMRCAR**	RCA - red	Copper	Solder	5
CMRCAY**	RCA - yellow	Copper	Solder	5
CMRCAW**	RCA - white	Copper	Solder	5
CMSVC**	S-Video	Copper	Passthrough	5
CJSV**	S-Video	Copper	Punchdown	5
CMB**	Blank	-	-	5

** - designates color

- b. **Modular Jack Quality Control**
Jack modules shall be 100 percent performance tested for continuity, crosstalk, insertion loss, and return loss. All lots and individual jacks shall be serialized for traceability.

2. **Standard Packaging**

Standard Packaging Quantity: 1 jack per bag, and 50 bags per carton.

The outlets and surface mount boxes shall support the network system by providing high-density in-wall, surface mount or modular office furniture cabling applications. The outlets consist of faceplates for flush and recessed in-wall mounting as well as mounting to the modular office furniture systems. The surface mount boxes can be mounted where in-wall applications are not possible or to support applications where surface mount is the best option.

All outlets shall fully utilize the interchangeable and individual *MINI-COM*® connector modules that mount side by side to facilitate quick and easy moves, adds and changes. All outlets shall be manufactured from high-impact thermoplastic material with a U.L. flammability rating of 94 HB or better. Most outlets and surface mount boxes shall be available in 5 colors including Off White (IW), Electrical Ivory (EI), White (WH), International Gray (IG) and Black (BL).

3. **Faceplates**

MINI-COM® **Executive Series** Faceplates shall be 1, 2, 4 and 6 port vertical single gang and 10 port vertical double gang faceplates with combination head screws, screw covers, labels, label covers and a curved, designer appearance. The faceplates shall mount to standard U.S. NEMA boxes and adapters with screw to screw dimensions of 3.28" (83.3mm). The insert labels shall meet UL 969. Each faceplate shall accept *MINI-COM* modules

that can be individually inserted and removed as required.

Part number	Gang	Number of Modules
CFPE1**Y	Single	1
CFPE2**Y	Single	2
CFPE4**Y	Single	4
CFPE6**Y	Single	6
CFPE10**-2GY	Double	10

** - designates color

MINI-COM Classic Series Faceplates shall be 1, 2, 3, 4 and 6 port vertical single gang and 2 and 4 port horizontal, single gang faceplates with painted combination head screws. The faceplates shall mount to standard U.S. NEMA boxes and adapters with screw to screw dimensions of 3.28" (83.3mm). Faceplates shall be available with or without labels. Dedicated sloped versions shall be available for improved bend radius control and decreased requirements in wall depth. Each faceplate shall accept *MINI-COM* modules that can be individually inserted and removed as required.

Part No.	Orientation	Labels included	Number of Modules
CFP1**	Vertical	No	1
CFP2**	Vertical	No	2
CFPL2**Y	Vertical	Yes	2
CFPSL2**Y	Vertical	Yes	2 sloped
CFPL3**Y	Vertical	Yes	3
CFP4**	Vertical	No	4
CFPL4**Y	Vertical	Yes	4
CFPSL4**Y	Vertical	Yes	4 sloped
CFPL6**Y	Vertical	Yes	6
CFPSL6**Y	Vertical	No	6
CFPH2**	Horizontal	No	2
CFPHS2**	Horizontal	No	2 sloped
CFPH4**	Horizontal	No	4
CFPHSL4**	Horizontal	Yes	4 sloped

** - designates color

4. **Modular Furniture Faceplates**

MINI-COM® Modular Furniture Faceplates shall be 4 port flat or 2 port angled faceplates that snap directly into TIA/EIA

standard furniture openings. The 2 port, angled faceplate shall provide a 45° slope to the side, in-line with the cable running through the furniture channel. If required, an extender shall be used with the 4 port flat faceplate to provide 12.7 mm (0.5") additional depth. Each faceplate shall accept *MINI-COM* modules that can be individually inserted and removed as required.

Part Number	Number of Modules	Orientation
CFFP4**	4	Flat
CFFPA2**	2	Sloped
CFFPL4**	4	Flat with Label

** - designates color

5. *Faceplate Frames and Inserts*
MINI-COM Executive Series Faceplate Frames shall be vertical, *single and double* gang frames with combination head screws, screw covers, labels, and a curved designer appearance. The faceplates shall mount onto standard U.S. NEMA boxes and adapters with screw to screw dimensions of 3.28" (83.3mm). Each faceplate frame shall accept *flat, sloped, sloped shuttered, sloped recessed and blank 1/2 and 1/3 size* module inserts that can be individually inserted and removed as required from the front of the frame without removing the frame.

Part Number	Gang	Number of Modules
CBE**Y	Single	Up to 6
CBE**2GY	Double	Up to 12

** - designates color

MINI-COM Classic Series Faceplate Frames shall be vertical, *single and double* gang frames with painted combination head screws. The faceplates shall mount onto standard U.S. NEMA boxes and adapters with screw to screw dimensions of 3.28" (83.3mm). Each Faceplate Frames shall accept *flat, sloped, sloped shuttered,*

individually inserted and removed as required from the front of the frame without removing the frame.

Part Number	Gang	Number of Modules
CB**	Single	Up to 6
CB**-2G	Double	Up to 12

** - designates color

MINI-COM® 1/2 or 1/3 size, sloped / sloped recessed / flat / sloped shuttered / blank inserts shall be used in all faceplate frames and be removable from the front of the frame using a small standard screwdriver without the need to remove the faceplate frame. Each insert shall accept individual connector modules that can be individually inserted and removed as required. The shuttered inserts shall include a spring-loaded shutter that automatically closes when released. The sloped and recessed inserts shall provide a 45° downward slope to provide adequate bend radius and connector protection both in front and in the rear of the faceplate frame.

Part number	Orientation	Size	Number of Modules
CHS2**-X	Sloped	1/2	2
CHS1S**-X	Sloped with shutters	1/2	1
CHS2S**-X	Sloped with shutters	1/2	2
CHF2**-X	Flat	1/2	2
CHSR2**-X	Sloped recessed	1/2	2
CHF2M**-X	Flat	1/3	2
CHB2**-X	Flat blank	1/2	0
CHB2M**-X	Flat blank	1/3	0

sloped recessed and blank 1/2 and 1/3 size module inserts that can be

** - designates color

Stainless Steel Faceplates

MINI-COM Stainless Steel
Faceplates shall be 2, 4 and 6 port
vertical single
gang and 4, 8 and 10 port double
gang faceplates with combination
head stainless steel screws. The
faceplates shall mount to standard
U.S. NEMA boxes and adapters
with screw-to-screw dimensions of
3.28" (83.3mm). Faceplates shall
be flush mounted for

clean look. Stainless steel material shall be riveted to high impact ABS backing to provide a durable faceplate with brush finish. Each faceplate shall accept individual copper connector modules that can be individually inserted and removed as required.

Part number	Gang	Finish	Number of Modules
CFP2SY	Single	Stainless steel	2
CFP4SY	Single	Stainless steel	4
CFP6SY	Single	Stainless steel	6
CFP4S-2GY	Double	Stainless steel	4
CFP8S-2GY	Double	Stainless steel	8
CFP10S-2GY	Double	Stainless steel	10

6. Surface Mount Boxes

MINI-COM® Low Profile Surface Mount Boxes shall be 1, 2, 4, 6 and 12 port low profile surface mount boxes with a 28 mm (1.1") maximum height. All connections (with exception of the 12 port low profile box) shall exit one side of the box, parallel to the wall. The boxes shall be capable of mounting with screws, adhesive, and/or magnets. The 2 port boxes shall include a removable blank for addition of a second port. The 4, 6 and 12 port boxes shall include breakouts for use with *PAN-WAY*® surface raceway and cable tie slots at each raceway entry point to provide strain relief on incoming cables. The 4 (except low profile 4), 6, and 12 port boxes shall include tamper resistant screws that securely fasten the cover to the base and are concealed by screw covers and labels. Each box shall accept individual *MINI-COM* modules that can be individually inserted and removed as required.

Part number	Number of Modules	Maximum Height
CBX1**-A	1	23 mm
CBXJ2**-A	2	23 mm
CBX2**-AY	2	27mm
CBXC4**-A	4	23 mm
CBX4**-AY	4	28 mm
CBXD6**-AY	6	26 mm
CBX12**-AY	12	26 mm

** - designates color

Other Outlet Components

MINI-COM® "106" Frames shall be a 2 or 4 port frame that mounts onto U.S. NEMA standard junction boxes and wall board adapters with screw-to-screw dimensions of 3.28" (83.3mm) and behind NEMA standard "106" duplex electrical faceplates. Frame shall accept individual modules that can be individually inserted and removed as required.

MINI-COM® "GFCI" Frames shall be 1, 2, and 4 port frames that mount to board adapters and behind NEMA standard "GFCI" electrical faceplates. Each frame shall accept individual connector modules that can be individually inserted and removed as required.

Part number	Number of Modules	Frame Type
CFG1**	1	GFCI
CFG2**	2	GFCI
CFG4**	4	GFCI
CF1062**Y	2	106 Duplex
CF1064**Y	4	106 Duplex

** - Designates color

SECTION 27.6

DATA COMMUNICATIONS HARDWARE

A. Data Communications Hardware Design

1. General

The Data Communications section of the DFW Design Criteria Manual highlights principles and concepts for many aspects of Systems Design related to integration with various IT components currently in use or planned for the DFW IT infrastructure. Specific products, models, and versions are included as appendixes because elements will tend to change more rapidly, over time, as compared with core principles and concepts. Designers must be certain to obtain the

latest information on products, models, and versions in use or planned for use in the DFW IT Infrastructure.

2. *Storage*

System design should include the storage infrastructure design and integration into the current DFW storage infrastructure. Multiple

protocols including Fiber Channel, NFS, iSCSI and others must be included. Additionally all device interfaces supporting the protocols and product lines must be included. See the “Manufacturers and Product Lines” sub section for current storage infrastructure details.

3. *Backup*

Restore/backup procedures should be designed to facilitate DFW Business Continuity requirements.

Restore/backup procedures should be designed to facilitate current DFW Airport retention policies and data protection policies. This shall include a defined backup scheme.

Restore/backup hardware and software should be designed within current standards as outlined in the “Manufacturers and Product Lines” sub section.

B. *Data Communications Servers*

Server hardware should be designed within the current platform as specified in the “Manufacturers and Product Lines” sub section.

In general, virtual servers are the preferred platform unless application and service requirements mandate a physical server. See the “Manufacturers and Product Lines” sub section for details on the current virtualization platform.

Design considerations must strictly be coordinated with DFW personnel, at a minimum, prior to the 50% drawing review. This will help to ensure that the latest products and versions, as needed or desired by DFW ITS is included in the final design documents. The

Design firm should ensure that they have the latest manufacturer, product line info, and versions of components to be considered in the design. This section “Manufacturers and Product Lines”, within the Data Communications section of the Design Criteria Manual, is subject to updates as availability and versions of products change. The core principles and concepts within the “Design Criteria” section, however, will be updated within scheduled updates of the other sections of the complete manual.

C. *Data Communications Storage and Backup*

1. *Storage*

The current DFW Airport storage infrastructure is multi-vendor based on two manufacturers, Hitachi Data Systems and NetApp. Current models in the product line include:

- Hitachi AMS 1000 controllers and storage trays
- NetApp
- Brocade IBM branded SAN32B Fiber Channel switches

Components in the design must include expansion/integration with current production components. This shall include expansion cards supporting various protocols, storage expansion trays, and other components as required.

2. *Backup*

The current DFW Airport enterprise backup system is a multi-vendor based on two manufacturers, Commvault and Quantum. Current models and versions in the product line include:

- Commvault Simpana Software
- Quantum i2K Tape Library

Components in the design must include expansion/integration with current production components. This shall include software, expansion cards, tape drives, and other components as required.

3. *Data Communications Servers*

The current DFW Airport Data Communications Servers is a multi-vendor environment including products from Dell and Sun. Current models in the product line include:

- Dell M1000 Blade Chassis
- Dell M610 Blade Servers (typically used as single application servers)
- Dell M710 Blade Servers (typically used as the VMWare virtualization host platform); The current platform is VSphere with the latest updates
- Dell I/O Blade Cisco Catalyst 3130X
- Dell I/O Blade Brocade M5424
- Sun T2000 (typically used as application servers for multiple apps)
- Sun V890 (typically used as database servers supporting multiple databases)

Components in the design must include expansion/integration with current production components. This shall include RAM capacity, CPU speeds and quantity, expansion cards supporting various protocols and other components as required.

SECTION 27.7 DATA COMMUNICATIONS PERIPHERAL DATA EQUIPMENT

A. Disaster Recovery Equipment

Disaster Recovery Equipment should be included in system design based on the “Five Nines” Matrix and the Criticality Matrix. See the “Manufacturers and Product Lines” sub section.

Disaster Recovery Equipment design should include the use of existing DFW equipment and/or additional equipment based on Recovery Point Objective (RPO), Recovery Time Objectives (RTO) and DR capacity regarding the application considered in the design.

B. Disaster Recovery Testing

A Disaster Recovery Testing Plan shall be included in system design with a minimum of two tests per year.

C. Remote Control Hardware

System design should include remote control hardware needed to integrate in to the current DFW KVM Infrastructure. This includes core/distribution matrix switches, edge switches, dongles, fiber, GBICS, and any components required to integrate with the KVM infrastructure.

D. Audio-Video Devices

To setup Audio/Video equipment in order to provide presentation capabilities in a conference room for any DFW Airport Board buildings. The room must be able to project images to a screen with video/audio capabilities from a computer, DVD/blu-ray, or satellite TV. Each configuration may vary depending upon the customer requirements. Some options listed below may not be included depending upon the scope of the project. This will include all parts and labor and ensure all equipment is functioning properly.

- Comply with applicable local, state and federal codes.
- Ceiling mounted DLP Projector of at least 4000 ANSI lumens. Minimum 1024 x 768 resolution. Must include all mounting gear and throw lenses if necessary.
 - Approved Projector Manufacturers are Panasonic, Sanyo, NEC, or Owner Approved Equivalent
- Distribution Amplifier or equivalent installed. (If necessary)
 - Approved Manufacturers: Extron or Crown
- AV System controller that must have the capabilities for multiple Audio & Video inputs.
 - Approved Manufacturers: AMX or Owner approved Equivalent.
 - Must also have touch panel user interface or wall mounted interface for users to be able to switch to multiple inputs.
 - i. DVD/Blu-Ray
 - ii. Multiple PC inputs / One input must be easily accessible for Laptops

- iii. MATV (satellite TV inputs)
- Audio Mixer. (If necessary)
 - Approved Manufacturers: Extron, Yamaha and Peavey
- DVD/Blu-Ray
- Ceiling Speakers mounted in the ceiling and all wiring necessary to run to amplifier.
 - Approved Manufacturers; Tannoy or JBL.
- Rotating or fixed RACK for all amplifier, controller, DVD /Blu-Ray etc. to mount in.
- Test & inspect to ensure the system works per the manufacture's specifications and DFW's requirements.
- Screen Controller, if the screen is not fixed then the Extron control unit should have the capabilities to raise and lower the screen when the system is turned on.
- Wireless Keyboard, Mouse, & Slide Presentation controller with at least a 75 foot range.
- Electrical for rack and ceiling mounted projector.
- Installation shall include the delivery; unloading; setting in place; fastening to walls, floors, ceilings, counters, and other structures where required. Interconnecting wiring of the system components, equipment alignment and adjustments, and all other Work whether or not expressly required herein which is necessary to result in a complete operational system. Install system in accordance with NFPA 70 and any other National, State, and/or Local applicable codes. Install equipment in accordance with manufacturer's written instructions.
 - Provide proper ventilation for all A/V equipment in enclosed areas.
 - All cables shall be marked with wrap-around number or letter cable markers at both ends with clear shrink tube covering the label. There shall be no unmarked cables at any place in the system. All cable markings shall correspond with

system wiring diagrams and as-built documentation.

- Warranty Work under this specification against faulty material or Workmanship. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, then the warranty of each system or piece of equipment used shall begin on the date of substantial
- completion for each phase. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.
- The Contractor shall prepare and submit two copies of owner's manuals containing warranties, guarantees, and equipment manufacturer's directions on products and materials provided.
- Upon completion of contract and progressively as Work proceeds, clean-up and remove dirt, debris and scrap materials. Maintain the premises in a neat and clean condition at all times during construction. Protect and preserve access to Head-end equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish entire piece of equipment when sustained major damage. All electronics must be protected from dust and other airborne debris.
- COMMISSIONING
 - Test all Audio-Video System components, in the presence of the Approving DFW Representative, for compliance with the performance standards.
 - Check all control functions, from all controlling devices to all controlled devices, for proper operation.
 - Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for all level controls, and record these

- settings in the “System Operation and Maintenance Manual”.
- The Contractor is responsible for all costs incurred to satisfy criteria requirements.
 - Deliver “Operation and Maintenance” manuals and “Instruction Guides” to Owner.

E. Disaster Recovery Equipment

The current Disaster Recovery Equipment in use in the DFW environment is multi-vendor including hardware from Quantum and software from Commvault Systems. Models and versions in the product lines include:

- Quantum i2K Tape Library
- Quantum i500 Tape library
- Commvault Systems Simpana Software

Components in the design must include expansion/integration with current production components. This shall include RAM capacity, CPU speeds and quantity, expansion cards supporting various protocols and other components as required.

F. Remote Control Hardware

The current KVM infrastructure is a multi-vendor environment utilizing products from Avocent and Thinklogical. Models and versions of products include:

- Avocent DSView Software
- Avocent AMX 5020
- Avocent DSR4030
- Thinklogical VEL-U000S05-LCTX
-
- Thinklogical VEL-U000S03-LCTX
- Thinklogical VEL-U000S03-LCRX
- Thinklogical VEL-U00S24-LCRX
- Thinklogical VEL-AV0S09-LCTX
- Thinklogical VOP-S05

Components in the design must include expansion/integration with current production components. This shall include GBICS, fiber jumpers, software, dongles, and other components as required to design an integrated and fully functioning system within the KVM infrastructure.

DIVISION 28

Electronic Safety and Security

SECTION 280 REFERENCES

280.1 General

- A. The publications listed below should be referenced when specifying additions or changes to the Emergency Voice Alarm Communication/ Mass Notification/ Public Address (EVAC/MN/PA) System.
- B. Specific reference in this document to codes, rules regulations, standards, manufacturer's instructions or requirements of regulatory agencies shall refer to the latest printed edition of each in effect at date of Contract unless the document is shown dated.
- C. Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).

280.2 Referenced Publications

280.2.1 Dallas / Fort Worth International Airport Guidelines including Design Criteria Manual

280.2.2 National Fire Protection Association:

- NFPA 70 National Electrical Code
- NFPA 72 National Fire Alarm and Signaling Code
- NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems

280.2.3 Building Industry Consulting Services International (BICSI):

- BICSI – Telecommunications Distribution Methods Manual (TDMM)
- BICSI – Information Technology Systems Installation Methods Manual (ITSIMM)
- BICSI – Network Design Reference Manual

280.2.4 Electronic Industry Alliance (EIA):

- EIA-160: Sound Systems

- EIA-299-A: Loudspeaker, Dynamic Magnetic Structures, and Impedance
- EIA-310-D-2: Universal Network Equipment Rack and Cabinet
- EIA SE-101-A: Amplifiers for Sound Equipment
- EIA SE-103: Speakers for Sound Equipment
- EIA SE-104: Engineering Specifications for Amplifiers for Sound Equipment
- EIA SE-105: Microphones for Sound Equipment

280.2.5 International Organization for Standardization (ISO):

- International Organization for Standardization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
- ISO 9001; Quality Assurance in Design/Development, Production, Installations and Servicing
- ISO 9003; Quality Assurance in Final Inspection and Test
- ISO 9004; Quality Management and Quality System Elements Guidelines;
- ISO/IEC JTC 1/SC 25/WG 3 N655 (Nov. 2001)
- Class D ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer Premises, 2002
- Class E ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer Premises
- Class EA Amendment 1 to ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer Premises, pending publication; Class F ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer Premises, 2002
- Class FA Amendment 1 to ISO/IEC 11801, 2nd Ed.
- ISO 9003 – Model for Quality Assurance in Final Inspection and Test
- ISO 10012-1 – Quality Assurance Requirements for Measuring Equipment

280.2.6 ANSI: American National Standards Institute:

- ANSI-C2 (2007) National Electric Safety Code (NESC)
- ANSI/TIA-526-7 – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (Method A)
- ANSI/TIA-526-14A – Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant
- ANSI/TIA 568-B – Commercial Building Telecommunications Cabling Standard
- ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
- ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
- ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunication Cabling and Components Standard
- ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard
- ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- ANSI/TIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- ANSI/TIA-Joint Standard – 607-A Commercial Building Grounding and Bonding Requirements for Telecommunications
- ANSI/TIA/EIA-854 Full Duplex Ethernet Specification for 1000Mbps Operating Over Category 6 Balanced Twisted Pair Cabling

280.2.7 Code of Federal Regulations (CFR): Code of Federal Regulations; CFR 47 Part 15; Radio Frequency Devices

280.2.8 Federal Communications Commission (FCC) regulations and standards.

280.2.9 ICEA: Insulated Cable Engineers Association S-84-608-1994 Telecommunications Cable, Filled, Polyolefin Insulated Copper Conductor

280.2.10 Institute of Electrical & Electronics Engineers (IEEE)

- 802.1 LAN/MAN Bridging and Management
- 802.3 CSMA/CD Access Methods (Ethernet)
- 802.3ae 10 Gigabit Specification
- 802.3z 1000 Base-S specification
- 802.3ab 1000 Base-T specification
- 802.3af/at Power over Ethernet
- 802.3u 100 Base-T specification
- 802.1Q VLAN
- 802.1P Prioritization
- 802.11 a/b/g/n CSMA/CA Access Methods (Wireless LANs)

280.2.11 NEMA: National Electrical Manufacturers Association (NEMA)

280.2.12 OSHA: Occupational Safety and Health Administration

280.2.13 UL: Underwriters Laboratories; UL 497

280.3 Conflicts

Where the requirements of the specifications conflict with other documents the following shall apply:

- Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.
- Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.
- Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

SECTION 281 ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

281.1 Automated Access Control System

The DFW Automatic Access Control System (AACS) System has been declared security

sensitive information by the DFW DPS. Information concerning AACS may be released only upon the approval of the Airport Security Coordinator/Chief of Police, or designee. The AACS requirements are specified in DFW Airport's "Design Guide for the Automatic Access Control System (AACS)" maintained by the DFWIT Department.

281.2 Security Gates and Other Security Devices across Fire Apparatus Access Roads

281.2.1 Facilities. All automatic gates and devices across required fire apparatus access roads shall open upon activation of the building fire alarm system and remain open until such time that the fire alarm is reset. These gates shall open with a signal from a bi-directional system. See Appendix B for specified manufacturer.

All automatic gates and devices shall incorporate a fail-safe manual backup or release. All gates and devices shall permit the safe exit of emergency vehicles at all times.

281.2.2 Roadways. All automatic gates and devices across required fire apparatus access roads shall open through one of the following methods. The gate shall open from a signal received from an Airport Board Signal Receiving Device (SRD), or; Airport Board Selected Vehicle Device (genie). All automatic gates and devices shall incorporate a fail-safe manual backup or release. All gates and devices shall permit the safe exit of emergency vehicles at all times.

SECTION 282 ELECTRONIC SURVEILLANCE

282.1 General Information

The DFW Closed Circuit Television (CCTV) System has been declared Security Sensitive Information (SSI) by the DFW DPS and the Transportation Security Administration. Information concerning CCTV may be released only upon approval of the Airport Security Coordinator/Chief of Police, or designee.

SECTION 283 ELECTRONIC DETECTION AND ALARM

283.1 General Information

The Fire Marshal's Office will determine whether a fire alarm system will be monitored by the DFW EBI/Central Fire Alarm System or be required to be monitored by an approved supervising station

283.2 Fire Alarm System

Fire alarm systems shall be provided, tested, and approved in Compliance with NFPA 72, the Fire Code, and the Section 289. Fire alarm submittals are required and shall be reviewed and approved by the Fire Marshal.

SECTION 284 FIRE DETECTION AND ALARM

284.1 Operation and Fire Detection and Alert Notification System

284.1.1 The Fire Alarm System (FAS) shall function as an integral component of the DFW Central Fire Alarm System (CFAS). The panel shall be UL 864 UOJZ and UUKL listed. See Appendix B for specified manufacturer.

284.1.2 The FAS shall supervise each individual device on an intelligent loop circuit such that alarm and trouble conditions are individually annunciated. All panels should be made up in a uniform and orderly manner.

284.1.3 A 120-Volt AC dedicated circuit shall power the fire alarm panel. A label shall be affixed inside the Fire Detection and Alert Notification System as to the panel designation and breaker number of the 120-Volt AC power source.

284.1.4 The panel shall contain batteries to provide standby emergency power sized to maintain the local fire alarm system operational upon loss of primary power. The batteries shall have the capacity to operate the system under standby condition for 24 hours plus 5 minutes under alarm conditions. Transfer from normal

to battery power shall be automatic. When a transfer occurs, the panel shall report a trouble alarm to the CFAS. The panel shall provide float/equalizing charge for the batteries.

284.1.5 The panel shall provide ground fault detection for the panel and device initiating circuits and shall report ground faults to the CFAS.

284.1.6 Fire Alarm System Panel shall not be used for junction boxes or pull boxes. Absolutely no splicing will occur inside the panel.

284.1.7 When terminating stranded wiring in the panel for all initiating and indicating devices "STA-KON" type lugs shall be used for the proper lug size and wire size. For devices that are not designed to be used with spade terminals, use manufacturer's suggested wiring termination technique.

284.1.8 The Fire Alarm System is located as approved by DPS.

284.1.9 The Fire Alarm System shall communicate with the DFW CFAS via fiber optic cable.

284.2 System Devices

284.2.1 Addressable devices shall receive power and communicate over the same pair of wires.

284.2.2 Additional devices shall be added to the intelligent loop circuit in such a way that the loop is continuous, with no tee tapping from any point in the circuit.

284.2.3 Each device shall contain screw terminals on rising plates for positive termination of up to 12 AWG wire.

284.2.4 Duct and area smoke detectors shall be provided with remote test and reset panels when the detector is not readily accessible from floor level.

284.2.5 No intelligent devices are allowed in confined spaces. Should a device be needed in a confined space, a remote monitor module shall be provided in an approved location.

284.2.6 All intelligent device covers shall be labeled with device address and panel loop number. The type of module shall be identified as either a control module or monitor module.

284.2.7 All intelligent sensors shall mount on a common base to facilitate the change of sensor type if building conditions change. The base shall be incompatible with conventional detectors to prevent the mounting of non-intelligent devices.

284.2.8 Each sensor shall contain an LED, which blinks each time the device is scanned by the Fire Alarm System. If the device is in alarm, the LED shall remain on to indicate the alarm condition.

284.3 Monitor Modules

284.3.1 The intelligent monitor module shall provide an addressable input for normally open or normally closed contact devices.

284.3.2 The monitor module shall provide a supervised initiating circuit, able to connect to either Class B supervised or Class A circuits.

284.3.3 The monitor module shall contain an LED, which shall blink upon Fire Detection and Alert Notification System scan. The LED shall latch on upon determination of an alarm condition.

284.3.4 The monitor module shall mount in a standard 4-inch by 4-inch deep electrical box.

284.4 Control Modules

284.4.1 The intelligent control module shall provide an addressable output for a separately powered alarm indicating circuit or control relay.

284.4.2 The control module shall provide a supervised indicating circuit. An open circuit fault shall be annunciated at the Fire Alarm System. The control module shall connect to either Class B or Class A circuits.

284.4.3 The control module shall provide a control relay. The relay shall have a single pole-double throw (SPDT) form "C" contact, rated at 2 amps at 28-Volt DC.

284.4.4 The module shall have an LED, which shall blink on Fire Alarm System poll. Upon activation of the module, the LED shall be latched on.

284.4.5 The control module shall mount in a standard 4-inch by 4-inch deep electrical box.

284.5 Initiating Devices

284.5.1 Ionization Duct Smoke Detectors shall be intelligent and have two SPDT alarm contacts and one SPDT trouble contact rated 2 amps at 120-Volt AC and be listed for applications involving air handling systems. Detector shall be installed in accordance with its listing.

284.5.2 Area Smoke Detectors shall be intelligent photoelectric type and be installed in accordance with their listing and NFPA 72.

284.5.3 Manual stations shall be intelligent, of die cast metal construction and designed for semi-flush mounting. The initiating circuit shall be Class A. Each manual station shall connect to a monitor module applicable to the Fire Alarm Panel.

284.5.4 Wet sprinkler systems shall have vane type sprinkler flow switches. Flow switches shall have retards adjustable up to 2 minutes. The device shall have a SPDT, which shall close upon water flow.

284.5.5 Dry sprinkler system alarm switches shall be pressure activated.

284.5.6 Supervisory switches for fire protection systems shall be installed in accordance with their listing. Lanyard type supervisory switches are not permitted except as approved by DPS.

284.5.7 Dry system air pressure switches shall be installed to monitor both high and low air pressure conditions.

284.5.8 Each initiating device shall connect to a separate monitor module. The initiating circuit shall be Class A.

284.5.9 Supervisory devices may be connected to a single monitor module when located in the same room. Supervisory circuit shall be two-wire supervised circuits, with the appropriate end of line resistor installed at the last device on the loop.

284.6 Wiring

284.6.1 Wiring shall comply with the National Electric Code (NFPA 70), National Fire Alarm and Signaling Code (NFPA 72), NECA 1-2009, project specifications, and the approved wiring diagram. If there are conflicts, the most stringent method shall be followed.

284.6.2 No wiring other than fire alarm loop, initiating, indicating, power, and communications circuits are permitted in fire alarm conduit.

284.6.3 Wiring shall be completely installed, ready for field connections to be made and tested for stray voltage, short circuits, and ground faults prior to connection to the intelligent modules. Stranded wires shall terminate at both the device and module with spade terminals sized to fit both the wire and screw terminal. Spade lugs are optional if the terminal is fitted with a wire clamp plate.

284.6.4 Color-coding of device initiating loops shall be as follows: Two conductors are of one color and the other two conductors are of a different color. Colors shall be continuous

throughout the entire loop. Where more than one initiating loop is routed in a single conduit, the colors associated with any loop contained in the conduit shall be different from the colors of any other initiating loop contained in the conduit.

284.6.5 All loop wiring shall be identified by their "in" and "out" circuits and loops. In is defined as coming from the panel. Labels for SLC circuits shall show panel number, loop number, and device number on the inside of the circuit. Indicating circuits labeling shall show power supply number and circuit number on the inside of the circuit. Labels shall be Self-Laminating of permanent type (wrap around) wire numbers are not acceptable.

284.6.6 Red and Black must be used for a 24-Volt panel power.

284.6.7 No voltage supply from any other source than the primary power 120-Volt AC and the panel 24-Volt DC power supply shall be utilized.

284.6.8 Intelligent loop circuits shall be labeled at all junction locations by the panel number and loop number.

284.6.9 Intelligent loop circuits shall be provided with adequate junction boxes be expandable and provide a means for connecting to the loop in the junction box.

284.6.10 Control and other panels shall be mounted with sufficient clearance for observation and testing. Fire alarm junction boxes shall be clearly marked for distinct identification.

284.6.11 Wiring shall be in EMT conduit, minimum 3/4 inch. Flexible conduits, mounting boxes, junction boxes, and panels shall be securely fastened with appropriate fittings to ensure positive grounding throughout the entire system. Conduits shall enter the panels from the sides or bottom. Where flexible conduits are used to connect device loop

wiring to alarm device, the Contractor is permitted to use 1/2 inch flexible conduit.

284.6.12 All fire alarm junction boxes shall be mounted in approved locations for ease of maintenance from floor level.

284.6.13 Backbone termination boxes should be of sufficient size to allow for termination.

284.6.14 All junction boxes shall be made up in a uniform and orderly manner.

284.7 Conduit / Raceway

The following raceway types shall be permitted:

- EMT conduit (3/4 inch minimum).
- RIGID conduit (3/4 inch minimum).
- Non-Metallic conduit for wet locations (3/4 inch minimum).
- Metal clad cable is permitted in concealed spaces for horizontal fire detection and alert notification branch circuits and connections to devices and fixtures.

284.7.1 All raceway types shall be new. Installing used raceway is unacceptable.

284.7.2 Using existing raceway is unacceptable without prior written permission of the Airport Contact.

284.7.3 Boxes, supports, and other accessories for the raceway installation shall be listed for the intended application.

284.7.4 All wiring shall be installed in conduit.

284.7.5 Install fire detection and alert notification system wire in conduit or approved raceway, parallel to existing building structure when possible.

284.7.6 Riser wiring and wiring between floors shall be installed in conduit.

284.7.7 Strap or bundle all cables and wires inside equipment enclosures and terminal cabinets, parallel to the enclosure sides.

284.7.8 All EMT conduit fitting shall be steel or malleable steel compression type. All rigid conduit fitting shall be threaded with plastic insert or bushing.

284.7.9 Flexible conduit and associated junction boxes connecting sprinkler water flow and supervisory switches shall be water resistant.

284.7.10 Fire alarm conduit and junction boxes shall be RED in color. Flexible conduit between fire alarm junction boxes and device mounting boxes that are less than 6 feet in length are not required to be RED. Device mounting boxes are not required to be RED.

284.7.11 Flexible conduit to devices requires conduit to be strapped between the junction box and device box.

284.8 Device Installation

Intelligent sensors shall be mounted in the ceiling of the protected area and not closer than 4 feet from any air conditioning register. Contractor shall define actual device locations in accordance with the manufacturer recommendations and NFPA approved methods.

Where manual stations are installed on the building exterior, the associated monitor module shall be mounted in a transparent enclosure to maintain the environmental limitations of the module. The manual pull station shall be mounted in an approved enclosure in the immediate vicinity of the module.

SECTION 285
FIRE ALARM DESIGN CRITERIA FOR OTHER
BUILDINGS OCCUPIED OR MAINTAINED
BY THE DFW AIRPORT BOARD

285.1 Operation

Operation shall be in accordance with NFPA 72 and the adopted Fire Code and shall report to an approved Fire Alarm Monitoring Station, or DFW CFAS, as directed by the Fire Marshal's Office.

Activation of any device shall:

- a. Audibly and visibly annunciate the alarm condition on the local FAS.
- b. Activation of supervisory alarms or trouble indications shall report to the DFW CFAS and audibly and visibly annunciate the alarm condition at the local FAS.
- c. Notification devices shall be provided and notify the occupants in the event of an alarm.

285.2 Fire Detection and Alert Notification System

285.2.1 The FAS shall function as an integral component of the DFW CFAS and or the Intelligent System devices referenced hereinafter. The panel shall be UL 864 UOJZ and UUKL listed.

285.2.2 The panel shall be modular, factory wired, and of dead front construction using solid-state components. The panel shall communicate with the CFAS using the equipment listed in Appendix B or fiber optic cables.

285.2.3 The panel shall be capable of monitoring and controlling fire alarm and security zones as required. Space within the panel shall be provided to allow for installation of equipment to accommodate zone expansion by 25 percent.

285.2.4 All panels should be made up in a uniform and orderly manner.

285.2.5 Fire alarm panels shall not be used for junction boxes or pull boxes. No splicing is permitted inside the panel.

285.2.6 Wiring terminations in the panel from all initiating and indicating devices shall use "STA-KON" type lugs sized for the proper screw size and wire size. For devices that are not design to be used with spade terminals, use the manufacturer's suggested wiring termination technique.

285.2.7 The FAS shall be powered by 120-Volt AC dedicated circuit. A label shall be affixed inside the Fire Detection and Alert Notification System as to the panel designation and breaker number of the 120-Volt AC power source.

285.2.8 Initiation device circuits shall be "Class A" whereby the circuits are supervised for opens and grounds, and all loop initiating devices will continue to operate with a trouble such as a single open or a single ground. If intelligent loop is provided, the FAS shall supervise each individual device on an intelligent loop circuit such that alarm and trouble conditions are individually annunciated.

285.2.9 The panel shall contain batteries to provide standby emergency power sized to maintain the local fire alarm system operational upon loss of primary power. The batteries shall have the capacity to operate the system under standby conditions for 24 hours and under an alarm condition for a minimum of 5 minutes.

285.2.10 The panel shall provide ground fault detection for the panel and device initiating circuits and shall report ground faults to the CFAS.

285.2.11 Where the panel is located in a facility remote from the Central Utility Tunnel, the panel shall transmit data to the CFAS via a Slave dialer or XLS1000 3-MODCOM DACT.

285.2.12 Where the panel is located in a facility accessible to the Central Utilities Tunnel, the panel shall transmit data to the CFAS by

proprietary data cable furnished by the Contractor and connected to the existing fire alarm fiber optic cable in the Central Utilities Tunnel.

285.2.13 The Contractor shall obtain from DFW ITS LIFE SAFETY the necessary information to properly address the fire alarm panel. The contractor shall provide to DFW ITS LIFE SAFETY the correct programming information a minimum of 10 days prior to the expected check out of the system.

285.2.14 No voltage supply from any other source than the primary power 120-Volt AC, the panel 24-Volt DC power supply, or approved Notification Appliance Power Supplies shall be utilized.

285.3 Initiating Devices

285.3.1 Ionization Duct Smoke detectors shall be installed in accordance with their listing. The detector shall have two SPDT alarm contacts and one SPDT trouble contact, rated minimum 2 amperes at 120 volts AC. The amplifier switching circuit shall be entirely solid- state and operate with a detector line voltage of 24-Volt DC.

285.3.2 Area Smoke Detectors shall be photoelectric type and be installed in accordance with their listing and NFPA 72. Detectors shall be equipped with a functional test device circuit capable of simulating a minimum acceptable amount of smoke for alarm. The test device circuit shall provide individual local testing of all components of the detector and shall not require generation of actual smoke within the building.

285.3.3 Duct smoke and area smoke detectors shall be provided with remote testing and reset when the detectors are not readily accessible from floor level.

285.3.4 Detectors shall mount on a standard 4-inch octagon or 4-inch square outlet box.

285.3.5 Detectors shall operate on a line voltage of 24-Volt DC. A means shall be provided to supervise the 24-Volt DC detector power for each zone.

285.3.6 Manual Pull Stations shall be of rugged die cast metal construction designed for semi-flush mounting. The manual stations shall be installed in accordance with their listing.

285.3.7 Sprinkler Alarms on wet type sprinkler systems shall have vane type sprinkler flow switches. Flow switches shall have retards adjustable up to 2 minutes, and be furnished with one normally open switch that will close upon water flow. Dry system alarm switches shall be of a pressure activated type.

285.3.8 Valve supervisory devices shall be installed in accordance with their listing. Lanyard type supervisory switches are not permitted unless approved.

285.3.9 Dry system air pressure supervision shall be a pressure switch installed to monitor and report both high and low air pressure conditions.

285.3.10 Each device shall contain screw terminals on rising plates for positive termination of up to 12 AWG wire.

285.3.11 If Intelligent loop is used, see 284.2 System Devices.

285.4 Wiring

285.4.1 Wiring shall be in accordance with the most recently adopted National Electric Code, NECA 1-2009, these design criteria, project specifications, and the approved wiring diagram. If there are conflicts, the most stringent method shall be followed.

285.4.2 No wiring other than fire alarm loop, initiating, indicating, power, and communications circuits are permitted in fire alarm conduits. Device wire shall be color-coded, minimum 14 AWG THHN copper wire, 600-Volt insulation for initiating and indicating

circuits. Transposing or changing color-coding of wires is not permitted.

285.4.3 Wiring shall be completely installed, and field connections made and tested for voltage and stray signals before final connections to the remote panel is made. Wires shall terminate both at the panel and the devices. Spade lugs are optional if the terminal is fitted with a wire clamp plate.

285.4.4 Color-coding of device initiating fault tolerant loops shall be two conductors of one color and the other two of a different color. Colors shall be consistent and continuous throughout the entire loop. Where more than one initiating loop is routed in a single conduit, the colors associated with any loop contained in the conduit shall be of different colors than any other loop in the conduit.

285.4.5 All loop wiring shall be identified by their in and out circuits and loops. "In" is defined as coming from the panel. Labels for signaling line circuits (SLC) circuits shall show panel number, loop number, and device number on the inside of the circuit. Indicating circuits labeling shall show the power supply number and circuit number on the inside of the circuit. Labels shall be self-laminating or permanent type (wrap-around wire numbers are not acceptable).

285.4.6 Solid red and black are reserved for and must be used for 24-Volt panel power with the use of audiovisual circuits.

285.4.7 Control and other panels shall be mounted with sufficient clearance and access for observation and testing. Fire alarm junction boxes shall be clearly marked for distinct identification.

285.4.8 Wiring shall be in EMT conduit, minimum $\frac{3}{4}$ inch. The entire raceway shall be grounded. Conduits shall enter panel from the sides or bottom only. Where flexible conduits are used to connect device loop wiring to

alarm devices, the contractor shall use $\frac{1}{2}$ inch flexible conduit.

285.4.9 All fire alarm junction boxes shall be mounted in approved locations for ease of maintenance from floor level.

285.4.10 All junction boxes shall be installed in a uniform and orderly manner.

285.4.11 Backbone termination boxes shall be of sufficient size to allow for termination on to terminal strips.

285.5 Conduit / Raceway

The following raceway types shall be permitted:

- EMT conduit (3/4 inch minimum).
- RIGID conduit (3/4 inch minimum).
- Non-Metallic conduit for wet locations (3/4 inch minimum).
- Metal clad cable is permitted in concealed spaces for horizontal fire detection and alert notification branch circuits and connections to devices and fixtures.

285.5.1 All raceway types shall be new. Installing used raceway is unacceptable.

285.5.2 Using existing raceway unacceptable without prior written permission of the Airport Contact.

285.5.3 Boxes, supports and other accessories for the raceway installation shall be listed for the intended application.

285.5.4 All wiring shall be installed in conduit.

285.5.5 Install fire detection and alert notification system wire in conduit or approved raceway, parallel to existing building structure when possible.

285.5.6 Riser wiring and wiring between floors shall be installed in conduit.

285.5.7 Strap or bundle all cables and wires inside equipment enclosures and terminal cabinets, parallel to the enclosure sides.

285.5.8 All EMT conduit fitting shall be steel or malleable steel compression type. All rigid conduit fitting shall be threaded with plastic insert or bushing.

285.5.9 Flexible conduit and associated junction boxes connecting sprinkler water flow and supervisory switches shall be water resistant.

285.5.10 Fire alarm conduit and junction boxes shall be RED in color. Flexible conduit between fire alarm junction boxes and device mounting boxes that are less than 6 feet in length are not required to be RED. Device mounting boxes are not required to be RED.

285.5.11 Flexible conduit to devices requires conduit to be strapped between junction box and device box.

285.6 Documentation and Acceptance Testing for All Systems

285.6.1 Documentation. Upon completion, provide complete point-to-point wiring diagrams of the installation. One copy shall be furnished to DFW Facilities Maintenance Fire Alarm Section for inclusion in Facilities Maintenance records.

285.6.2 All final as-builts shall show conduit routing, junction boxes as well as termination boxes. Wire flow and end of line (EOL) resistors shall be clearly marked at device and on the print.

285.7 Maintenance and Operations Manuals

285.7.1 Intent. The intent of this Section is to require complete documentation of the FAS for the purpose of system operation and maintenance (O&M) during and after the warranty period. It is intended that the O&M manuals be exhaustive in the coverage of the

system to the extent that they may be used as the sole guide to the trouble shooting, identification, and repair of defective parts.

285.7.2 The Contractor shall provide the DFW DPS Fire Prevention and Airport Board with three complete drawing books and O&M manuals on the completed system. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, relay, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the O&M manuals. The maintenance manual requirement of this Section is in addition to Shop Drawing requirements. Maintenance manuals and drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

285.7.3 Maintenance Manuals and Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this project shall be crossed out.

285.7.4 All Drawings developed specifically for this project shall be reduced to 11 inches by 17 inches, folded, and bound with hard plastic covers. The 11-inch by 17--inch Drawings provided shall be easily readable after printing, even if this requires dividing large Drawings into several parts. Text shall be no smaller than 1/16 inch. The drawing book documents shall

be produced with Microstation (current version in use at DFW) and the electronic files shall be provided to the Airport at the completion of the project on CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (arrangement drawings), find how it is wired (wiring diagrams), its detailed Specifications (vendor data sheets), and how to repair it (spare part lists).

Include the following drawings as a minimum:

- Functional Block Diagram: Provide overall block diagrams showing the major interconnections between subsystems.
- Arrangement Drawings: Provide Drawings showing the physical arrangement of all major system components.
- This shall include:
 - 1) Elevation drawings of all equipment racks showing the location of each component in the racks. Components in the racks shall be identified as in the functional block diagrams.
 - 2) Wiring diagrams showing all field installed interconnecting wiring.
 - 3) Wire identification on the diagrams shall agree with the wire markers installed on the equipment.

285.8 Acceptance Test

Following completion of the wiring and prior to termination of devices, an installation inspection is required.

Upon completion, the Contractor, in the presence of DFW maintenance fire alarm technician, DFW Fire Prevention representative, and appropriate DFW Development representatives, shall conduct such tests and inspections necessary to verify that the installation is complete and fully operational to the given intent and has been installed in accordance with the Specifications and approved Drawings.

All intelligent device covers shall be labeled with device address and panel loop number. The type of module shall be identified as either a control module or monitor module.

All equipment and materials necessary to conduct these tests shall be furnished wholly by the Contractor.

The following device keys shall be provided by the Contractor upon completion and acceptance:

- One key for each duct smoke detector installed
- One key or tool for each manual pull station installed
- One key or tool for each water flow device installed
- One key for each supervisory device installed
- One key or tool for each panel installed

Following completion of the installation and progressively during the course of installation, the contractor shall remove all trash, debris, and surplus material occasioned by this operation so that at all times the environment presents a safe, neat, and orderly condition conducive to other activities.

SECTION 286 AIRPORT SECURITY CONTROLS

286.1 AOA Fencing

Security fencing shall be constructed at locations adjacent to the Air Operations Areas (AOA) with no gaps at grade (maximum of 2 inches below gates).

286.2 Fence and Gates

Six feet in height of number 10 gage, 2-inch galvanized steel chain link mesh with three strands of #12 gage, four-point barbed wire mounted above the fence with an outward extension of 45 degrees. In addition, Razor Wire shall be looped and attached on top of the barbed wire in 20-inch loops as per fence specifications. Any water crossings or outfalls

shall have coverage equal in strength and durability to the actual fence. Fence posts shall be installed on 10-foot centers maximum. Post, rails, and braces shall be zinc-coated steel sized in accordance with the table below. Hinges and latches shall be zinc-coated. Concrete retaining walls 6 feet or higher will

286.3 Genies and AOA Gate Actuators
Information regarding DFW gate actuators and genies has been declared SSI by the DFW DPS and the Transportation Security Administration. Specifications may be released only upon the approval of the Airport Security

Use and Section	Nominal Outside Diameter (Inches)	Normal Weight per Foot (+/- 10% Tolerance)	
		Type I	Type II
End corner and pull posts			
Fabric height of 6'-0", round	2.375	3.65	3.12
6'-0", square	2.00	2.60	
Over 6'0", round	2.875	5.79	4.64
Over 6'0", square	2.50	5.10	
Rails and post braces	1.66	2.27	1.83
Intermediate Posts For Fabric Heights	Nominal Outside Diameter (Inches)	Normal Weight per Foot (+/- 10% Tolerance)	Normal Weight per Foot (+/- 10% Tolerance)
6'-0" and less, round	1.90	2.72	2.28
C Section	1.875	2.28	2.28
Over 6'-0", round	2.375	3.65	3.12
C Section	2.25	2.64	2.664

field spliced with special attachments provided by the manufacture, Polyolefin- coated frame and top track thermally fused

only require the barbed wire extensions and razor wire.

286.4 Chain-Link Cantilever Slide Gates

286.4.1 Gate Frames. Fabricate chain link cantilever slide gates in accordance with ASTM F 1184, Type II, class 2, using 2-inch square aluminum members, ASTM B – 221. Alloy and temper 6063 – T6, weighing 0.94 pound per foot (lb/ft). Weld members together forming rigid one-piece frame integral with top track. (No substitution allowed.) Frame members are to be square and straight to within over a 40-foot span in an unstressed state. Provide two truck assemblies for each gate leaf, except for gates larger than 30 feet. Frame sizes over 27 feet in length shall be shipped in two parts and

Coordinator/Chief of Police, or designee.

within minimum 10-mil per ASTM 1043 (after fabrication). Coating before fabrication will not be allowed. If gate is not to be polyolefin coated, eliminate reference to polyolefin coating. For gate leaf size 23 to 30 feet, weld an additional 2-inch square lateral support rail adjacent to top horizontal rail. Bottom rail shall consist of 2-inch by 4-inch aluminum member weighing 1.71 lb/ft.

286.4.1.1 Bracing. Provide diagonal adjustable length truss rods of 3/8-inch galvanized steel in each panel of gate frames.

286.4.1.2 Top Track/Rail. Enclosed combined one-piece track and rail, aluminum extrusion with weight of 3.72 lb/ft. Track to withstand reaction load 2,000 pounds.

286.4.1.3 Truck Assembly. Swivel type, zinc die cast, with four seal lubricant ball bearing rollers, 2 inches in diameter by 9/16 inch in width, and two side rolling wheels to ensure truck alignment in track. (No substitution allowed.). Mount trucks on post brackets using 7/8-inch diameter ball bolts with ½-inch shank. Truck assembly to withstand same reaction load as track (2,000 pounds).

286.4.1.4 Miscellaneous. Gate hangers, latches, brackets, guide assemblies, and stops shall be malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking.

286.4.1.5 Bottom Guide Wheel Assembly. Each assembly shall consist of two 3"-inch diameter rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb in proper alignment. Attach one assembly to each guide post.

286.4.1.6 Rotating Beacon. A Red rotating beacon will be installed at a minimum height of 7 feet from grade and adjacent to electronically operated gates. The beacon will activate upon opening and closing of the gate and must be clearly visible to approaching drivers.

286.4.1.7 Gate Post. For gates under 31 feet: galvanized steel 4-inch OD Schedule 40 pipe, ASTM F – 1083, weighing 9.1 lb/ft. Provide one latch post and two support posts for single slide gates and four support posts for double slide gates.

For gates 31 feet or larger: two pairs of support posts for each leaf (dual) 4-inch OD Schedule 40 pipe, ASTM F – 1083 weighing 9.1 lb/ft each. Posts connected by welding 6-inch by 3/8-inch plate between posts as shown on drawings. Also one 4-inch latch post. Finish to match fence.

286.5 Signs

286.5.1 AOA Signs. The Airport Board will furnish sign graphics in the form of a master

suitable for photographic enlargement. Signs shall be constructed of screen-printed reflective vinyl film on a .080 inch anodized aluminum panel. Anchor signs to fence fabric with #6 galvanized wire ties.

286.5.2 Fence Signs. Warning signs shall be affixed to the fence on centers of 200 feet maximum and at each turn of the fence of 45 degrees or greater. Signs shall be 24 inches in height by 30 inches in width. Fence sign graphics will include the Airport brand and the following verbiage: "Air Operations Area – No Trespassing." In addition, the following will be added to the bottom of the sign: "WARNING ~ RAZOR WIRE." Sign specifications approved by the DFW DPScan be obtained from the DFW Sign Shop.

286.5.3 Gate Signs. All AOA gates will be assigned a gate number by the DPS. Sign specifications approved by the DPS can be obtained from the DFW Sign Shop.

286.6 Concrete Mow Strip

A concrete mow strip 36 inches in width shall be installed at all permanent fencing. The concrete strip shall be 4 inches in thickness and reinforced with flat 6-inch by 6-inch, W2.9 X W2.9, welded wire fabric. Place the strip on a 2-inch sand cushion. Provide contraction joints spaced 4 feet on center and pre-molded 1/2-inch expansion joint material spaced at 32 feet on center.

286.7 Post and Cable System

A post and cable system shall be installed on the Air Side of AOA fences, 3 feet from and parallel to the fence, to separate International Parkway and the Service Roads. The posts must meet Standard DMS-7200 and the cable must meet Standard ASTM-A-475.

286.8 Bollards

Bollards will be used at locations where the Post & Cable System cannot be installed. Bollard shall include but are not limited to gaps where the Post and Cable System is anchored to the ground and changes directions, or where the terrain is not suitable for the system. Bollards shall be 6-inch galvanized pipe filled with concrete. The pipe

shall be anchored in concrete 3feet below grade. The exposed pipe shall be 3feet 6inches above grade. Bollards shall be spaced at 5 feet center to center. If a mow strip is being added to the AOA fence, the mow strip shall be expanded to incorporate the bollards.

286.9 Gate Barriers

Barriers are required for AOA gates as determined by the DPS. The system shall meet the Department of State standard for testing as called out in SD-STD-02.01, revised in March 2003, and must meet the K-12 impact rating of a 15,000-pound vehicle traveling at 50 mph.

Gate barriers must include sub-surface. Electrical components shall be located on the AOA side to avoid activation from the non-AOA side.

Barriers shall be automatically lowered/raised to allow passage of authorized vehicles by either a card swipe through the Airport Board's AACS, Intellikey, genie, or combination, and shall also be capable of being operated manually from inside a guard house.

286.10 Gate Locks

All unmanned AOA gates shall be equipped with an electronic lock and key system and shall comply with CFR 49, Section 1542.207. Provide Intellikey Stand-Alone System compatible with Intellikey ASC 4000 System or DPS-approved equal. The system shall utilize an audit trail and provide access control by user, time, date, and location. The system shall be constructed of weatherproof stainless steel and utilize a captive chain in the locking mechanism that automatically compensates for sags and misalignment.

286.11 AOA Screening

Screenings shall not be attached to AOA fencing or gates. No vehicles or property may be stored within 10 feet of an AOA fence or gate. Any construction design for the parking of vehicles will include the means to maintain the 10-foot separation such as striping, wheel stops, signs, or other approved architectural

methods.

286.12 AOA Guard Stations

286.12.1 Guard Houses. Guard houses are required at AOA gates when determined by DFW DPS.

286.12.2 Lighting. Lighting requirements for guard stations shall provide area lighting with intensity at ground level of 10 foot candles within a 20-foot radius of the door of each guard station and 5-foot candles within 40 feet of each guard station. These requirements may change based on new technology or FAA rules that may prohibit same. Refer to IESNA Lighting Handbook, 9th Edition for additional technical information. LED Illumination is preferred.

286.12.3 Lightning Protection. Lightning protection for guard stations (see Division 26).

286.12.4 Building with AOA Interface. All building constructed at locations adjacent to the AOA shall be designed and equipped with Automatic Access Control on any door providing direct access to the AOA.

SECTION 287 MINIMUM STANDARDS FOR TEMPORARY CONSTRUCTION WALLS IN THE SIDA AREA

287.1 General Requirements

287.1.1 A Security Plan shall be submitted for any work in the Terminals that will involve the Security Identification Display Area (SIDA).

287.1.2 Submit a narrative explaining how security will be maintained along with a suitable drawing to include detailed notes.

287.1.3 DPS will review the Security Plan to ensure compliance with all applicable security requirements.

287.1.4 Changing the SIDA requires DPS to initiate a "Changed Condition" to the Airport

Security Program which must be approved by the Transportation Safety Administration (TSA).

287.1.5 Once the review has been completed, an “approved” or “rejected” status will be issued.

287.1.6 If rejected, specifications will be included to achieve approved status.

287.2 Temporary construction walls

Temporary construction walls utilized in the SIDA (sterile/secure) shall meet the following minimum standards:

- Temporary construction walls shall utilize 5/8-inch sheetrock, on both sides, as a hardened surface.
- Temporary construction walls shall utilize metal studs, on 16-inch centers, as wall supports.
- Temporary construction walls shall be fastened to each stud, top plate, and bottom plate.
- Temporary construction walls shall extend from floor to deck with no openings.
- All temporary construction walls require DPS inspection upon completion, and prior to any continued construction.

Temporary construction walls shall not interfere with the operation of CCTV cameras and/or AACS. Prior to the deactivation of CCTV/AACS, ITS and DPS approval is required. If approved, only contractors holding a class B security license will conduct servicing, deactivation or removal of CCTV cameras, alarms, and/or wiring required to be moved during construction.

Temporary construction walls shall not interfere with emergency fire door operation. DPS Police, DPS Fire, and DFW ITS will be notified prior to removing access to any fire door or deactivation of alarms.

Any emergency fire exit door in a SIDA or Secure temporary wall shall be equipped with CCTV monitoring on both sides of door and contacts on the door to initiate an alarm in the module control relay (MCR).

Each emergency fire exit door shall be equipped with a local alarm to sound a horn (minimum of 94db) and strobe (minimum dual cd @115) in the immediate area of the door.

Any locks/cores involving SIDA wall construction shall be coordinated with DPS.

SECTION 288 PAVE

288.1 EVAC/MN/PA Design Components

288.1.1 Terminal Buildings. The terminals are classed as an assembly occupancy and shall meet the requirements of the IBC, the International Fire Code and the National Fire Alarm and Signaling Code (NFPA 72), as adopted by DFW.

Five primary functional areas are designated in the terminals:

288.1.1.1 Gates. A gate will be one announcement zone with a dedicated microphone whose primary function is to board airplanes. A zone group encompassing to two gates and the local concourse will be created for expanded paging.

288.1.1.2 Concourse. Concourse zones shall be sized to span the entire concourse.

288.1.1.3 Ticket Halls. Zones for ticket halls shall be designed to cover those functional areas. Microphones shall be provided based on stakeholder input.

288.1.1.4 Bag Claim Areas. Zones for bag claim areas shall be designed to cover those functional areas. Microphones shall be provided based on stakeholder input.

288.1.1.5 Back of House Areas. These areas are Emergency Voice Evacuation zones and shall be sized to provide for efficiency and appropriate geographic distribution. TSA Check Points are considered Back of House and shall be zoned individually.

288.1.2 Airport Operations Center (AOC). The AOC is currently provisioned with eight microphones, one at each of the operator stations, for making live announcements. Each operator station is also equipped with a Courtesy Announcement System (TCAS) application with predefined messages for text to speech messages.

288.1.3 Emergency Operations Center (EOC). The EOC is equipped with two microphones for making emergency pages to each of the component systems individually or campus wide.

288.1.4 Future non-terminal buildings. Systems for future non-terminal buildings shall be designed based on the requirements of the IBC, the National Fire Alarm and Signaling Code (NFPA 72), and best practices from DFW PAVE experiences as adopted by DFW and the functional requirements as determined by the stakeholders.

288.1.5 The DFW Terminal EVAC/MN/PA System includes:

- Announcement Control System hardware in Terminal Main Communications Rooms and Airport Operations Center
- Backup, or Lifeline, Announcement Control System hardware in secondary Terminal Main Communications Rooms
- Message Servers in specified Terminal Main Communications Rooms
- Digital Amplifier Mainframes and Amplifier Cards in Terminal Communications Rooms
- Ambient Noise Collectors in specified Communications Rooms
- Ambient noise sensors and associated wiring in Speaker zones
- Speakers and associated wiring in PA (existing speakers and wiring has been utilized until the TRIP project replaces them)
- Microphone stations and associated data cabling
- Rackmount Microphone stations in specified Communications Rooms
- IED Enterprise System software
- Flight Announcement System and Courtesy Announcement System software

- Other work and accessories required for a complete and operational system

288.1.6 The EVAC/MN/PA System collects, manages, and distributes high quality audible information to specific areas throughout the terminal buildings. The system has been specifically designed to intelligibly reproduce live, prerecorded, or assembled voice messages. The system is a fully network based digital system and analyzes the ambient sound level in specified zones to adjust the distributed sound level in the zone accordingly.

288.2 National Fire Alarm and Signaling Code (NFPA 72).

The EVAC/MN/PA System shall be capable of performing Emergency Voice Evacuation announcements and Emergency Mass Notification messages in compliance with NFPA 72, 2010 and any changes, additions or upgrades to the system shall be fully compliant as well.

288.3 Programming.

All hardware and software requirements for EVAC/MN/PA System functionality shall be coordinated with the DFW Board. This includes, but is not limited to, network connectivity, paging priorities, digital message assembly, system access, microphone paging, and paging station button functionality and screens.

288.4 Digital Message Distribution Operation

288.4.1 Each message processed by the system must be intelligible at destination areas.

288.4.2 Messages are coordinated such that dissimilar messages will not be distributed within an area at any given time. No message shall be lost because of coordination or priority preemption unless they are no longer timely.

288.4.3 Background music is distributed over the EVAC/MN/PA System and is ducked or muted for all page messages within the area

affected by the page messages. Background music is muted during the night.

288.4.4 Priority is assigned such that emergency paging function immediately cancels all other audio announcements or messages in the affected zones. Local paging functions have a higher priority than background music, and recorded messages in the local paging zone. Recorded messages override background music in all zones.

288.5 Fault Tolerance and Degraded Mode Operations

The system design is based on distributed intelligence.

288.5.1 All equipment containing microprocessors are powered by a Stored Emergency Power Supply System in compliance with NFPA 72 and the Standard on Stored Electrical Energy Emergency and Standby Power Systems (NFPA 111), which are located in each communications room containing EVAC/MN/PA System components.

288.5.2 Failed or abnormal performance of any active system component generates a supervisory signal at the local paging interface and system workstation and triggers a trouble signal at the Fire Alarm Panel.

288.5.3 Standby amplifier channels are automatically substituted for failed amplifier channels. Amplifier outputs are protected so they can survive a shorted output line while reporting an off normal condition to the system workstations.

288.5.4 LAN Distribution. The System distributes data between EVAC/MN/PA System nodes and from microphone stations to EVAC/MN/PA System nodes utilizing the DFW Airport Board Ethernet LAN utilizing TCP/IP protocol. LAN switches are provided and maintained by the DFW Board.

288.5.5 Multi-Zone Operation. Performs simultaneous distribution of independent announcements or messages to different zones or zone groups. The system is capable of distributing a minimum of eight different

concurrent messages from any given EVAC/MN/PA System node.

288.5.6 Digital Message Assembly. Standard or repetitive messages are studio-recorded voices that are assembled from digital audio files stored in the system audio library. Assembled messages form complete phrases capable of distribution without real time operator input.

The EVAC/MN/PA System is capable of recording, storing, and playback of permanent messages. Message "takes" are stored in non-volatile memory.

Two types of permanent messages are provided:

288.5.6.1 Standard messages include:

- Public service announcements
- Regulatory announcements
- Other institutional messages required by the DFW Board
- Standard messages are assignable to any zone or zones and may be initiated by any assigned paging station or scheduled for play by a system clock. The system clock is synchronized to the facility master clock system.

288.5.6.2 Assembled messages allow message "takes" or phrases to be "assembled" in real time to create a complete message and allow dynamic information by the user or database to be included within the message to give specific information or instructions. Assembled messages include:

- Flight boarding announcements
- Flight arrival and bag claim announcements
- Gate change announcements
- Delayed flight or cancelled flight announcements

288.5.7 Digital Audio Library. The digital message files shall contain CD quality (minimum 44.1 kHz 16 bit), fixed and variable digitized message files that can be prepared

by a professional announcer and supplied and arranged in data tables as follows:

- Bag Claim look-up table
- Gate Room look-up table
- Fixed message files may also be standalone non-assembled messages such as security messages and parking warnings

288.5.8 Microphone Paging

288.5.8.1 A user ID input shall be required to unlock a microphone station for live or recorded announcements. The microphone station shall be automatically locked after a specific period of time, configurable by the system administrator.

288.5.8.2 Announcements shall be able to be distributed live if the destination zone(s) is not in use. If not available, the page shall be able to be recorded and played back in queue when the destination zone(s) is available. The microphone's display shall indicate busy when input resources are not available.

288.5.8.3 Microphone stations shall be capable of paging to a zone or zone groups based on the user ID's privileges and the microphone station configuration.

288.5.8.4 A user ID shall be able to be established for Emergency Responders that allows authorized users to make announcements during emergency events from any microphone station.

288.5.9 Remote System Control. Remote configuration and independent adjustment of signal processing of each system component (ambient noise compensation, equalization, gain management, etc.) shall be able to be accomplished from system workstations.

288.5.10 Ambient Noise Analysis System. An Ambient Noise Analysis system shall adjust signal levels in response to either ambient noise levels or computer commands. Three modes of operation shall be possible:

1. Automatic. Changes attenuation levels in response to noise levels reported by remote sensors.

2. Controlled. Changes attenuation levels based on remote sensors of automatic channel.
3. Fixed Attenuation. Fixed attenuation as set by the computer and system administrator.

288.5.11 High-Quality Sound Reproduction. The system shall provide clean audio, free from noises such as pops, clicks, hiss/hum, and access/ disconnect tones at all loudspeakers at all times during operation including standby mode. Distortion shall remain within specified limits.

288.5.12 Monitor Test System Operation. The EVAC/MN/PA System shall include self-diagnostics that operate in real time under software control. This self-testing shall include testing of audio operation, power supplies, power amplifiers, speaker circuits, and network communications.

288.5.13 Software. Software applications shall have a graphical user interface and have the characteristics of an application program. All operating features shall be available without requiring knowledge of the underlying programming language. All features shall be available by answering prompts and responding to menus. All menus shall be subdivided into logical groups. All operator input is to be checked to ensure that no input error can render the system, or a portion thereof, inoperable.

288.5.14 Security. All software shall provide multiple levels of password protection. Initially, three levels of security shall be established and specific rights to program areas shall be assigned by the system administrator.

- Level 1: Allows user to configure the system, define graphical user screens, set system parameters and defaults, map alarm communications and features listed for Levels 2 and 3.
- Level 2: Allows user to modify system parameters, enable modem, acknowledge alarms, and features listed in Level 3.
- Level 3: Allows user to operate the system, view system settings and print current system configuration.

288.5.15 The amplifier system shall be a rack-mounted, modular assembly using slide-in circuit boards in plug-in card files to allow easy expandability and servicing. External connections shall be made to removable compression terminals. All external connections shall be made on backplane circuit boards to allow circuit cards to be removed for replacement without disconnecting cables.

288.5.16 The EVAC/MN/PA System shall be comprised of several integrated sub-systems that form a complete system for airport announcement and message management. These systems shall include:

- Networked computer for system administrator configuration and control
- Networked computer-based Announcement Control System (ACS)
- Multi-bus digital recording and playback system
- Ambient noise sensing and control system
- Equalization system
- Automatic test and monitor system
- IP-addressable, power over Ethernet microphone stations
- Comprehensive software for announcement control and multi-lingual messages
- Redundant power supplies
- Power amplifiers

288.5.17 Other products may be incorporated into the system as they are developed based on functionality, changes in the operational model, and value to the stakeholders.

288.6 Performance Requirements

288.6.1 Technology. The system shall utilize the latest in digital audio, video, and networking technology. With the exception of the speaker circuit, the entire system shall be digital and not utilize combinations of analog and digital circuits. At the first point of connection to the system, microphones and other program sources shall be digitized and remain in the digital domain until the final power amplifiers. Systems that use multiple stages of analog/digital quantization are not acceptable.

288.6.1.1 The system shall be entirely software driven. No analog controls may exist anywhere in the system that could allow unauthorized adjustments or users.

288.6.1.2 Microprocessors shall manage and control all system functions and hardware including microphone communication stations, announcement queuing, telephone interfaces, distribution of emergency announcements, local announcements, terminal announcements, background music distribution, announcement recording, and messaging.

288.6.2 System Architecture. The system shall feature distributed processing, with multiple ACS software controllers. The ACS controller shall provide a network-centric architecture to minimize central head end equipment. This will eliminate the possibility of complete system failure should catastrophic failure happen in any one room or area. This distributed topology will also allow for local interface terminations with other systems, rather than the need to route connections to a centralized head-end location. Failed or abnormal performance of any active system component shall generate a fault to the fault reporting system.

288.6.3 Ethernet Network. The entire system shall operate on a single Ethernet network. The network shall be designed using a Partially Connected Mesh configuration with a gigabit (minimum) backbone between all core, intermediate, and edge switches. The network shall be designed and installed using recognized industry practice and tested in accordance with ANSI/TIA/EIA 568B-1, 2, and 3.

288.6.4 Software. All system software for every system component shall be integrated into a single enterprise-class application utilizing a common database.

288.6.4.1 The entire system shall be programmed, controlled, and monitored by

use of a single software application provided by the manufacturer of the system.

288.6.4.2 Setup of announcement control, messaging, signal processing, and amplifier control functions shall utilize graphically oriented objects and a common tree-view for the entire system. When expanded completely, the left portion of the window shall show a tree view of the ACS nodes controlling each area of the facility (individual concourses, terminals, gates, etc., or as applicable). Each expanded view shall include the functional setup parameters for each ACS, microphone communications station, integrated digital power amplifier system, and visual display device. These include but are not limited to microphone communications station setup, zone and zone group setup, user and user group setup, permanent digital record and playback (DRP) configuration, audio monitor and testing setup, zone equalization, ambient analysis setup, and power amplifier control.

288.6.5 Password Security. System access to setup workstations, servers, and remote access shall require an authenticated user name and password. Access to microphone stations shall require a user ID and PIN. Each user ID and PIN shall allow for up to eight characters. The password server shall allow assignment of users to employer user groups for restricted access to appropriate functions and areas.

288.6.6 Announcement Distribution. The system shall provide for distribution of announcements and messages to each zone of the system. A zone is defined as the smallest addressable area of speaker coverage. The system shall prevent a single zone from receiving more than one announcement or message at a time. No announcement or message shall be lost or discarded because of coordination or priority preemption unless configured as such through the business rules programming. For initial programming, configure the systems as follows:

288.6.6.1 Program material sent to zones (i.e., Background Music) shall be ducked during any announcement or message.

288.6.6.2 A local or multi-local zone group announcement shall not delay a terminal announcement from playing, but it shall interrupt and override the terminal announcement in the zones that have been assigned to its use.

288.6.6.3 Multiple emergency announcements may be made at one time if no zone conflicts for that class of announcement exist. Regardless of zone announcements, emergency announcements immediately suspend all other zone activity in the affected zones until completed or cancelled.

288.6.7 TCAS. TCAS is an SQL server application that allows creation and management of courtesy announcements from a web browser. Standard and customized templates are to be used to create common or ad hoc messages, which may use an IED microphone paging station for audio or an integral text to speech engine. Announcements are capable of delivering both aural and textual messages for ADA compliance and shall be available in multiple languages. Management supports private messages, automatic replays, full logging, and archiving.

288.6.8 Priority Levels. Announcements and messages shall be processed and distributed based on defined levels of priority. A minimum of 256 priority levels shall be available. Initial priority levels shall be assigned as follows:

- Not Assigned
- Emergency Live Announcements
- Emergency Messages
- Not Assigned
- Local Announcements and Messages
- Not Assigned
- Terminal Announcements and Messages
- Not Assigned
- Not Assigned
- Program Material (Background Music)

288.6.9 Signal Routing. The system shall provide for simultaneous routing of the following traffic:

288.6.9.1 Each ACS Instance or LAN segment shall route up to 240 paging stations, and 32 message channels to up 65,536 zone outputs. Routing shall be limited only by the number of channels that are dynamically assigned. No announcements shall be routed through the servers unless being stored for delayed playback.

288.6.9.2 The system shall be capable of distributing eight program background music channels assignable to any zone output.

288.6.9.3 The system shall distribute and monitor audio from any monitor point to the requested monitoring speaker station (rack-mount speaker).

288.6.9.4 All routing of signals shall be on the digital audio network.

288.6.9.5 All switching shall be quiet with no audible switching transients, clicks, or pops.

288.6.10 Announcement Properties. Each announcement shall be configurable with announcement properties. These include:

- Announcement gain
- Priority level
- Time to wait in a ready state
- Time to warn for cutoff
- Maximum length
- Maximum wait in busy queue
- Activate with only partial resources
- Preempt all
- Continue with some zones preempted
- Preemption zone kill
- Recover zones as available
- Ducking
- Zone mute
- Emergency

288.6.11 Multi-Local Zone Groups. The system shall have the ability to program multi-local zone groups for each microphone communications station. These zone groups shall be pre-established groups of relational zones that are commonly accessed from those stations. A preprogrammed 'soft button' shall be used to access those zone groups.

288.6.12 User Groups. The system shall provide for editable user group assignments that control user access. User groups are sets of zone assignments within the facility. Zone groups may be selected by user groups based on approved access. User groups shall be available to users at microphone communication stations based on their authenticated membership in a user group and password/PIN.

288.6.13 Logging. When a dedicated or virtual system server is included in the system topology, and the server has been loaded with Enterprise software, the Logging System portion of the software shall provide complete logging/ archival and exporting functions for the following four types of system activity:

288.6.13.1 User Activity Log. This feature shall record all log in and out activity by time and date and record event descriptions for each. This includes all changes made to the system setup configuration.

288.6.13.2 ACS Announcement Log. This feature shall record all events in the system including all announcements and messages that play. It shall include the user logged in, announcement type, time and date, originating station, destination zone(s), and length.

288.6.13.3 Communications Station Security Log. This features logs the status of communications stations. It shall include the user, user's company (e.g., airline), station name, and status.

288.6.13.4 Fault Logger. This feature shall log all system faults. It shall include type and location fault, time and date of fault, time and date of restoration, and applicable test data. Faults shall be assignable to fault classifications and configurable for prioritized delivery.

288.6.14 System Capacity. Each system shall provide for up to 32 ACS nodes. Each ACS node shall provide support for up to 240

microphone communications stations, 480 expansion microphone stations, and over 65,000 zones. Any microphone communication station may be assigned to any combination of zones in the system.

288.6.15 Audio Specifications

- Frequency Response ± 0.5 dB at 20 Hz to 20kHz
- Test: Measure the electrical power output of each power amplifier at normal gain setting at 50, 1,000, and 12,000 Hz. The maximum variation in power output at these frequencies must not exceed ± 0.5 dB.
- Total Harmonic Distortion (THD) < .05 percent at Rated Amplifier Output 20Hz to 20kHz
- Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1,000, 3,000, 8,000, and 12,000 Hz into each pre-amp channel and measure the distortion in the power amplifier output. The maximum distortion at any frequency is three percent (3 percent) total harmonics.
- Noise Referenced to Input -120 dBu 20Hz to 20 kHz
- Signal-to-Noise >90dB
- Maximum Latency – From Communications 11.9 ms Station to Power Amps through three Network Switches

288.6.16 Messaging Servers. The messaging system (DRP) shall be integral to the function of the ACS and be integral to an ACS controller or reside on the network as a message server appliance.

288.6.16.1 Eight channels of recording and eight channels of playback shall be simultaneously available in each message server. Each channel shall provide a minimum of 130 seconds of recording. Times shall be configurable based on announcement type.

288.6.16.2 When a communications station or workstation initiates an announcement, the system shall dynamically assign a communications channel, and assign it to an

open DRP channel. The announcement shall be played if the microphone switch is released prior to the end of the record time. If the microphone switch is pressed and held during a 5-second (or as programmed) silence period, the announcement shall be cancelled. The announcement will playback automatically, to the selected zone group, in its assigned queue position.

288.6.16.3 Messages shall be stored in non-volatile memory and have a minimum capacity of 20,000 minutes.

288.6.16.4 The system shall support minimum of eight languages.

288.6.16.5 The system shall support minimum of three types of messages. Each message shall have an audio and visual element to provide visual paging that duplicates the audio in the designated zones. The audio and visual elements shall start together and maintain continuous synchronization through the duration of the message.

288.6.16.6 Types of Messages. Standard Messages. These are standard single file (take) messages of following categories. Standard messages may be assigned to any zone or zone group and may be initiated by any assigned communications station or scheduled for play by the system clock.

- Emergency announcements and instructions
- Public service announcements (no parking, no smoking, etc.)
- Regulatory (do not leave bags unattended, etc.)
- Other institutional messages

Assembled Messages. Assembled messages shall allow audio message “takes” or phrases to be “assembled” in real time to create a complete message. Assembled messages shall allow dynamic information provided by the user or a database to be included within the message to provide for specific information or instructions. The user shall have the ability to “build announcements” using stored takes utilizing the built in editing system. Takes shall

be professionally recorded human voices and edited to allow assembly in any random order. Each message shall be comprised of up to 30 takes. The following messages shall be assembled:

- Flight boarding sequence announcements
- Flight arrival, bag claim, and delay announcements
- Gate changes or other gate operations
- Delayed flight or canceled announcements
- Message libraries for English (and others if applicable)
- Live Text-to-Speech Messages. Text-to-Speech Messages shall use a high quality text to speech engine to create audio messages from text. Text-to-Speech messages shall be used only for courtesy announcements where announcements require dynamic messages and real voice takes cannot be anticipated or recorded. Provide message libraries for English, French, Spanish, German, Korean, Japanese and Chinese.

288.6.17 Ambient Noise Analysis and Control. The systems shall include the capability to automatically adjust the volume levels in each zone based on changes in the ambient noise levels in those zones.

288.6.17.1 Each zone that includes a sensor within its boundaries shall have automatic control.

288.6.17.2 The system shall automatically null announcement or program material for that zone to prevent “run-away” or inaccurate volume tracking, and shall provide smooth unobtrusive control.

288.6.17.3 Software shall allow for setup of the following parameters:

- Automatic, slaved to an automatic channel, or fixed modes.
- Configuration of one to four sensors for control of a zone and control of multiple zones from one or more grouped sensors.
- Control of threshold, maximum gain allowed and scaling ratio.

- Software shall provide for real time monitoring of sensor levels, program levels, output levels, and gain changes.
- System shall provide for automatic setup of zones using the integrated system messaging.

288.6.18 System Equalization. The system shall provide for frequency response equalization for each speaker zone output. Filter types shall allow notch, high pass, or low pass. Filters shall have a Q range of 0.055 to 33. Provide nine filters for each zone output.

288.6.19 Automatic Backup Amplifier Switching. The system shall include backup amplifier switching in the event of the failure of a power amplifier.

The system shall automatically detect failure or abnormal operation of a power amplifier, and replace the faulty amplifier with a spare amplifier without operator initiation.

One spare power amplifier shall be installed in each amplifier mainframe.

The spare amplifiers shall be powered up only when they are transferred into service. The system shall detect a failure, power up the spare amplifier, and complete the transfer for restored operation within two seconds of an amplifier failure.

288.6.20 Monitoring System. Provide complete integrated aural and signal level monitoring of the system at designated monitor points. This capability shall be available for selection at each system workstation for level monitoring and at each monitor speaker location for aural monitoring. Audio routing shall be automatic from any monitor point to any listening point.

288.6.20.1 Selection shall be instantaneous and not introduce popping or other audio noise.

288.6.20.2 Provide monitor points for each direct digital input, local analog input, ambient channel output, equalizer output, amplifier input, amplifier output, and speaker zone.

288.6.20.3 Provide capability to select an announcement or message in progress from the main activity screen and select monitor points for that activity during the announcement or message.

288.6.20.4 Provide a dynamic multi-channel monitoring screen selectable for each amplifier mainframe. The screens shall include calibrated VU meter bars, channel status, signal preference, and fault status for each of the 16 channels. The screen shall also indicate status of the backup amplifier channels.

288.6.21 Testing System. The system shall provide for self-diagnostics that operate in real time under software control.

288.6.21.1 This self-testing shall include testing of any combination of communications stations, direct digital input, local analog input, ambient channel output, equalizer output, amplifier input, amplifier output, and speaker zones.

288.6.21.2 The system shall be capable of testing to a resolution of 0.5 dB.

288.6.21.3 Manual or programmed audible frequency self-testing shall be available as well as an inaudible (20 kHz) test designed to exceed the requirements of NFPA Standard 72F.

288.6.21.4 All testing must be capable of operating simultaneously with normal system operations including test setup. Systems that disrupt or play audible test tones to more than a single zone at a time are not acceptable.

288.6.21.5 Each speaker line shall be tested for GFI on both sides of the balanced speaker cabling. This testing shall be available without applying power to the amplifier to verify cabling integrity prior to powering.

288.6.21.6 All test results shall be reported to the fault reporting system.

289.1 General

All installations must be coordinated with the DFW IT Department.

The EVAC/MN/PA System design and all modifications shall comply with all requirements of the State of Texas and of DFW.

The EVAC/MN/PA System shall comply with the requirements of the National Fire Alarm and Signaling Code (NFPA 72), the Airport's Inspection Authorities, and with the Manufacturer's instructions.

Audio modeling using an approved simulation software is required to predict the intelligibility of the space based on architectural features and materials interacting with speakers and their placement.

289.2 Design Requirements

289.2.1 Each physical speaker/amplifier zone shall be comprised of a discrete contiguous space with a common function (each gate hold room, concourse circulation adjacent to each gate hold room, airline ticketing lobby, baggage claim area, security checkpoint, concessions, operations office, etc.). Areas with different functions shall not be combined in the same physical speaker/amplifier zone.

289.2.2 The speakers for each speaker/amplifier circuit shall consistent within the circuit.

289.2.3 Speaker spacing shall be based on ceiling heights, ceiling materials, and type of space the zone encompasses. Speakers shall be tapped and balanced with amplifier settings so that announcements are intelligible.

289.2.4 Each physical speaker/amplifier zone that will have varying amounts of ambient noise shall have at least one ambient noise sensor, and zones shall be evaluated for more than one ambient noise sensor based on size. Ambient noise sensors shall be mounted such that they are closer to sources of ambient noise than to EVAC/MN/PA System speakers.

SECTION 289 SYSTEM DESIGN REQUIREMENTS

289.2.5 In areas of the Terminals that have undergone TRIP renovations, the EVAC/MN/PA System shall be designed for Voice Evacuation and Mass Notification announcements in compliance with NFPA 72.

289.2.6 Voice Evacuation

289.2.6.1 All occupied areas of the building shall utilize the EVAC/MN/PA System for Voice Evacuation. Multiple physical Speaker zones may be combined into a single Voice Evacuation zone through system programming.

289.2.6.2 Voice Evacuation zones shall be coordinated with the Fire Alarm System so that fire alarm zones are not split among more than one voice evacuation zone. DFW DPS and IT Departments shall approve all changes to Voice Evacuation zones.

289.2.6.3 Evacuation alarms will be initiated by the Fire Alarm System, which will initiate Fire Alarm System strobes and signal the EVAC/MN/PA System to distribute a pre-recorded Voice Evacuation message.

289.2.7 Mass Notification

289.2.7.1 All areas of the building that can be occupied shall utilize the EVAC/MN/PA System for Mass Notification announcements. Mass Notification announcements shall use the same zones programmed for Voice Evacuation and shall be coordinated with fire alarm zones.

289.2.7.2 The EVAC/MN/PA System will initiate Mass Notification announcements. It will signal the Fire Alarm System to initiate strobes and distribute a recorded or live announcement through the EVAC/MN/PA System.

289.2.7.3 Mass Notification announcements may be initiated from any EVAC/MN/PA System microphone station when an authorized user is logged into the microphone station.

289.2.8 In the areas of the Terminals that have undergone TRIP renovations, all cabling shall

be installed in conduit. In areas of the Terminals that have not undergone TRIP renovations, cabling exposed in public areas shall be installed in conduit.

289.2.9 EVAC/MN/PA System hardware shall be housed in DFW Communications Rooms in equipment cabinet(s) within each room designated for the EVAC/MN/PA System. EVAC/MN/PA System cables shall be installed in conduits within DFW Communications Rooms.

289.2.10 DFW Communications Rooms contain at least one EVAC/MN/PA System Zone Tie Box. The zone tie boxes house terminal strips and shall be used as intermediate termination points for the following wires:

- Speaker cables from physical Speaker zones to amplifiers
- Ambient noise sensor cables from physical Speaker zones to ambient noise sensor collectors

289.2.11 Speaker and ambient noise sensor cables shall not terminate directly on amplifiers or ambient noise sensor collectors without first terminating on terminal strips in the zone tie box. Wire terminations shall be labeled in zone tie boxes with the type of wire, zone name, and zone description.

289.2.12 Capacity: At each equipment location, provide 20 percent spare system capacity including, but not limited to all amplifier card slots, inputs, outputs, terminal strip positions, etc.

289.3 Specification Requirements

The following is required for all specifications:

- Contractors must coordinate in advance with the DFW Operations Center (972-973-3112), DFW IT Department, and DFW DPS before performing any work affecting the existing EVAC/MN/PA System. Operating, programming, modifying, or impairing the existing system without approval of the Airport is strictly prohibited.
- When renovating an area that contains devices for the EVAC/MN/PA System, test the system to document its condition

before changes are made. Operation of EVAC/MN/PA System devices outside of the work area must be maintained.

- Submit for approval copies of the following shop drawings and product literature.
 - Shop drawings shall contain title blocks identifying the project name and number. Submittals shall be marked to indicate the specific models, sizes, types, and options being provided. Submittals not so marked and incomplete submittals will be rejected.
 - Plan drawings showing the locations of the system components, including any adjustments in the quantities.
 - Riser diagram showing system components, interconnecting wiring, and connections to other building systems and equipment.
 - Wiring diagrams showing manufacturer and field connections at device terminals, complete with conductor color codes and wire numbers.
- To maintain complete compatibility with the installed EVAC/MN/PA System, the equipment referenced in Appendix B or equivalent equipment specifically approved by the DFW Information Technology Department, shall be used for any system modifications and expansions of the EVAC/MN/PA System. The exact equipment and wiring configurations to be used shall be included in submittal to and approval from the DFW Information Technology Department.

289.3.1 Qualifications

- Installation shall be performed by factory trained and certified technicians skilled in the installation of the type, brand, and style of equipment to be installed.
- The Contractor shall meet the qualifications for Emergency Communications Systems (ECS) installations in compliance with NFPA 72, 2010 Ed. Contractor shall meet the requirements of the State of Texas Fire Alarm Rules.
- The Contractor shall be responsible for all EVAC/MN/PA System programming related to the specific project.

289.3.2 Warranty

- Provide a complete parts and labor warranty for twelve months from the date of final acceptance of the system by the Owner.
- Provide a telephone response to Owner's questions within 4 hours and on-site assistance within 24 hours.
- Additions and alterations to the EVAC/MN/PA System will be incorporated into the DFW Information Technology Department's master service and warranty agreement with the EVAC/MN/PA System manufacturer.

289.3.3 Installation

- Provide wiring and raceways as follows and in accordance with related Sections of the DFW Design Criteria Manual, and manufacturers' instructions.
- Concealed in walls, exposed on walls, and above non-accessible ceilings, provide wiring in conduit, minimum 3/4" EMT.
- Paint EVAC/MN/PA System junction boxes, covers, conduit fittings white.
- Final connections to the EVAC/MN system components and system programming shall be performed by technicians who are factory trained in the type, brand, and style of the equipment that has been installed and licensed in the State of Texas to perform Fire Alarm installations.
- Label connectors, plugs, outlet boxes, cables, and cable terminations. This labeling shall use English language descriptors and be fully documented in as-built drawings.
- Dimensioned locations of outlet boxes, cables, and cable terminations shall be fully documented in as-built drawings.
- Raceway for EVAC/MN/PA wiring shall not be shared by power or any other electrical wiring that is not part of the low-voltage EVAC/MN/PA System systems.
- Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
- Install input circuits in separate cables and raceways from output circuits.

- Provide protection for exposed cables where subject to damage.
- All cables shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length.
- Test polarity of existing speaker circuits and for shorts prior to connecting wiring to new amplifier.
- Speaker circuits shall be wired in a single circuit each without paralleled branches.
- Splice cable only at terminal block units.
- Install input circuits in separate cables and raceways/pathways from output circuits. Separation of input and output circuits shall be in accordance with manufacturer's installation instructions.
- Install all cables no closer than 12 inches from any horizontal or backbone cabling, power system cable/raceway, or fluorescent/ballasted light fixtures.
- Leave a minimum of 12 inches excess cable at each termination at speaker and termination blocks.
- Leave a minimum of 12 feet excess cable at the communications rooms EVAC/MN/PA System equipment cabinets.
- Provide protection for exposed cables where subject to damage.
- Use suitable cable fittings and connectors.
- Cables shall not be installed with a bend radius less than that specified by the cable manufacturer.
- Test cable polarity prior to connecting amplifiers.

289.3.4 Testing

- Demonstrate operation of the EVAC/MN/PA System modifications in accordance with NFPA 72 and manufacturer instructions.
- The test shall be witnessed by a DFW IT Department representative.

289.3.4.1 Acceptance Test Requirements

- Operational Test. Perform an operational system test to verify conformance of system to the Specifications. Perform tests

that include originating program material distribution, page material distribution, message distribution coordination, zone distribution selection, message assembly, system supervisory, alarm and monitoring functions, ambient noise control functionality, and paging operator workstation features. Observe sound reproduction for proper volume levels and freedom from noise. All zones affected by the project shall be included in the test.

- Intelligibility Test. Perform intelligibility tests in compliance with NFPA 72 Chapter 18, 24 and this Manual.
- Acoustic Coverage Test. Feed pink noise into the system using octaves centered at 4,000 and 500 Hz. Use a sound level meter with octave band filters to measure the level at approximately 40-foot spacing intervals in each zone. For spaces with seated audiences, the maximum permissible variation in level is ± 2 dB and the levels between locations in the same zone and between locations in adjacent zones must not vary more than ± 3 dB.
- The documentation of tests, measurements and adjustments performed shall include a list of personnel and the list of certified test equipment used and shall be in compliance with NFPA 72.
- All information recorded from all testing shall be shown on the as-built documents.

DIVISION 31

Earthwork

SECTION 311 SITE CLEARING

311.1 Clearing and Grubbing

Site work includes clearing, grubbing, grading, drainage, paving, and special site development structures. All site work shall be designed and conducted to improve the overall aesthetics of the Airport and to promote future development.

SECTION 312 EARTH MOVING

312.1 Grading

The site shall be prepared preserving the natural character of the terrain by minimum disturbance of existing ground forms, with the objective to develop an attractive, suitable, and economical project site. Surface and subsurface flow from stormwater shall be diverted away from buildings and pavements to prevent undue saturation of the sub-grade that could damage structures and weaken pavements.

312.2 Excavation and Fill

312.2.1 Excavation for Structures. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

Excavated boulders, rock, and concrete shall be incorporated into general landscaping to reduce the amount of materials to be landfilled.

All bracing, sheathing, or shoring shall be performed as necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws.

Unless otherwise provided, bracing, sheathing, or shoring involved in the construction shall be removed after the completion of the structure. Removal shall be effected in a manner which will not disturb or mar finished masonry.

312.2.2 Excavated Soil Materials. Excavated materials must be managed and disposed of in accordance with DFW EAD Soil Management Plan. Projects that involve subsurface drilling or the excavation, stock piling or movement of soils require a soil management plan be submitted and approved by EAD that details procedures to be employed to ensure proper handling and disposal. No excavated material or concrete rubble may be removed from the Airport without approval from EAD. Submit requests through the Building Official.

312.2.3 Backfill for Structures. The area around a structure shall be filled with approved material, in horizontal layers not to exceed 8 inches in loose depth. For areas under pavement and safety areas, compact to 95 to 100 percent of the Standard Proctor Density, in accordance with ASTM D 698. For all other areas, compact to 93 percent of the Standard Proctor Density. Moisture content shall be held to a range of from 1 percent below to 3 percent above optimum. Each layer shall be deposited all around the structure to approximately the same elevation.

Reuse of excavated soils into structural designs and general landscaping is encouraged to reduce the amount of materials to be landfilled.

The use of compost materials shall be used in the top layer of all fill materials to improve stormwater infiltration, promote ground water

recharge, and reduce the need for fertilizers and other chemicals to stimulate plant growth.

In the case of concrete, backfilling shall not be placed against any structure until the concrete has been in place 7 days, or until tests made by the laboratory under supervision of the Engineer establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it. Sufficient strength shall be interpreted as being 75 percent of the design strength, or the strength expected to be obtained in 7 days, whichever is greater.

312.3 Erosion and Sediment Controls

312.3.1 Storm Water Pollution Prevention Plan. For projects disturbing greater than 1 acre, a Storm Water Pollution Prevention Plan, including an erosion control plan, must be submitted to the Building Official along with a signed Notice of Intent before a construction permit will be granted. Erosion control measures shall be designed and implemented to effectively prevent discharge of sediments to the storm drain system and receiving waters. Care shall be taken in the design and implementation of such measures to ensure that a safety hazard, such as ponding water on a roadway, does not occur.

312.4 Permitting

312.4.1 Preliminary Actions. In order to ensure compliance with the above-described objectives, the Designer shall provide information in order for submittal of the following documents along with application for the construction permit to construct or renovate a facility from which there will be stormwater discharge:

- Documents describing the type and nature of all activities to occur at the site that could potentially impact stormwater quality.
- Documents detailing the structural controls to be constructed at the facility to impel stormwater discharges to meet EPA benchmark standards, by reducing the discharge of both point and non-point source pollutants (e.g., oil and grease, metals, sediment, and trash).
- The use of stormwater filtration devices, oil/water separators, infiltration swales, and rain gardens shall be used to reduce stormwater runoff and improve the quality of runoff.
- A certification, sealed by the design engineer, stating that “Based upon the above representations, the proposed structural controls will reduce the discharge pollutants to the DFW stormwater collection system, and/or receiving waters.”
- A certification, sealed by a Licensed Professional Engineer in the State of Texas and signed by the owner/operator of the facility, stating that all structural controls supporting the facility will be maintained in manner to ensure effective operation and minimize the discharge of pollutants; and operators will develop and implement a Pollution Prevention Plan upon occupancy of the facility to identify all activities with the potential to impact the quality of stormwater discharges (or general environ-

mental compliance) and the best management practices to be implemented.

312.5 Spill Prevention Control and Countermeasures Plan

Facilities may be subject to Spill Prevention Control and Countermeasures Plan (SPCC) regulations of 40 CFR 112. The design of any new or renovated facility must include a submittal by the Operator to the DFW EAD, including a formal determination as to whether a SPCC is required; and if so, the design must incorporate the measures specified at 40 CFR 112 or any subsequent applicable federal or state regulation. Under the provisions of the SPCC 112 regulations Part II (73 FR 74236) effective January 14, 2010, completely buried oil storage tanks are exempt from the rule. In addition, the rule redefines "facility," that is, the owner or operator now has discretion in identifying which building, properties, parcels, leases, structures, installations, pipe, or pipelines make up the facility.

SECTION 313 SPECIAL FOUNDATIONS AND LOAD-BEARING ELEMENTS

313.1 Bored Piles

Drilled piers shall be straight shaft type only. Use no belled piers.

SECTION 314 TUNNELING AND MINING

314.1 Tunnel Construction

Tunnels shall include all below grade, enclosed structures used by pedestrians and vehicles or to hold utilities.

Due to the varied applications of tunnels, the design criteria shall be established on a project to project basis.

Items of particular interest which should be addressed are: waterproofing, ventilation, lighting and utilities, drainage, exiting, fire protection, cathodic protection/ corrosion control, and overburden loading.

DIVISION 32

Exterior Improvements

SECTION 321 CURBS, GUTTERS, SIDEWALKS AND DRIVEWAYS

321.1 Sidewalks

Pedestrian concrete walks shall be constructed between buildings and other essential locations where such a need may occur. The minimum standard width for sidewalk pavement shall be 4 feet with proper cross slope for adequate drainage. The minimum standard walkway pavement shall be of 4-inch thick concrete reinforced with No. 3 rebar at 12 inches each way on a minimum 2-inch sand cushion. Rolled wire fabric will not be permissible as walkway or other reinforcing. Provide contraction joints spaced every 4 feet (approximate). Pre-molded ½-inch expansion joint material spaced at 32 feet is required. Unless allowed otherwise in the adopted Building Code, sidewalks terminating at building doors shall be constructed as landings flush with the finish floors to the interior of the building. Slopes at landings shall not exceed 2 percent (1/4 inch) slope.

321.2 Pavement Markings

321.2.1 Fire Lane Markings. Fire lanes shall be marked with a 6-inch painted red stripe. The words "FIRE LANE NO PARKING" shall be stenciled in white paint, 4-inch high letters with a ¾-inch stroke. The interval between stenciled signs shall be adequate to inform the public of the existence of the fire lane but in no event shall the interval be greater than 20 feet. Markings shall be on each side of the designated fire lane. The shade and type of paint shall comply with State of Texas specifications for traffic paint.

SECTION 322 SITE IMPROVEMENTS

322.1 Fences and Gates

322.1.1 Leased Property Fencing. All fencing on leased property is the responsibility of the Tenant and shall be aesthetically pleasing. This can be accomplished by use of material matching or similar to adjacent structures. Chain-link fencing shall be screened with plantings where appropriate.

322.2 Retaining Walls

322.2.1 Design Criteria. Wherever slopes must be steeper than a slope of 4:1 (four horizontal units to one vertical unit), the use of retaining walls will usually be required. Either vertical or battered wall faces are acceptable. Exposed concrete shall be buff color with surface texture matching that of adjacent buildings. Trenching or sprinkler systems shall not be allowed in the passive soil area.

Retaining wall design and materials shall comply with the applicable sections of the Building Code and the geotechnical investigation report for that project. TxDOT standards to be adhered to unless directed otherwise by DFW.

322.3 Expansive Soils

The effect of wall movement caused by expansive soils shall be taken into account and, when necessary, appropriate design steps shall be taken to minimize them.

322.4 Factor of Safety

The factor of safety for overturning shall be 1.5 minimum and 2.0 maximum. The factor of safety for sliding and circular soil arc failure shall be a minimum of 1.5. Expansion joints shall be provided every 90 feet maximum and contraction joints every 30 feet maximum.

SECTION 323 PEDESTRIAN BRIDGES

323.1 General

Pedestrian bridge length, width, height, and construction materials shall comply with the Building Code.

323.2 Materials

Construction material specifications, strengths, handling, storage, and testing shall comply with the TxDOT "Standard Specifications for Construction of Highways, Streets and Bridges."

323.3 Design Loads and Loading Combinations

The minimum live load shall be 100 psf. Where equipment and small vehicles are anticipated to use this structure, live loads shall be increased accordingly.

In addition to live and dead loads, the following loadings shall be taken into account:

- Earth Pressure
- Buoyancy
- Wind (Including Jet Blast and Uplift)
- Shrinkage
- Temperature
- Stream Flow
- Construction Loads
- Any Special Loads

Loads shall be applied in such a manner as to produce the maximum stresses.

Loading combinations shall be the same as those described in the American Association of State Highway and Transportation Officials (AASHTO) guidance "Standard Specifications for Highway Bridges" and interim specifications.

323.4 Clearances

Vertical clearances over roadways shall be 1 foot greater than outlined in Section 34, Obstruction Clearances.

SECTION 324 SCREENING DEVICES

324.1 Exterior Mechanical Equipment Screening

All visible equipment, whether roof- or ground-mounted, must be painted alike and screened from view wherever possible. Color for such equipment, including roll-up doors, mechanical equipment, metal canopies, piping, electrical equipment, etc., and any other equipment of specialized function, shall match. Specially designed screens, suitable plant materials, and architectural enclosures can be used for screening purposes depending on the facility and location. Roof-mounted equipment must be concealed behind parapet walls or in a screened enclosure of approved materials. Equipment should be grouped in clusters, preferably a single cluster to minimize the number of visible screens. Screen wall supports shall be designed with an enclosed, sealed shape with minimum 16-inch vertical clearance to the first obstruction above the roof surface to allow for proper flashing installation.

SECTION 325 IRRIGATION

325.1 General Information

Installation of automatic watering systems is required for the entire area along International Parkway, the infield areas and the Terminal Green Belts. Outlying areas such as the secondary service roads in support areas, perimeter planting areas, and airfield grass areas do not require sprinkler systems. However, truck watering of trees in these areas will be necessary for the first 2 years after initial planting.

325.2 Permitting Requirements for Domestic Water Systems

325.2.1 Prior to issuance of a permit, a letter from the Engineer of Record must be on file confirming that irrigation design is in accordance with Texas Commission on Environmental Quality (TCEQ) Chapter 344 (Landscape Irrigation).

325.2.2 Prior to issuance of a Certificate of Completion, a letter from the Contractor must be on file confirming that irrigation

construction and operation conform to the approved design documents. The design Engineer of Record must certify to the placement and operation of the system.

325.3 Permitting Requirements for Reclaimed Water Systems

325.3.1 Prior to issuance of a permit, a letter from the Engineer of Record must be on file confirming that irrigation design is in accordance with TCEQ Chapter 210 (Reclaimed Water) and Chapter 344 (Landscape Irrigation).

325.3.2 Prior to issuance of a Certificate of Completion, a letter from the Contractor must be on file confirming that irrigation construction and operation conform to the approved design documents. The design Engineer of Record must certify to the placement and operation of the system.

325.3.3 Turbo water meters with strainer Recordall Transmitter Register (RTR), pit electronics with data profiling capabilities for reclaimed water are required. Meter register must be purple in color and properly stamped for reclaimed water.

325.4 Temporary Irrigation

325.4.1 Potable Water. Temporary irrigation systems used to establish the growth of turf in airfield areas require special considerations. Approval by the DFW Operations Department is necessary prior to final design.

325.4.2 Reclaimed Water. Temporary reclaimed water used to establish the growth of turf in airfield areas require special considerations. Approval by the DFW Operations Department is necessary prior to final design.

325.5 Design Guidelines

Design Criteria for Reclaimed Water is as follows:

- TCEQ Chapter 210, Standards for Installing Reclaim water Pipeline

- TCEQ, Chapter 217, Design Criteria for Sewer Systems
- AWWA. Planning for the Distribution of Reclaimed Water. Manual M24, Water Supply Practices

325.6 Potable Water Line Separation

Reclaimed water piping shall be separated from potable water piping by a horizontal distance of at least 9 feet. Where the 9-foot separation distance cannot be achieved, the reclaimed water piping must meet the line separation requirements of TCEQ Chapter 290. After separation from the potable water line the existing irrigation tap shall be capped at the potable water main and any existing pipe removed.

325.7 Sewer Line Separation

Where a reclaimed water line parallels a sewer line, the reclaimed water line shall be constructed in accordance with subsection E or F of the Texas Administrative Code. The horizontal separation distance shall be 3 feet (outside to outside) with the reclaimed water line at the level of or above the sewer line. Reclaimed water lines that parallel sewer lines may be placed in the same benched trench.

325.8 Distribution System

All reclaim water distribution systems must be designed to prevent operation by unauthorized personnel.

325.9 Irrigation System

The irrigation system shall be designed so as to prevent incidental ponding or standing water, and shall be managed to minimize the inadvertent contact of reclaimed water with humans. Irrigation systems shall be designed so that the irrigation spray does not reach any privately-owned premises outside the designated irrigation area or reach public drinking fountains.

SECTION 326 IRRIGATION EQUIPMENT

326.1 Approved Manufacturer

Refer to Appendix B for manufacturer requirements for all irrigation materials and equipment. This provides common equipment throughout the Airport, allowing maintenance personnel to make necessary repairs while maintaining a quality system. All pipe and fittings shall be Schedule 40 Purple PVC.

326.2 Sleeving

All irrigation shall be installed with sleeving for newly-developed areas so that sprinkler systems can be incorporated without the disruption of transportation systems. It is required that purple PVC piping be used in general planting areas.

326.3 Irrigation Controllers

All irrigation controllers shall be mounted in stainless steel cabinet models. All irrigation satellite controllers must be connected to a Cluster Control Unit (CCU) by a two-wire path. All new sites must have a CCU with stainless steel cabinet with two-wire path to each satellite controller. Each CCU must have a compatible freeze sensor and rain sensor.

326.4 Freeze Sensors

Freeze sensors shall have a temperature set point of $3^{\circ}\text{C} \pm 2^{\circ}\text{C}$ (37°F), 24-Volt AC, 6-amp rating, closed above 3°C and open below 3°C . Freeze sensor shall be mounted at a height and location that is out of direct sunlight and where free outdoor air circulation is possible. Each freeze sensor must be attached by a two-wire path (of no lighter gauge than 20 AWG) to a sensor decoder. Sensor decoders must be housed in the base of a stainless steel controller cabinet (within an existing satellite controller cabinet, a CCU cabinet, or a separately installed cabinet). The sensor decoder shall be also connected to the two-wire path.

326.5 Rain Sensors

Rain sensors shall be tipping bucket / magnetic reed switch style; rainfall per tip: 0.01 inch. Each rain sensor must be attached by a two-wire path (of no lighter gauge than 20 AWG) to a pulse decoder. Pulse decoders must be

housed in the base of a stainless steel controller cabinet (within an existing satellite controller cabinet, a CCU cabinet, or a separately installed cabinet). The pulse decoder shall be also connected to the two-wire path.

326.6 Wiring

Wiring shall be 12 gauge-UF irrigation wire using 3M brand "DBY" or "DBR" connectors.

326.7 Gate Valves

All gate valves of 4-inch or 3-inch size shall have standard cube head on stem. Valve stack shall be standard cast iron or equivalent with appropriate cast iron lid. All electric valves shall be enclosed in a standard 10-inch valve box.

326.8 Valve Boxes

All remote control valves, isolation valves, pressure valves, altitude valves, and reducing valves for onsite reclaimed water systems shall be install below grade in a valve box.

326.9 Quick Coupler Valves

Flush lawn quick coupler valves shall be provided in all landscape planted areas.

All quick couplers shall be located so that all trees and planting areas can be reached by a 100-foot length of hose.

All quick coupling valves for reclaimed water shall be specifically for reclaimed water use. The quick coupling valve should be a two-piece, capable of having a discharge rate between 5 and 100 gallons per minute (gpm) with a maximum working pressure of 150 psi. The valve shall be constructed of heavy cast brass and shall have a purple, thermoplastic, locking rubber cover with molded wording "Do Not Drink- No Tomar" in English and Spanish with the universal symbol for nonpotable systems imprinted on the locking cover. To prevent unauthorized use, a special coupler key for opening and closing the valve shall be provided for the exclusive operation of the valve. Quick coupling valves for reclaimed water must be installed approximately 12

inches from walks, curbs, and paved areas. Quick coupling valves used in the reclaimed water system must be installed in a valve box marked "Reclaimed Water" and a reclaimed water identification tag must be permanently attached to the quick coupler valve so that it is clearly visible when the box lid is removed.

326.10 Maintenance Equipment

Refer to Appendix B for manufacturer of maintenance equipment.

SECTION 327 IRRIGATION INSTALLATION

327.1 Irrigation Piping

Irrigation piping shall not be installed on top of roadway slopes or along retaining wall toes, unless cut-off valves are positioned at lower levels and away from structure.

327.1.1 Irrigation Water Piping. All pipe and fittings shall be Schedule 40 PVC.

327.1.2 Reclaimed Water Piping. All pipe and fittings shall be Schedule 40 purple PVC.

327.2 Pipe Deflection

Longitudinal deflection at each pipe joint shall not exceed 1 degree in any direction.

327.3 Pipe Bedding

After trench has been cut to a depth below the barrel of the pipe a distance of 3 inches, the bedding shall be brought to a point slightly above grade with compacted sand. Bell holes shall be formed and, if required, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up in uniform layers of either side of the pipe and over the pipe to a point level with the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698. Moisture content shall be within -2 to +4 of optimum.

SECTION 328 SIGNAGE

328.1 Reclaimed Water Advisory Signs

All sites using reclaimed water must post clearly visible standard sized signs 12-inch by 9-inch advisory signs indicating the use of reclaimed water must be installed at all entrances to the customer's facility where they can be easily seen to the extent necessary to advise passerby. Signs must be placed no further than 1,000 feet apart. For medians, a sign shall be placed at the beginning and end of every median. The lettering on the signs must be a minimum of ½ inch in height and must be Black or White on a purple background and include the name of the Water Agency. Where required for aesthetic or corporate identity purposes, alternate color-coding schemes may be adopted, subject to the approval of DFW Airport Water Agency.

328.2 New Aboveground Reclaimed Water Lines

Aboveground reclaimed water pipe lines, whether new or existing, must be labeled with the words "Reclaimed Water-Do Not Drink-No Tomar" and color coded purple to differentiate reclaimed water pipelines from potable water pipelines. If purple identification tape is used to label the pipe and/or color code the pipe, the tape must be adhesive, permanent, and resistant to the environmental conditions. Purple bands may also be painted around the circumference of the pipe at 10-foot intervals for color coding.

328.3 New Buried Reclaimed Water Lines

The use of purple pipe and sprinkler heads will be the preferred method for identification of new buried reclaimed water piping, both constant pressure mainlines and intermittent-pressure laterals.

328.4 Existing Water Lines Converting to Reclaimed Water

Existing buried piping which will be converted to reclaim water use need not be marked unless the piping becomes exposed, such as during installation of new pipeline, modification of the system, or maintenance of existing pipe. Purple reclaimed water

identification tape, used above or wrapped around the pipe, will be the preferred method.

328.5 Reclaimed Water Sprinkler Heads

The preferred method for existing sprinkler heads that will be distributing reclaim water shall be identified with purple rings attached to the top of the heads.

328.6 Irrigation Controllers for Reclaimed Water

All reclaimed water system controllers must be identified by affixing a sticker or "nameplate" to the inside and outside of the controller cabinet enclosure. Stickers or nameplates must be weatherproof and must contain wording in English and Spanish, indicating that the controller is for reclaimed water system use.

328.7 Valve Boxes for Reclaimed Water

Purple valve boxes shall be used and shall have an advisory label or nameplate permanently molded into or affixed onto the lid with rivets, bolts, etc., and constructed of weatherproof material with the wording "Reclaimed Water – Do Not Drink – No Tomar" permanently stamped or molded into the label.

328.8 Gate Valve Boxes for Reclaimed Water

New and existing isolation valves must be installed in a marked valve box with a reclaimed water identification tag on the valve operator or if the valve operator is too deep to reach, at the top of the valve extension. New and existing remote control valves shall be installed in a marked valve box with reclaimed water identification tag on the box lid and valve and shall be enclosed in a standard 10-inch valve box.

328.9 Reclaimed Water Storage Facilities

All storage facilities should be identified by signs and labeled with words "Caution: Reclaimed Water" or "Do NOT Drink – Unsafe Water" or "No Tomar" or similar wording.

IRRIGATION AREAS

329.1 Large Grass Areas

The large open grass areas along International Parkway shall be irrigated with rotor type heads distributing water from 40 to 90 feet in diameter, depending on the available pressure. Sprinklers of substantial construction shall be used to withstand the abuse normally associated with heavy maintenance equipment. These rotor heads shall be on Schedule 80 swing joints. See Appendix B for specified manufacturer.

329.2 Small Grass Areas

Small grassed areas, which occur adjacent to roadway paving, shall be sprinkled with smaller diameter pop-up heads so that close control can be maintained on wind-blown mist. All pop-up spray heads shall be per Appendix B with appropriate nozzles and nozzle screens.

329.3 Groundcover

Groundcover areas along International Parkway and in the fields shall be irrigated according to the size of the planting areas and obstructions within these areas. The groundcover underplanting for the Tree Crepe Myrtles will require sprinklers per Appendix B with appropriate spacing and proper nozzles, to provide adequate coverage. Large open plantings of groundcover shall incorporate rotor type heads with proper nozzles for proper coverage.

SECTION 329

SECTION 331
GENERAL DESIGN CRITERIA FOR WATER,
SANITARY SEWER AND RECLAIMED
WATER

331.1 Purpose and Scope

Sections 331, 332, 333, and 338 (Utility Sections) of this Manual are to be used by engineering professionals for use in design and construction of water, wastewater and reclaimed water systems owned and operated by DFW.

The Utility Sections apply to all distributed assets designed for all contracts where the asset(s) will be dedicated back to DFW for operations and maintenance (O&M). Additionally, any distributed assets constructed by a private party but intended for dedication back to DFW must follow the provisions of these sections.

This technical resource is not intended to substitute for any professional engineering judgment by the designer who will assume ultimate responsibility for selection, reference and appropriate application of the Utility Sections.

If a conflict be found between this DCM and other local, state or federal regulation, the most stringent criteria shall be used during design. The Engineer of Record shall notify the Assistant Vice President (AVP) of Utility and Energy Systems in writing about any such conflicts in these sections.

The term ROW is utilized throughout this manual, and as the DFW Airport does not have Rights of Way for its roadways, this term is meant to include the property between the individual lease lines on the opposite sides of the roadways, and between the opposite sides of the AOA on the roadways where control of access exists.

331.2 General Information and References

Material and construction for potable water sanitary sewer, and reclaimed water main additions or extensions shall be accomplished in accordance with the "Standard Specifications for Public Works Construction", North Central

Texas Council of Governments, latest edition, unless otherwise revised or altered by requirements of these sections and/or DFW.

Aircraft loading shall be considered while designing potable water, sanitary sewer, reclaimed water main and their appurtenances inside the Air Operation Area (AOA). All applicable Federal Aviation Administration (FAA) rules, regulations, standards, specification shall be implemented during design.

Design Criteria for Potable Water Distribution Systems are as follows:

- TCEQ Title 30, Chapter 290, "Public Drinking Water", along with all applicable laws, regulations, codes and standards.
- AWWA Standards

Design Criteria for Wastewater Collection and Distribution Systems are as follows:

- TCEQ Chapter 217, "Design Criteria for Domestic Wastewater Systems"

Design Criteria for Reclaimed Water Distribution Systems are as follows:

- TCEQ Chapter 210: "Use of Reclaimed Water", and TCEQ Chapter 210.70: "Reclaimed Water Facilities".

331.3 Internal Record Search

The designer shall research all pertinent DFW records including, but not limited to, the following:

331.3.1 Design Records

These are water main, sanitary sewer lines, and reclaimed water line construction plans and do not necessarily represent "as built" information, or have not yet been constructed.

331.3.2 As Built/Record Drawings

As-Built records that shows the actual construction alignment of existing mains. These records sometimes vary from the original design due to unforeseen construction problems.

331.3.3 Water, Wastewater, and Reclaimed Water Master Plans:

Latest water, wastewater, and reclaimed water

master plans must be reviewed to be in compliance with any recommendations.

The Engineer of Record shall notify the Assistant Vice President (AVP) of Utility and Energy Systems in writing with any explanations of design deviation from the Utility Master Plan.

331.3.4 DFW Geographical Information System (GIS):

DFW GIS integrates various geographically referenced utility infrastructure records of the DFW Airport.

331.4 Utility Location Request

The designer must conduct a comprehensive investigation of all nearby existing and proposed utilities in order to avoid possible conflicts. This shall include calling 811 to schedule a surface marking of known utilities. This shall include, but not limited to, the following utilities:

- Gas (G)
- Telephone (T)
- Underground Electric (UE) and Overhead Electric (OE)
- Cable (C)
- Fiber Optic (FO)
- Storm Drain (SD)
- Petroleum (P)
- First Flush Storm Water System
- Potable Water
- Reclaimed Water
- Sanitary Sewer
- Irrigation Systems
- Spent Aircraft Deicing Systems

Non franchise utilities, DFW owned, will require coordination with DFW staff and is required in the design phase where a Level A SUE is required.

331.5 Field Investigation

Field investigations including Geotechnical Investigation, Subsurface Utility Engineering (SUE) or Environmental Investigation shall be conducted for all water, wastewater, and reclaim water main designs.

331.5.1 Geotechnical Investigation

The design and construction of water, wastewater, and reclaimed water systems must account for the variability of the uncertain subsurface conditions, and the potential project

cost associated with the variability. This is especially critical on large projects or projects containing complex or difficult geotechnical problems where alignment and/or grade changes may be appropriate based on geotechnical recommendations. The general criteria for geotechnical investigation, is described as follows:

331.5.1.1 Investigation Requirements and Criteria:

A geotechnical investigation may be conducted prior to design and/or construction of a project. However, data from earlier project design activity can be incorporated if sufficient and reliable data is available for the current project.

- If required, the geotechnical report shall be prepared by a professional engineer with considerable geotechnical, design and construction experience relevant to the anticipated project.
- Investigate subsurface materials and conditions according to these requirements, which represent the minimum acceptable level of care. Higher levels of care, which would involve more extensive sampling, testing, analyses, and reporting, may be required for certain projects.
- Boring locations shall be within an offset distance of no more than 20 feet from the centerline alignment of the water/wastewater/reclaimed water main or at the location of the proposed structure. If this cannot be achieved, Geotechnical Engineer shall provide the exhibit with proposed bore location with explanation for exception from this requirement to DCC Code.
- Investigate subsurface materials and conditions on all pipeline projects except those involving "small" repairs, pipe replacement along the exact same alignment as the existing pipe, in-place lining of existing pipe, or pipe bursting where the proposed pipe will not be more than one to two standard pipe sizes larger than the existing pipe. The projects to which these requirements apply include tunneling, guided boring, directional drilling, pipe bursting, pipe jacking, and auger boring. These methods are defined

herein as "tunneling and trenchless methods."

- Perform investigations that are appropriate for the project. The requirements given herein address a broad category of projects. It is not possible in these requirements to identify all possible geotechnical issues that may arise or that may be unique to a particular project.
- Tailor the investigation to the type of construction, the anticipated geology, the landforms and topography, and the project schedule and budget.
- Involve professionals who are experts in the particular type of underground construction. For pipelines constructed by tunneling and trenchless methods, the site exploration, laboratory testing, geotechnical analyses, and reporting shall be planned and implemented in conjunction with engineers whose expertise is in tunneling and trenchless construction methods and with geologists or engineering geologists experienced in civil engineering construction.
- Locate geotechnical borings by taking into account topography and landforms, expected subsurface materials and conditions, and proposed type of construction. Borings for tunnels and trenchless methods must be located in conjunction with engineers and engineering geologists who are experts in those types of construction.
- Where truck-mounted drill rigs cannot access critical boring locations, obtain the necessary specialized drilling equipment.
- Locate geotechnical borings, including piezometers, which are part of investigations for tunnels and trenchless methods far enough off of the proposed pipe alignment so that they do not impact construction.
- Advance borings in soil or soil-like materials using continuous flight auger, hollow stem auger with drag bit, or thin-walled tube. Obtain samples using thin-walled tube or split spoon. In general, reserve split-spoon sampling for cohesion less materials.

- Advance borings and obtain samples in rock or rock-like material using double-tube core barrel.
- Conduct in situ tests, such as Standard Penetration Tests and packer tests, as needed to characterize the subsurface materials and conditions.
- Conduct geophysical tests (resistivity, ground penetrating radar, seismic, and very low frequency) as needed to locate the soil/rock interface, cavities, porous rock, and faults.
- Locate geotechnical borings at all proposed work and access shafts and pits for tunnels and trenchless methods
- Install and abandon piezometers and ground water monitor wells in compliance with State law.
- Backfill boreholes outside pavement using non-shrink grout from the bottom of the borehole to within three feet of the ground surface. Plug the upper three feet with cuttings from the borehole
- Reference the location of each boring to the Texas State Plane Coordinate System and the ground surface elevation to USGS MSL with horizontal and vertical positional tolerances of +/- one foot. The EOR should contact DFW DCC's survey group to get the latest requirements.

331.5.1.2. Depth:

Minimum-boring depths shall be:

Incoming Pipe Trench Depth (TD)	Minimum Bore Depth
0' To 10'	TD+5'
10' to 25'	TD+10'
25' and deeper	1.5*TD

Section 331.5.1.3 Laboratory Testing for Open Cut Construction:

- Conduct Unconfined Compressive Strength, Atterberg limits, Moisture content, Grain size

analyses test for soil and soft rock, including shale, mudstone, clay shale and claystone.

- Special testing as required to characterize collapsible soils, soils susceptible to particle migration, etc.
- Unconfined compressive strength for rock.

Section 331.5.1.4 Laboratory Testing for Tunneling and Trenchless methods:

- In addition to the testing described in Section 331.5.1.3, conduct slake durability, cell pressure and as required for soil and soft rock, including some shale, mudstone, clay shale, and claystone.
- In addition to the testing described in section 331.5.1.3, conduct cerchar abrasivity, point load, Brazilian tensile and punch penetration test for rock.

Section 331.5.1.5 Laboratory Testing for Corrosion studies:

- Conduct tests for resistivity, pH, chlorides and sulfates, as needed

Section 331.5.1.5 Geotechnical Analyses:

- Check for, identify, and reconcile inconsistencies in subsurface information or subsurface materials and conditions that may impact design or construction. Compare the boring logs to one another, compare the logs to mapped stratigraphy as contained in Environmental Geology of the DFW area and compare the logs to personal experience in the same area. Assess the potential for "differing site condition" claims based on these comparisons and undertake additional investigations, as needed, to resolve such inconsistencies.
- Provide geotechnical parameters and construction recommendations appropriate for the type of construction and covering the topics requested. In all cases, provide project-specific recommendations. Avoid generalized discussions and detailed explanations of theory or phenomena.
- If the project is open cut construction, provide bearing capacity for thrust blocking, provide maximum lift thickness for backfilling, identify need for excavation retaining system to protect surrounding infrastructure, identify aspects of the behavior of the in situ

subsurface materials that could affect design (for example, highly plastic soils and extremely flat pipeline grades are incompatible for gravity line construction if water can enter the trench during construction), provide lateral earth pressures for underground structures (do not provide lateral earth pressures for excavation safety systems)

- If the project is utilizing Trenchless construction methods, provide soil and rock properties, characteristics, and geotechnical parameters required by the tunneling and trenchless construction engineers.

Section 331.5.1.6 Geotechnical Report:

- Use only 8½" by 11" and 11" by 17" sheets. If needed, prepare color illustrations, maps, drawings, photographs, and other graphics to adequately convey the information.
- Characterize soil by reporting, at a minimum, the engineering classification (group name and symbol), color, relative stiffness, shrink / swell potential, unconfined compressive strength, unit weight, moisture content, liquid limit, particle size distribution, and plasticity index. Where appropriate, report SPT results and collapse potential.
- Characterize rock by reporting, at a minimum, the geologic material, color, degree of weathering, relative hardness, RQD, percent recovery, unconfined compressive strength, unit weight, and relative frequency and infilling of discontinuities. Where appropriate, report SPT results.
- Characterize groundwater by reporting observations and expected occurrence. Provide mitigation methods in case groundwater is encountered.
- Submit preliminary reports for review with the preliminary design documents. Submit final reports with the 100 percent submittal of design documents.
- If the project is open cut construction, the final report shall include two separate report, Geotechnical data Report (GDR) and Geotechnical Design Memorandum (GDM). Geotechnical data report shall include the boring location map, boring logs, text describing the investigation and the

subsurface materials and conditions that were encountered. It shall also include the State Plane coordinate and USGS ground surface elevation for each boring on the boring log. Geotechnical Design Memorandum shall provide geotechnical recommendations specific to the project and only for items or issues requested.

- If the project is utilizing tunneling and trenchless methods, the final report shall include three separate report, Geotechnical data Report (GBR), Geotechnical Baseline report, and Geotechnical design Memorandum. Geotechnical data report and Geotechnical memorandum shall be per above list. Geotechnical Baseline Report shall provide the geotechnical information to establish what constitutes "anticipated site conditions for the project." The experts in underground construction must author or co-author the GBR because it is a contractual document that allocates risk associated with construction. Use clear, concise prose organized in parallel structure. Provide specific, quantifiable, and measurable baselines, not subjective, vague descriptors. Describe baseline conditions reach by reach, sequentially along the project alignment. (A reach is defined as a segment having consistent ground conditions and excavation methods.) Address all baseline conditions and design and construction considerations for each reach in a single section of the GBR. Write the GBR using parallel structure to present information reach by reach in the same repetitive manner. Discuss distinctly different elements of work separately. For instance, discuss tunnels separately from shafts. Minimize the presentation of information not related to baseline conditions.

331.5.2. Subsurface Utility Engineering (SUE): Subsurface Utility Engineering (SUE) process may be conducted in project planning, design or construction phase(s) to obtain reliable subsurface utility information. Using this technology, it will be possible to avoid many utilities relocation before construction and many unexpected encounters during construction, thereby eliminating many costly, time-

consuming project delays. In addition, all existing utilities shall be located and marked prior to initiation of survey for design.

331.5.2.1 SUE Provider requirements:

- SUE shall be conducted by well-trained, experienced and capable individuals using state-of-the-art designating equipment, vacuum excavation or comparable non-destructive locating equipment; state-of-the-art surveying and other data recording equipment and software systems, as necessary.
 - Quality Level D
Is simply the process of gathering record data (which is not necessarily so simple). This data could be digital records, paper records, internet search, site inspection or just talking to people who are familiar with the site. The available data could be limited and not produce a complete picture of what is onsite. In addition, if the source of some data is unknown or questionable, the completeness and accuracy of the investigation could be compromised. In any event, once the data is collected, it is compiled into a drawing that states the quality level.
 - Quality Level C
Involves the process of surveying the visible utility features, or if they have already been surveyed, checking the surveyed locations for their accuracy. This data is compiled with the Quality Level D data and both levels are labeled accordingly. Quality Level C data could, and often will, conflict with the Quality Level D data and raise questions as to the locations of some underground utility lines.
 - Quality Level B
Involves designating the underground utilities, for example, by markings provided through an 811 call or by contacting an individual utility company. This data is added to the data collected from Quality Levels D and C. The designated utilities are then surveyed and added to the drawing which can then

be identified as representing the results of a Quality Level B investigation.

- Quality Level A
Involves physically locating the actual utility – often by ‘potholing.’ Once the utility is potholed it is located horizontally and vertically by survey measurements. This location is typically to the top of pipe, which should be noted on the drawing.
- The SUE provider shall call 811 and others for utility locates for exposing utilities.

331.5.3. Environmental Investigation

The designer shall evaluate all available resources to identify any potential environmental issues, including possible soil or groundwater contamination, during the preliminary design phase of water, wastewater or reclaimed water projects. This process shall be coordinated with DFW Environmental Affairs Department (EAD).

331.6 Crossings

Throughout the airport, utility crossings exist, this section is meant to determine how specific attributes of the airport are to be crossed with the utilities.

331.6.1. Roadway, Runway, Taxiway, Ramps, and Driveways Crossing

Encasement pipe shall be used to encase the carrier pipe. Carrier pipe shall have restrained joints by internal restraints system. The crossing should be perpendicular to the roadway, runway and taxiway’s alignment based on existing conditions.

Encasement pipe for roadway crossing shall be minimum of ten (10) feet away from edge of pavement.

Encasement pipe for runway and taxiway crossing shall be minimum of fifty (50) feet away from runway and taxiway safety areas or obstacle free zone whichever is greater.

331.6.2. Utility Crossing

Foreign mains are typically defined as water, wastewater, telephone, electric, cable, fiber optic, storm drain, petroleum and any other franchise or public utility own and/or operated by outside entities (Non-DFW).

331.6.2.1 Foreign Mains Crossing DFW Water/Wastewater/Reclaimed Water Mains

- All foreign lines crossing DFW Utility mains shall be at 90 degree (preferable) or 60 degree (minimum).
- The vertical separation between proposed foreign main and existing DFW Utility mains shall be in accordance with Table 331.6.2 while meeting all applicable DFW, state and federal requirements.

Table 331.6.2

		Foreign Pipe (in)			
		8- 12	16- 24	30- 66	72 & Larger
DFW Main (in)	8- 12	2	2.5	3	3.5
	16- 24	2.5	3	3.5	4
	30- 66	3	3.5	4	4.5
	72 & Larger	3.5	4	4.5	5+

Note: All dimensions in (ft.) shall be measured from outside diameter (O.D.) to outside diameter (O.D.)

- All foreign wastewater lines crossing over DFW mains shall be encased with 150 psi pressure-rated pipe. The length of encasement shall be minimum 18 feet centered at the DFW water main.

331.6.3. Railroad Crossing

All mains crossing under railway tracks shall be placed in an encasement pipe, from the railroad ROW to ROW.

- Casing pipe and joints shall be made of metal capable of withstanding the railroad loadings and other loads superimposed upon them.
- The engineer of record shall contact the railroad authority and the appropriate regulatory agency for any additional design and/or construction requirement. Engineer of record shall copy AVP of Utility and Energy Systems on all correspondence with each regulatory agency.

331.6.4. State Highway Crossing

The engineer of record shall contact the State Department of Transportation (DOT) and/or the appropriate regulatory agency to determine any

special design, construction requirement and/or permitting requirements. Engineer of record shall copy AVP of Utility and Energy Systems on all correspondence with each regulatory agency.

331.6.5. Culvert Crossing

Encasement pipe shall be used to encase the carrier pipe. Carrier pipe shall have restrained joints by internal restraints system. The minimum vertical clearance between encasement pipe and the bottom or top of culvert shall be two (2) feet. The encasement pipe shall be extended a minimum of fifteen (15) feet from the outside edge of culvert. The Engineer of record shall coordinate with DFW Energy Transportation and Asset Management (ETAM) System Performance/Watershed Management. All correspondence shall be copied to AVP of Utility and Energy Systems.

331.7 Tunneling and Trenchless Technology

These technologies shall be considered in order to minimize the disturbance of the environment, traffic, congested living or working areas while utilizing more efficient methods of installation, inspection, repair, rehabilitation, and replacement of underground utilities.

331.7.1 Technical References

The following references, as applicable, may be reviewed in conjunction with this manual: "Trenchless Technology Pipeline and Utility Design, Construction, and Renewal", by Mohammad Najafi and Sanjiv Gokhale, 2004.

331.7.2 General Consideration

- Location of Excavation Pits: The location, size and depth of the boring pits shall be evaluated during design. Location of the entry pit is preferred at the lower elevation end of the tunnel when there is a slope. This will allow any groundwater or any boring slurry to flow by gravity from the tunnel into the bore pit where it can be pumped out during construction.
- Size of Encasement Pipe: The encasement pipe size shall be determined by the

designer, with the knowledge that DFW requires spacers in the annular space instead of grout.

- Loading: Encasement pipe and joints shall be designed to withstand the imposed loading.
- Annular Space: The annular space between the encasement and carrier pipe shall have spacers around the entire pipe with a spacing designed by the designer.
- Corrosion Protection: Encasement pipe shall be protected against corrosion. Where both carrier pipe and casing pipe are both metallic. They shall be separated electrically by using insulated spacers.

331.8 Casing and Carrier Pipes

Water/sanitary sewer/reclaimed water mains shall be considered for encasement under the following condition:

- Highway/railroad crossing
- Runway and Taxiway
- Creek/water body crossing
- As required by the design

The carrier pipe shall be restrained or welded all around joints or be a monolithic pipe between span sections.

331.8.1. Steel Encasement Pipe:

Designer shall be responsible for determining the minimum wall thickness of steel encasement pipe as required for any specific application with following minimum conditions:

- Steel pipe with minimum yield strength of 35,000 psi, or as required by FAA for airfield applications.
- Minimum thicknesses of steel encasement pipe for different diameters are shown under Table 331.8.2 which must be verified by the designer. These wall thicknesses shall be increased by at least 0.063 inch for uncoated casing and by at least 0.063 inch for coated or uncoated steel casing to be installed by jacking or boring.
- If the casing pipe is placed by open cut, the casing pipe shall be coated.

Table 331.8.2.: Minimum Thickness of Steel Encasement Pipe

Encasement Pipe I.D. (in)	(Coated or Cathodically Protected)
12 or Under	0.188
14	0.188
15	0.250
16	0.219
18	0.250
20	0.281
21	0.312
22	0.281
24	0.312
26	0.344
27	0.438
28	0.375
30	0.406
32	0.438
34- 36	0.500
38	0.500
40	0.531
42	0.562
44- 46	0.594
48	0.625
50	0.656
52	0.688
54	0.719
56- 58	0.750
60	0.781
62	0.812
64	0.844
66- 68	0.875
70	0.906
72	0.938

331.9 Permits

All the required permit approval notice(s) must be included in the final construction documents. These includes, but not limited to, the followings:

- TXDOT Right-of-Way Access Permit

- TXDOT Utility Permit
- USACE permits (example 404, NW-12. Etc.)
- Approval letter from other entities or agencies having jurisdiction

331.10 Instrumentation and Control

All instrumental and control systems shall comply with the existing Supervisory Control and Data Acquisition (SCADA) systems and control systems that are currently being used by DFW. Plans and specification shall be provided by the Engineer of Record with each plan submittal for the project.

331.11 Pipe Color

All mains will follow the following pipe color scheme.

Utility	Pipe Color
Water	Blue
Sanitary Sewer	Green
Reclaimed Water	Purple

331.12 Markers and Detector wires

All pipes shall be placed with detector wire over the pipe, and a utility marking tape placed one foot above the pipe. The color of the tape shall match the color of the pipe material and shall identify what the specific utility.

331.13 As-Built Drawing

All projects shall be constructed in conformance with approved sealed plans and specifications as possible. Any field change shall be documented in As-Built drawings for all water, wastewater, and reclaimed water pipeline projects. Refer to Division 1 Specifications for these requirements.

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331.14 Record Drawing

All as-built changes shall be incorporated in Record Drawings by the Engineer of Record. Refer to Division 1 Specifications for these requirements.

331.15 Asset Identification Number

Design Engineer shall co-ordinate with DFW ETAM System Performance Group and DFW ETAM Utilities Group for proposed asset identification number. Asset Identification

number shall be called out on design plan. At minimum follows asset shall have asset identification number in the drawing.

- Isolation Valve
- Pumps and Motor
- Fire Hydrant
- Cathodic Protection Test Station
- Water Meter
- Air Release, Air/Vacuum, and Combination Air Valves
- Flush Points
- Sampling Stations
- Backflow Preventer
- Manhole, Junction Structure
- Lift Station

**SECTION 332
WATER UTILITY DISTRIBUTION**

332.1 DFW Airport Water System

This Section includes various aspects of water main design including replacement criteria, sizing, depth, embedment, and location. Also included are design criteria for various water appurtenances including different types of valves, fire hydrants, flush points, meters along with corrosion protection system.

Water distribution mains shall be designed in conformance with “30 TAC §290: Public \Drinking Water”, as enforced by Texas Commission on Environmental Quality (TCEQ), Latest Edition, and with all applicable laws, regulations, codes and standards.

332.2 Water Main Sizing

332.2.1 Water Pipeline Network

The DFW potable water pipeline network is classified according to **Table 332.2.1**.

Table 332.2.1: DFW Airport Water Main Classification

Type	Typical Size Range (in)	Direct Service Connection
Distribution Main	16” and Smaller	Permitted
Transmission Main	Larger than 16”	Not Permitted

332.2.2 Looped Mains

Where practical, new water main installations shall be looped to improve system water flow.

332.2.3 Water Demand

DFW Airport water system must be able to supply water at rates which fluctuate over a wide range during different times of year and hours of the day. Per capita usage can vary greatly depending on the area’s zoning and the efforts made by the owners for water conservation.

332.2.4 Size/Capacity Determination Criteria

Pipe shall be sized for the combined maximum day demand and fire flow demand.

A Hazen William Friction Coefficient C=80 shall be used for all service line flow calculations. A higher C coefficient may be used for new mains only upon the approval from DFW Utility Group.

The Engineer of Record shall submit water use calculations showing average day demand, maximum day demand, peak hourly demand, building square footage and total acres for the proposed use. The average day demand, peak day demand, and peak hour demand used in design shall be approved by DFW Utility Group.

Pressure reducing valves (PRV), as required by the plumbing code, shall be installed inside the building, and must be illustrated and identified on site utility plan.

Minimum operating pressure is 50 psi at the highest elevation meter location using average day demand.

The maximum allowable velocity at peak hour demand shall not exceed 5 feet per second (fps).

The minimum pressure at any point must not be less than 35 psi residual.

332.2.4.1 Fire Flow

Service lines shall be adequately sized to provide the minimum required fire flow and duration at a residual pressure of 20-psig or greater.

Required Fire flow shall be as specified by the International Fire Code (IFC), Appendix B, latest edition, or by the National Fire Protection Association (NFPA) Standard No. 1, Chapter 18, table 18.4.5.2.1 whichever is more stringent. Design Engineer shall co-

ordinate with DFW Fire Protection Engineer for fire flow requirement.

Emergency demands are considered to be fire flow requirement plus peak day demand.

Maximum allowable velocity during emergency demand shall not exceed 10 feet per second (fps).

The minimum residual pressure at any point during emergency demand must not be less than 20 psi.

332.2.5 Sizing Criteria

The water mains must be sized in accordance with any approved master plan established for that area. If a master plan is not available, the sizing of the water main must be based on engineering analysis of initial and future demand of the area to be served. Water transmission and distribution mains must be sized to meet peak daily water demand plus required fire flow plus any additional criteria as needed. When site-specific data is unavailable, designer shall use the most conservative data while meeting or exceeding the following minimum criteria for sizing distribution mains.

332.2.5.1 Minimum Pipe Size

332.2.5.1.1 General Area: Minimum 8-inch main shall be used for all general areas.

332.2.5.1.2 Industrial Area: Minimum 12-inch main for industrial areas shall be used.

332.2.5.2 Non-Standard Pipe Sizes: 14-inch, and 18-inch water pipes are considered nonstandard for the DFW Potable Water system and shall not be used.

332.3 Depth of Cover

The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe.

332.3.1 Minimum Cover

The following **Table 332.3.1** applies to water main installation in public right-of-way.

Table 332.3.1: Minimum Depth of Cover for Water Mains

Size of Main	Min. Depth of Cover (ft)		
	Standard Pipeline	Highway Roadway	Runway Taxiway
12" and smaller	6	6	Engineering Evaluation & FAA Regulations
12"-16"	6	6	
20" and larger	7	7	

- * Mains shallower than 6 feet will require special engineering evaluation and engineering controls.
- ** Water mains under highway and railroad right-of-way must meet all additional criteria as required.
- *** Water mains under aircraft taxiways and runways must also meet all additional FAA standards as required.

332.4 Location

332.4.1 New Main Installation

New water mains shall be placed outside paved areas and as dictated by the design requirements.

The main should be located, where maintenance can be accomplished with the least interference with traffic, structure, and other utilities.

332.5 Horizontal Alignment

332.5.1 Change in Direction

Changes in horizontal alignment shall be achieved by deflection of joints or by use of fittings. Deflection of pipe joints at fittings is prohibited. Longitudinal bending of pipe is not allowed.

The maximum bend for waterlines is 45-degrees.

332.5.2 Pipe Laying

All water mains shall be laid as straight as possible between intersections and follow right-of-way or centerline alignment curves at a uniform distance from the right-of-way or centerline, as appropriate.

332.5.3 Joint Deflection

The maximum deflection angles of pipe joint are typically restricted to 50% of the manufacturer's recommendation. Otherwise, horizontal bends will be required.

332.5.4 Bends

Horizontal bends shall be restrained type fittings/joints and shall also be blocked with concrete as necessary. Horizontal bends shall also be placed such that the concrete blocking can be poured against undisturbed earth and will not bear against the backfill or bedding of another utility.

332.5.5 Stationing

Stations must be to the tenth of foot (Ex: STA. 1+90.5). If necessary, station equations can be used at a point along the alignment where the stationing changes. The station equation generally represents the meeting of two stationing systems or the change in authority over the centerline:

332.6 Vertical Alignment

332.6.1 Change in Direction

Changes in vertical alignment shall be achieved by deflection of joints or by use of fittings. Deflection of pipe joints at fittings is prohibited. Longitudinal bending of pipe is not allowed.

The maximum bend for waterlines is 45-degrees.

332.6.2 Pipe Laying

Mains are to be installed as straight as possible, but excessive depths shall be avoided. For reference, excessive depths are lines designed over 20 feet. This is due to limited ability of standard equipment by operations to reach these mains.

332.6.3 High Points

Excessive high points that trap air and restrict water flow must be avoided. High points should be designed to coincide with the location of proposed fire hydrants, where possible. Where high points are unavoidable, air valves should be considered.

332.6.4 Bends

Vertical bends shall be restrained type fittings/joints and to be blocked with concrete as necessary. All pipe will be restrained with retainer glands and concrete blocking.

332.6.5 Combined Angle Bend

Combine angle bend can be used where horizontal point of intersection (PI) and point of vertical intersection (PVI) are located at the same point. A combined angle can be shown in **Figure 332.5.6.4**.

$\text{Cos } A = (\text{Cos } H)(\text{Cos } V)$ Where,

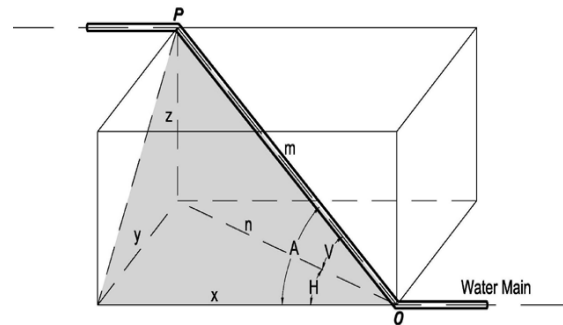


Figure 332.5.6.4: Combined Horizontal and Vertical Angle

$\text{Cos } A = x/m$	$A = \text{Combined Angle}$
$\text{Cos } H = x/n$	$H = \text{Horizontal Angle}$
$\text{Cos } V = z/m$	$V = \text{Vertical Angle}$

332.6.6 Slope

All water mains shall be designed to have minimum 0.1% slope to allow draining and flushing, if necessary. The vertical change in slopes is restricted to 50% of the manufacturer's recommended deflection. Otherwise, vertical bends will be required. Vertical bevels can be considered to accommodate long vertical curves of bevel or deflected joints in lieu of a bend for large concrete main in accordance with manufacturer's recommendations. Vertical curves are not to be less than 100 feet in length. The PVC, PVI, and PVT should be at quarter, half, or full stations (Ex: PC Sta. 0+00, PI Sta. 0+50 and PT Sta. 1+00).

332.6.7 Slope Designation

Design slopes shall be to the nearest hundredth of a percent (Ex: Slope 5.20%).

332.6.8 Elevation Designation

Elevations shall be shown to the nearest hundredth of a foot (Ex. El. 495.95).

332.7 Pipe Material & Embedment

332.7.1 Pipe Material Selection

Recommended pipe material is summarized in **Table 332.7.1**.

Table: 332.7.1: Recommended Water Pipe Materials & Embedment's

Pipe & Material Specification	Pipe Size (in)	Joint Specification	Embedment
PE	¾ - 3	Fusible C901	Engineering Analysis Required (See 332.7.3)
PVC AWWA C900 (DR-14)	4 - 12	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477	
PVC AWWA C905 (DR-14)	16	Fusible Fusible C 900 Certa-Lok Certa-Lok C900/RJ	
RCCP- Bar Wrapped ANSI/AWWA C303 Class 150	20 - 42	Bell & Spigot ANSI/AWWA C303	

Pipe material shall be selected based on lowest life cycle cost. PVC is the preferred material smaller pipe sizes (≤16" diameter). Reinforced concrete cylinder pipe (RCCP) is preferred for larger pipe sizes (>16") Other materials such as ductile iron and steel may be specified upon approval by the DFW Airport Utility.

The Engineer of Record shall prepare a Technical Memorandum that includes recommendations for preferred pipe materials, with case study that includes pros and cons on pipe type.

When a metal pipe including concrete cylinder, ductile iron or steel is specified, the pipe must be protected from corrosion. Corrosion protection measures should be part of any pipeline design using these materials. For ductile iron pipes a minimum single layer of 8-mil liner low density polyethylene (LLDPE) wrapping is required. When steel pipe is utilized, the pipe interior lining shall be cement-mortar and exterior coating shall be either cement-mortar, tape or polyurethane as approved by the Utilities Group. All joints on metal pipe shall be bonded, and in locations with reactive soils or induced currents a cathodic protection system may be necessary.

332.7.2 Fittings

All PVC and ductile iron pipe shall use full body ductile iron fittings. Compact fittings are not allowed. All 90-degree bends shall be avoided in the system, if possible.

332.7.3 Embedment Requirements

Designer shall specify class of embedment and its detail on design drawings. The type of embedment to be used is determined by pipe material and depth of cover.

For flexible pipe, Engineer of Record shall prepare a Technical memorandum that includes the maximum pipe deflection anticipated by the pipe. Pipe deflection shall

not be more than 50% of manufacturer recommendation.

332.8 Separation Distance Between Water & Wastewater Mains

When a water main is installed near an existing wastewater facility, conveyance, or appurtenance, separation requirements of 30 TAC §290.44(e), as enforced by TCEQ, governs the minimum separation distances.

332.8.1 Cross Connection

No physical connection shall be made to a drinking water supply system where a potential or actual contamination hazard exists unless the public water system is protected from contamination. Any appurtenance shall be designed and constructed so as to prevent any possibility of sewage entering the drinking water system.

332.8.2 Backflow and Siphonage

The rules of 30 TAC §290.44(h) apply to backflow and siphonage control.

332.9 Connection to Existing Mains

Testing and Chlorination: A new valve shall be installed at the point of connection for water main extensions to facilitate testing and chlorination of the new main prior to its placement into service.

Tapping Water Mains: Where services require the tapping of any existing reinforced concrete cylinder water distribution main, the Designer shall specify that the Contractor employ a qualified specialty contractor to perform this service. Tapping of all water mains shall be done in accordance with AWWA standards and coordinated with DFW Utilities Services. The tap shall be performed only at the horizontal tangent of the main in conjunction with either a tapping gate valve with a dielectric insulating gasketed flange.

Tapping Fee: All new or enlarged, permanent water meter installations, served by DFW

Airport's potable water distribution system, will be subject to an impact tapping/connection fee. Tapping impact fee will be charged with the water bill after the permanent meter and account is established.

Wet Connection: At all points where wet connections are made to existing lines, the tapping connection fittings shall be supported by blocking up to the spring line with minimum 2,000 psi concrete.

332.9.1 Tapping Sleeve and Valve

Tapping sleeve and valve shall be used whenever possible for connections to existing mains to avoid interruption of water services.

Taps are restricted to at least one standard pipe size smaller than the tapped pipe. (e.g. If the existing main is 16-inches, the largest pipe that can be tapped will be 12-inches.)

Full-body tapping sleeves shall be used. A tapping sleeve will not be allowed if the materials and conditions of the existing main preclude tapping. "Size-on-size" taps will not be permitted, unless made by use of an approved full bodied mechanical joint tapping sleeve.

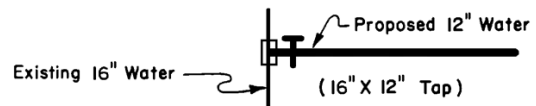


Figure 332.9.1: Tapping Criteria for Water Mains

For all RCCP water mains, tapping sleeves are not permitted.

332.9.2 Cut in Connections

Connections 4" and larger of new mains to existing mains shall be made by cutting in a tee. Tapping sleeves may be allowed in lieu of cutting in a tee on a case-by-case basis.

If the system needs an additional valve, then a cut-in connection with a valve and tee should be used.

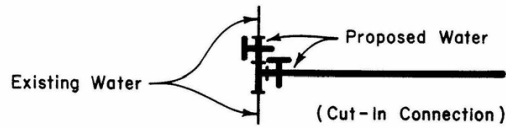


Figure 332.9.2: Cut-In Connection

332.9.3 Standard Connection

When connecting to a crossing water main, two tees with intervening valve(s) are required.

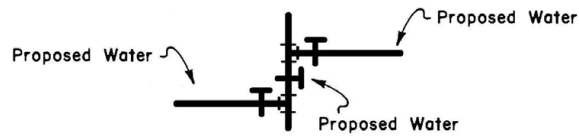


Figure 332.9.3: Standard Connection

332.9.4 Four Way Connection

Crosses are not permitted. However, Type-D connections may be allowed when other types of connection are not feasible.

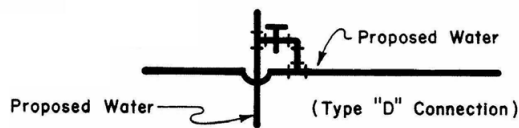


Figure 332.9.4: Type D Connection

332.10 Water Services and Connections

332.10.1 General Requirements:

Water services shall be in accordance with DFW Utility Group. The design engineer shall co-ordinate with DFW Utility Group for service connection location and detail.

Water meters shall be placed within the public right-of-way (ROW) or on the lease boundary except for Central Terminal Area (CTA). Meter box should be located inside the Terminal building for CTA. Except for CTA, meters may not be located inside the building

or fence line, and must be vehicular accessible from roadways.

Water services are not to cross railroad, interstate or state highways.

Water meter boxes and its appurtenances are not allowed in sidewalks, paved areas, driveways or load bearing pavement.

Service taps, regardless of type, shall not be made in vaults.

Permanent domestic water services shall not be supplied from fire hydrant leads.

Domestic water service may tap in to fire loop or lead-in, provided that the domestic tap is located prior to the backflow preventer, which is located at lease boundary/ROW.

Service taps on fire loop after the backflow preventer are prohibited.

Each site (tenant) must have its own water service which must not cross any existing or projected lot (or lease) line(s).

Water service shall be at least one size smaller than the proposed or existing main. Size on size connections are generally not allowed unless special permission is granted from DFW Utility Group.

332.10.2 Small Water Service:

Typical small water services range from 1-inch through 2-inch in diameter. Water service over 30-feet shall be a minimum of 1-inch diameter. Typically, AWWA C901 poly-pipe with Ford couplings and fittings shall be used for small water service.

Designer shall show all DFW service meters on drawings.

332.10.2.1 Large Water Service:

Typically, large water services are greater than 2-inches in diameter. A service line of minimum 4-inches will be required for a 3-inch meter.

Typically, PVC C900 (DR 14) pipe shall be used for large water services.

Large service meter vaults shall be located at the lease-line (except for Terminal buildings) with easy access and with protection from vehicular traffic.

Designer shall work with DFW’s Utilities Group on the evaluation of all large meter vaults.

332.11 Dead-End Mains

332.11.1 General Requirements:

Dead-end main situations are to be avoided whenever possible. “Dead-end main” means a water main over fifty feet long and not being fed from both ends at the time of installation.

332.11.2 Special Consideration:

If the dead-end main is 8-inch or larger, a fire hydrant shall be installed five (5) feet from the end.

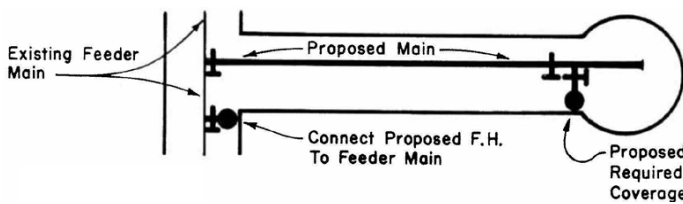


Figure 332.11.2: Dead-end Mains

All dead-end mains shall include a smart-flush device with the capability to monitor temperature, chlorine residual, and shall be self-powered if electric utility power is not available. The smart flush and monitoring unit shall have a de-chlorination option.

332.12 Abandonment of Water Mains

Where possible abandoned water mains shall be removed.

Water mains shall be abandoned by cutting and plugging where it is not possible to remove the existing pipe.

The cut and plug shall be as close to the main left in service as practical unless there is other impending utility work planned that could disturb the plug. If the new main is to be constructed to connect to the existing main at the point of cut, a cut and plug is not required. If the main to be abandoned at a tap and valve, the abandoned tapping sleeve and valve shall be removed.

332.12.1 Abandonment of Water Appurtenances Fire Hydrants:

Removed/Salvaged fire hydrants shall be handed over to DFW Utilities Group.

332.12.2 Valves

Small Valve: Valves smaller than 16-inches are not to be salvaged. Upon removal of the valve cover, stack, and stem extension, the valve body must be abandoned by filling with 2 sacks per cubic yard mix of sand to a point at least 12-inches below the pavement.

Large Valve: Valves 16-inch and larger may be salvaged if requested by DFW.

333.12.3 Abandonment of Vaults

Vaults shall be abandoned by filling with sand and/or gravel compacted to 90% (95% in pavement) of maximum standard proctor dry density.

The bottom of the vault shall be filled with class B concrete up to the top of abandoned pipe openings.

332.13 Corrosion Protection System (Corrosion Control)

This section is applicable to all metal water pipes and fittings where corrosive environments or soil may potentially damage the pipes and appurtenances. Typically, soil resistivity less than 1000 ohms-cm can be considered as extremely corrosive soil.

Within the Airport boundary, all metal piping and fittings shall be protected by a cathodic protection system that is designed by a NACE certified professional and installed by a licensed contractor.

332.13.1 Preventive Requirement

The following requirements shall be used as a guide for the Engineer of Record for the design of a system to reduce corrosion as much as possible.

332.13.1.1 Material Selection:

PVC pipe shall be used for all mains 16-inch and smaller.

All RCCP shall be used with required dielectric coatings, as necessary.

332.13.1.2 Dielectric Coating:

External and internal protective coating shall be considered for all metallic pipes as necessary to limit the rate of cathodic reaction.

332.13.1.3 Electrical Isolation:

Isolating Joints by using insulating kits or other means are required to prevent galvanic corrosion for all metallic pipes in the following locations:

- Changes in pipeline materials
- Connections to existing piping (i.e. old and new piping)
- Inlet and outlet piping of plant facilities
- Laterals from transmission mains
- Taps to existing RCCP
- Valve to RCCP
- Metallic casing spacer to RCCP

332.13.2 Mastic Coating and Plastic Encasement:

All fittings shall be coated with mastic and shall be wrapped in poly-plastic.

332.13.3 Monitoring Requirements:

The system shall include test stations and electrical continuity as follows.

332.13.3.1 Corrosion Test Station (CTS):

All RCCP and PCCP shall be designed with CTS at least at every 1000 feet to measure any potential current or resistance.

Designer shall provide GPS coordinates for all CTS locations.

332.13.3.2 Electrical Continuity:

All pipelines shall be electrically continuous between CTSs through joint bonding wires, or welded joints, as necessary.

332.13.4 Corrosion Protection System (CPS)

Corrosion Protection System (CPS) is to be designed to introduce an external DC current which makes the structure a cathode. The CPS must be designed by a NACE certified professional engineer with considerable experience in corrosion engineering.

332.13.5 Corrosion Survey:

A detailed corrosion survey shall be conducted along the proposed or existing water main alignments. This investigation, shall include, but not be limited to the following:

- Field soil resistivity measurements
- Soil and groundwater sample analysis
- Stray DC earth current and foreign line cathodic protection system activity
- Identification of potential corrosion problems

332.13.6 Data Evaluation:
All field and laboratory data obtained from the corrosion survey shall be used to develop corrosion prevention and monitoring design recommendations.

332.13.7 Final Design:
Based on the corrosion survey and subsequent data evaluation and approval by DFW, a corrosion protection system shall be designed by a NACE professional engineer. This system may include, but not be limited to, the following methods:

Galvanic Protection (GP) System: Current generated from metal at higher energy level.

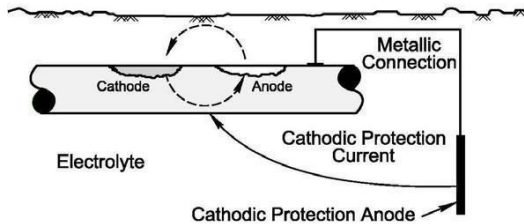


Figure 332.13.7.1: Galvanic Protection (GP) System

Impressed Current Cathodic Protection (ICCP) System: Current generated from transformer-rectifier energizing a relatively inert anode.

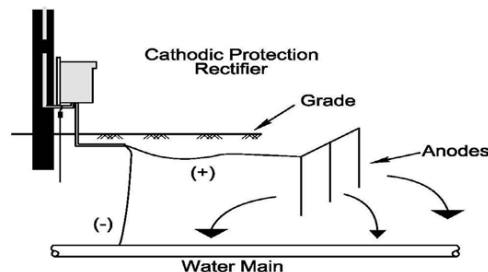


Figure 332.13.7.2: Impressed Current Cathodic Protection (ICCP) System

332.14 Testing Procedures

All tests shall be coordinated with and verified by DFW Utilities Group.

332.14.1 Hydrostatic Testing and Chlorination:

All water mains shall be hydrostatically tested and chlorinated before being put in service. The Contractor shall be responsible for conducting hydrostatic tests and chlorination.

332.14.1.1 Hydrostatic Testing

Perform Hydrostatic pressure and leakage test using methods and per performance requirements of AWWA M23 for PVC Pipe and M9 for Concrete Pressure Pipe or 150 psi for 2 hours for water main and 200 psi for fire main whichever is more stringent.

Prior to establishing the required test pressure, the designer must consider the operating condition of the system including but not limited to Normal working pressure, maximum sustained operating pressure, and Maximum transient pressure along the pipeline.

332.14.2 Disposal

The chlorinated water can be hauled off in water trucks or discharged into wastewater manholes as approved by DFW Utilities Group and DFW Environmental Affairs Department.

The chlorinated water can be discharged to a storm drain or sheet flow in open field with proper de-chlorination method as approved by DFW DCC and DFW EAD.

332.14.3 Disinfection and Sterilization

Disinfection and sterilization shall be performed in accordance with AWWA C651, latest edition, and will be performed by the installation contractor.

- All Bac-T samples will be collected by a DFW Utility employee and tested by the third party National Environmental Laboratory Accreditation Program (NELAP) certified laboratories.

332.15 Water Utility Distribution System Isolation Valves

332.15.1 Gate Valves

Gate valves shall be non-rising stem, solid-wedge gates with cast iron body and bronze mountings. Valve bodies shall be flange-by-flange. If possible, all gate valve stems should be vertical.

Unless otherwise specified, valves 3-inches to 12-inches in size with working pressures of 200 psi or less shall be in strict accordance with AWWA Standard Specification for "Gate Valves for Ordinary Water Works Service," designation C509, latest revision. Gate valves with resilient seated gates in accordance with AWWA C509, latest edition.

Gate Valves 16-inches and larger shall be installed with an integral bypass valve in a vault. The valve shall be non-rising stem unless otherwise indicated, shall have a gear reduction actuator, and shall turn counterclockwise to open. Valves shall be provided with a 2-inch square nut operator unless otherwise designated.

Valves or corporation stops smaller than 16-inches for buried service shall be provided with 2-inch square nut operator. The operating nut or extension of any valve shall be between 18-inches and 24-inches below finished grade.

There shall be a valve on each fire hydrant lead restrained to the main. These and all valves 24-inches and smaller shall be resilient seated gate valves.

Valves shall be located at the intersection of two or more mains and shall be spaced so that no more than three (3) customers will be without water during a shutout. For lines smaller than 24-inches, typical spacing should be 1500 feet. Mains 24-inches and larger shall be valved at intervals not to exceed 2,000 feet.

Branch piping (both new and future branches) shall be separated from the main with gate valves.

Valves shall be located so that isolating any segment of water main requires closing of no more than three (3) valves.

The operating nut or extension of any valve shall be between 18-inches and 24-inches below finished grade

If possible, all gate valve should be vertical. All gate valves 16-inches and larger shall have the bonnet located in a vault or manhole.

All valves 16-inch and larger shall have a gear reduction actuator.

Valves having "push on" joints are not permitted for fire hydrant leads and laterals.

Butterfly valves shall not be allowed.

Water mains shall be designed so that valves can be installed vertically unless conditions dictate otherwise.

332.15.2 Valve Stacks and Vault:

Valves or corporation stops buried in the ground shall be provided with cast iron valve stacks of proper dimensions to fit over the valve bonnets, and to extend to the finished ground line in paved areas or slightly above finished grade in other areas. Tops shall be complete with covers and shall be adjustable. Valve stacks shall be set vertical and concentric with the valve stem. A concrete pad shall be poured around all valve stacks when not in paved areas. Design engineer shall provide the detail for the concrete pad.

332.15.3 Valve Flanges:

Flanges for valves shall be drilled to match connecting flanges. All flanges shall conform to the standard specification of the American National Standards Institute. Flanges shall be Class 125 for all pipe, fittings, and valves 3 to 12 inches in diameter with a working pressure

of 200 psi or less, and flange bolts shall be coated for corrosion control.

332.15.4 Blocking Under Valves:

All gate valves 8-inches and larger, which are buried shall rest on a concrete pad. The pad shall extend for the full width of the trench to the back of the bell (or flange). Concrete shall be 2000 psi for blocking valves.

332.16 Tapping Sleeve

Tapping sleeve and valve shall be used whenever possible for connections to existing mains to avoid interruption of water services. Taps are restricted to one standard pipe size smaller than the tapped pipe. If the existing main is 16-inches, the largest pipe that can be tapped will be 12-inches.

All taps on RCCP shall be in accordance with the manufacture's recommendations.

332.17 Bends

All bends shall be DI with factory Mastic Coating and Poly wrapped. All fittings shall be flanged by MJ fittings.

332.18 Water Utility System Fire Hydrants

Fire hydrants shall be 5¼-inch. Hydrants shall be a breakaway traffic model with 6-inch mechanical joint shoe to be buried at 5 feet, except where different depth is shown in the hydrant schedule.

Subsurface hydrants are not allowed for use on the airport except when approved by the Fire Marshal. Subsurface (or flush-mount) fire hydrants shall be flush type models with box and cover and shall be back-filled as approved by DCC Code Enforcement and the Fire Marshal's Office.

Hydrants shall have one 5¼-inch outlet and two (2) - 2½-inch outlets with National Standard Threading. All hydrants will be fitted with (supplied and installed by the contractor) a 5-inch quick coupler adapter.

Hydrant operation shall be 1½ inch flat to point, open to left, by not more than eight or nine full turns of the operating nut. Hydrants shall meet the requirements of AWWA C502.

Hydrants shall be installed on both sides of all divided road/highways to provide adequate firefighting coverage. Roads/highways where opposing lanes of traffic are separated by a vehicle obstruction shall be considered a divided road/highway.

The entire fire hydrant assembly shall have restrained joints.

Fire hydrants shall not be located within nine feet in any direction of any sanitary sewer main, lateral, or service regardless of material of construction.

Fire hydrants shall be designed so as not to interfere with sidewalk ramps, trash receptacles, and street light and signal pole foundations.

To avoid sidewalks, ramps, and other features, fire hydrants placed near a street corner should be located outside the curve radius and a minimum of 4 feet from ramps. Exceptions may apply in the existing development or long (i.e. >5 feet) radius curb return.

Placement of fire hydrants should take into consideration above ground improvements, landscaping, critical root zones, grades and other utilities

When replacing existing water lines along with new fire hydrant leads, the drawings shall indicate that existing fire hydrants in-service more than 10-years are to be replaced with new.

332.18.1 Fire Hydrant Spacing

Fire hydrants shall be spaced at a maximum interval of 500 feet.

A fire hydrant shall be located so to reach each building with no more than 250 feet of hose along the most direct route considering all physical impediments.

At minimum, one fire hydrant shall be located within 100 ft of the Fire Department Connection (FDC)

332.18.2 Fire Hydrant Locations

The location of all public fire hydrants shall meet the following criteria:

- Fire hydrants shall be located as near to the street intersections as possible but out of the radius of curb turnouts, within 2.5 to 7.5' behind curb or projected future curb.
- No more than one fire hydrant will be allowed on a dead end main.
- Fire hydrant locations between street intersections shall be at the projection of a property line between lease holders.
- New fire hydrants shall be placed as close the location of the existing fire hydrant to be replaced as possible.
- Rail lines, controlled access highways, divided roadways, fences and walls will inhibit laying the fire hose in the most direct route and must be considered as barriers.

332.18.3 Fire Hydrant Leads:

Water mains serving a private fire hydrant must be 8-inches or larger and the minimum acceptable fire hydrant lead is 6-inches.

Maximum length of fire hydrant lead shall be 100 feet unless otherwise approved by DFW. Any lead over 50-feet in length requires an 8-inch lead.

A double check backflow preventer is required on fire hydrant leads over 100 feet in length. Backflow preventer must be at the main tap.

332.18.4 Fire Flow Tests:

The following items shall be addressed when performing a fire flow test:

- The pressure hydrant should be closer to a feed main than the flow hydrant.
- The number of flow hydrants should be determined.

The following data need must be recorded during a fire flow test:

- Static Pressure: This refers to the pressure reading before water flows. It is taken from the pressure hydrant just prior to time of the fire flow test.
- Residual Pressure: This refers to the pressure reading while water is flowing. It is taken from the pressure hydrant while the flow hydrants are flowing full.
- This pressure is taken to determine the fire flow for sufficient fire coverage.
- Pitot Pressure: This reading is taken by a pitot gauge from the flow hydrants.
- The pitot gauge should be inserted into the center of the flowing outlet at approximately half of the diameter away from the nozzle.

A validation fire hydrant flow test is required to close-out all applicable permitted construction, as proscribed by the Fire Marshal.

332.18.5 Backflow Preventer and Detector Check Valve:

See Section 332.24 (Backflow Preventer and Detector Check Valves) for detailed requirements.

Backflow preventer assemblies that are installed in private plumbing systems, fire protection systems, and process water systems that are directly or indirectly connected to or on properties serviced by the DFW Airport water distribution system shall obtain laboratory and field-testing approval as required by Federal, State Rules and Regulations.

To prevent contamination of the potable water system from stagnant water in dead end potable water service lines (e.g., private

fire systems, private fire main, section for future use, etc.), the installation of an approved backflow prevention assembly is required downstream of the DFW meter, and an approved detector-check backflow preventer assembly is required on fire loop at the lease line.

332.18.6 Blocking and Drainage:
Concrete blocking shall be poured behind hydrants against undisturbed earth. Washed pea gravel shall be placed appropriately around the shoe of the hydrant to effectively drain the hydrant barrel.

332.18.7 Isolation for Maintenance:
All fire hydrants shall be isolated from the main waterline and from other water services by installation of a gate valve between the main waterline and the fire hydrant in order to facilitate repair of the fire hydrant without having to shut off the main waterline.

332.18.8 Fire Hydrant Extensions Water Mains must be brought to 5 feet below grade at fire hydrant locations. A maximum 1-foot extension is allowed for adjustment.

332.18.9 Cathodic Protection:
All fire hydrants shall be cathodically protected.

332.18.10 Subsurface Fire Hydrants:
All subsurface fire hydrants shall have a 7-foot solid red circle painted around the access cover helping to identify its location and use as a fire hydrant. The marking shall be reduced in size when appropriate to keep from encroaching on any airfield operations pavement marking.

332.19 Water Meters

Water meters shall be required at all service points and shall conform to the following.

332.19.1 Water Meters:

Water meters shall be sized in accordance with good design practice for the service intended. Meters specified shall be compatible with electronic data collection equipment to enable on-site electronic collection of meter readings. Water usage shall be recorded on both a visual odometer and in an electronic memory. Also note the following:

- All new applications shall utilize Badger Beacon with HR-E LCD encoders, LTE endpoints.
- Meters up to 2 inches in size shall be positive displacement disc type meters. These water meters shall meet or exceed the requirements of AWWA C700 for Cold Water Meters - Displacement Type.
- Meters greater than 2-inches, and all irrigation meters regardless of size, shall be turbine type. All turbine meters shall have a strainer. These water meters shall meet or exceed AWWA C701 Class 2 standards.
- If both high flow and low flows are anticipated, a compound type meter shall be used. These meters shall meet or exceed the requirements of AWWA C702 for Cold Water Meters-Compound Type.
- Registers for all meters shall read in straight U.S. Gallons.
- Meters with HR-E LCD and pit electronics shall have data profiling capabilities.
- Meters shall be constructed of compatible metals throughout to prevent any corrosive reaction between component metals.

332.19.2 Water Meter Sizing:

Water meters shall be sized in accordance with the International Plumbing Code and with AWWA M22: Sizing Water Service Lines and Meters, latest edition. Accordingly, all

applicable water usage including domestic, irrigation, mechanical and fire flow demand shall be considered while sizing a water meter.

332.19.3 Meter Boxes:

Where possible, meters and meter boxes shall be located at the lease line. Meter boxes or vaults shall be specified for each meter. Provide clay dam and link seal at pipe penetrations into vault.

Meter locations shall be identified on the plans and shall be outside the facility served and at a location that is accessible to utility personnel and service equipment at all times.

Construction details shall be shown on the plans including the details of all internal piping. Piping details shall include a minimum requirement of two isolating valves, the meter, backflow device downstream of the meter and any necessary additional fittings required to remove or service the water meter without closing valves at any location.

All installations requiring 3-inch or larger meters shall be provided with a bypass line with gate valve and arranged such that the bypass can provide unmetered service to the facility during periods of time when the meter is being serviced or replaced. All meter boxes or vaults containing 3-inch or larger meters shall be free draining or be provided with a sump pump which discharges into the nearest storm drain. All drainage design for meter vaults shall be coordinated and approved by DFW.

Meter boxes and vaults shall have cast iron or steel deck plate covers as required to provide adequate service access to the meter location. Deck plate covers shall have an opening for the transmitter mount. Where the weight of the cover or cover sections exceeds 25 pounds, all meters shall be provided with sensor extension cable for mounting the

sensor on the box or vault, which shall be easily readable through a small access door in the cover.

A concrete pad shall be placed around all meter boxes, extending 12-inches minimum around perimeter of the box.

A 12-inch thick gravel bed shall be placed below each meter box.

332.19.4 Meter Depth:

Meters shall be positioned at 18 inches below the top of the Meter Box.

332.19.5 Positive Displacement Meters with Electronics:

332.19.5.1 Pit or Vault Application:

- 1-inch meter with HR-E LCD and pit electronics with 3-foot lead (specify wire length if more than 3 feet needed)
- 1½-inch meter with test plug and HR-E LCD and pit electronics with 3-foot lead (specify wire length if more than 3 feet needed)
- 2-inch meter with test plug and HR-E LCD, and pit electronics with 3-foot lead (specify wire length if more than 3 feet needed)

332.19.5.2 Mechanical room or Interior Room Application:

- 1-inch meter with HR-E LCD and outdoor remote NOT PREWIRED (specify lead wire length if more than 25 feet needed)
- 1½-inch meter with test plug HR-E LCD and outdoor remote NOT PREWIRED (specify lead wire length if more than 25 feet needed)
- 2-inch meter with test plug HR-E LCD and outdoor remote NOT PREWIRED (specify lead wire length if more than 25 feet needed)

332.19.6 Turbine Meters with Electronics:

332.19.6.1 Pit or Vault Application:

- 3-inch turbo meter with strainer, HR-E LCD and pit electronics (specify lead wire length if more than 3 feet needed)
- 4-inch turbo meter with strainer, HR-E LCD and pit electronics (specify lead wire length if more than 3 feet needed)
- Compound meters, HR-E LCD and pit electronics (specify lead wire length if more than 3 feet needed)

332.19.7 Compound Meters:

A compound meter shall be used where high flow rates are necessary, but also where smaller rates of flow are present and require accurate measurement. Compound meters shall have two measuring elements and a check valve to regulate flow between them.

332.20 Outlets

Blind flanges or plugs, as applicable, shall be furnished and installed on all valves located at outlet points or terminal points where the water main does not continue. Dead-end main structures shall be avoided whenever possible. If unavoidable, dead-end mains shall be designed to accommodate periodic flushing. The following two design alternatives shall be considered:

- Locate a fire hydrant less than 50 feet from the main's end.
- Install a smart flush at the main's end.

332.21 Air Release Valves, Air/Vacuum Valves and Combination air Valves

Automatic air release (and vacuum release) valves shall be installed at high points on water transmission mains 16-inches and above to exhaust and admit air to prevent vacuum conditions and air related surges.

Air valves are not required on water distribution mains 12-inch and smaller where fire hydrants and service connections provide a means for venting trapped air.

332.21.1 Air Release Valve Design: The Engineer is responsible for determining the size and type of air release valves necessary to assure the watersystem operates properly based upon the water system characteristics and shall provide calculations determining the size and type of valves for review by DFW Utility Group when requested. Air release valves may be necessary on any size of main.

At a minimum, on water mains 16 inches in diameter and larger, and on smaller mains where appropriate, combination air valves will be placed at all high points and air/vacuum valves shall be placed at the down-slope side of all gate valve locations. Air/vacuum and vacuum release valves shall be approved on a case-by-case basis.

All mains twenty-four (24) inches and larger will include an 18-inch outlet with flange including a 1-inch corporation (minimum) for installation at high points where the installation of an air release valve (ARV) would be necessary. In the absence of an ARV requirement, an 18-inch outlet with flange including a 1-inch corporation shall be placed every 2,500-feet. Proposed waterline connections to air release valve piping are prohibited.

Air release valves shall conform to the requirements of AWWA C512.

332.21.2 Surface Boxes:

Surface box for manual air release where required shall be cast iron box and lid, 12 inches deep and 24 inches in diameter. Raised letters on the cover shall read "WATER".

The top of the air release valve shall be no less than 24-inches below the surface box lid.

In unimproved areas provide a 24-inch marker, 4-feet high, with a 4-foot square concrete pad.

332.22 Purging and Flush Points

332.22.1 Flush Points

Flush points are to be installed primarily to flush water mains as needed.

332.22.1.1 General Requirements

- Fire hydrants shall not be used in lieu of flush points
- Flush points shall not be designed to flush water to storm drains in order to prevent migration of chlorine residual in storm water system.
- The developer may need to extend a lateral to the end of the cul-de-sac so that it can be used to flush the water thru a flush point.

332.22.1.2 Type

Smart flush is recommended as flush unit. At minimum the flush unit should have following probes/sensors:

- Combined Chlorine
- Temperature
- Total Chlorine
- PH

Dechlorination option should be included in the flush system.

332.22.1.3 Size:

Flush points shall be 2 inches or larger based on design calculations.

332.22.1.4 Location:

- Dead-end mains
- High/Low Valve Assembly

332.23 Sampling Stations

The designer shall coordinate the need for and the location of Sampling Stations with DFW Utilities Group.

332.24 Backflow Preventer and Detector Check Valves

Backflow prevention device shall be considered at the following locations to protect public water system from cross contamination:

- Commercial property water service line
- Dedicated irrigation lines
- Fire Lines

332.24.1 Water Service Connections: All temporary construction water services shall be provided with a line sized reduced pressure zone-double check backflow preventer valve assembly and water meter. Services shall not be initiated until backflow prevention devices have been tested and approved for operation by a TCEQ certified tester. All original test forms shall be returned to the Plumbing Inspector at DFW Airport Design, Code, & Construction Department, P.O. Box 612008, DFW Airport, TX 75261-2008.

332.24.2. Backflow Preventers:

Where the service line provides potable water for a domestic service and also connects with other closed or chemically treated systems that could foreseeable contaminate the potable water line, a backflow preventer shall be installed. Drains off the backflow preventer assembly shall be drained to the sanitary sewer. Taps to mains, to provide water for fire protection or other closed pipe systems, shall have a double check valve assembly at the fire line tap. An alternate method of backflow prevention consisting of a 12-inch air gap between an unrestricted overflow of an atmospheric makeup tank and the source of water is also acceptable. All double check and reduced pressure backflow preventers must be certified for operation after installation by a TCEQ certified tester. All original test forms shall be returned to the Utility Inspector at DFW Airport Design, Code, & Construction Department, P.O. Box 612008, DFW Airport, TX 75261-2008.

332.24.3 Detector Check Valves

A single Detector Check (DC) on closed fire line shall typically be used to measure fire flow for approved automatic fire sprinkler only.

- Typical size of a Detector Check (DC) is 4" (min.), 6", 8" and 10" as necessary. A 5/8"- 1" Nutating Disc Positive Displacement (PD) meter is also typically used in a bypass line conjunction with Detector Check (DC).
- Bypass line in a dedicated fire line should not be used for domestic use.

On looped private fire mains, a Detector Check (DC) shall be installed on both taps to the public main.

332.24.4 Reduced Pressure Backflow Preventer:

All pressure reducing backflow preventers that are installed to protect high-hazard services from back-flowing must be tested annually from the date they are installed and certified by a TCEQ certified tester. All original test forms shall be returned to the Plumbing Inspector at DFW Airport Design, Code, & Construction Department, P.O. Box 612008, DFW Airport, TX 75261-2008. Provide weather protection and automatic heated enclosure (i.e. hotbox) if located outside.

Examples of high-hazard services are:

- Aspirators
- Autoclaves
- Sterilizers
- Lab bench equipment
- Sewage pumps
- Sewage ejectors

332.25 Thrust Blocking

332.25.1 Thrust Blocks:

Concrete with a minimum strength of 2,000 psi in 28 days shall be placed for blocking at each change in direction of the pipe line, in

such manner as will substantially brace the pipe against undisturbed trench walls. All fittings shall be mastic coated and wrapped in poly-plastic prior to thrust block placement to allow future removal of concrete without damage to fittings. Concrete blocking shall have been in place 4 days prior to testing the pipe line. Thrust blocks shall be used at:

- Changes in direction, as at tees and bends
- Changes in size, as at reducers
- Changes in elevation, as at tees and bends (concrete block anchors preferred)
- Stops, as at a dead end
- Valves, where thrusts may be expected

332.25.2 General Requirements:

All pressurized water mains shall be restrained against unbalanced thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.

332.25.3 Thrust Restraint System:

Any or a combination of the following thrust restraint systems are acceptable for potable water mains:

- Horizontal Thrust Block
- Vertical Thrust Block/ Anchor Block
- Joint Restraint System

332.25.4 Horizontal Thrust Block:

Horizontal thrust block shall be designed to transfer horizontal thrust force to larger bearing area, as needed.

332.25.4.1 Design Considerations:

332.25.4.1.1 Design Pressure (P):

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most applications.

332.25.4.1.2 Thrust Force (T):

- Unbalanced thrust force occurs at the following configurations shall be restraint as needed (**Figure 332.25.4.2.2**):
- Bend
- Wye
- Deadend
- Bifurcation
- Tee
- Reducer
- Closed Valve

332.25.4.1.3 Bearing Area (Ab):

Thrust bearing area can be calculated as follows:

$$A_b = S_f T / S_b$$

Where,

- A_b = Bearing Area
- S_f = Factor of Safety, Typically 1.5
- S_b = Horizontal Bearing Strength
- T = Hydrostatic Thrust

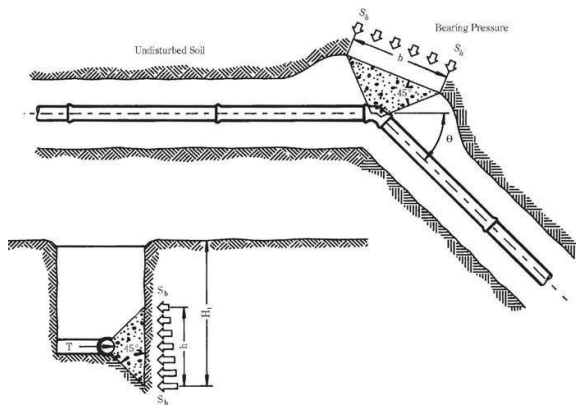


Figure 332.25.4.1.3: Horizontal Thrust Bearing Area

Source: *Thrust Restraint Design for Ductile Iron Pipe*, by DIPRA, 2002

In the absence of actual Horizontal Bearing Strength, **Table 332.25.4.1.4** can be used to estimate soil bearing strength:

Table 332.25.4.1.4

Soil	Bearing Strength (lb/ft ²)
Muck	0
Soft Clay	1,000
Silt	1,500
Sandy Silt	3,000
Sand	4,000
Sandy Clay	6,000
Hard Clay	9,000

Source: *Thrust Restraint Design for Ductile Iron Pipe*, by DIPRA, 2000

332.25.4.2.4 Block Dimension:

Block dimension shall be determined based on the required bearing area with following criteria:

$$b = A_b / h$$

Where,

- A_b = Bearing Area
- b = Block Width
- h = Block Height

Block height (h) shall be equal to or less than one-half the total depth to the bottom of the block, (Ht), but not less than the pipe diameter (D).

$$h \leq 0.5 H_t$$

$$h > D$$

Block height (h) should be chosen such that the calculated block width (b) varies between one and two times the height.

$$h = b \sim 2b$$

332.25.4.2.5 Installation:

Bearing surface shall be placed against undisturbed soil extending beyond joints. If not, the fill between the bearing surface and undisturbed soil must be compacted to at least 90% Standard Proctor density.

Thrust block shall not be used in swamps or marshes.

Horizontal thrust block may not be practical for large water main due to size restriction

332.25.5 Vertical Thrust Block/Anchor Block:

Vertical thrust blocks shall be designed to counter vertical thrust force by weight and to transfer horizontal thrust force to larger bearing area, as needed.

332.25.5.1 Design Consideration:

332.25.5.1.1 Design Pressure (P):

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most application.

332.25.5.1.2 Thrust Force (T)

Unbalanced thrust force occurs at the configuration shown in **332.25.5.1.2:**

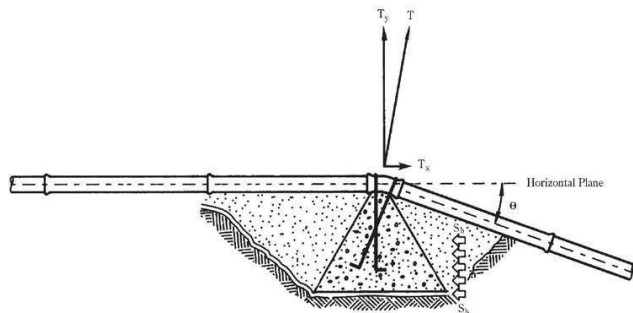


Figure 332.25.5.1.2: Vertical Thrust Block

Horizontal Hydrostatic Thrust: $T_y = PA \sin \Delta$

Horizontal Hydrostatic Thrust: $T_x = PA \sin \Delta$

Where,

P = Internal Pressure (psi)

A = Bearing Area

Δ = Deflection Angle (degree)

332.25.5.1.3 Volume of Vertical Thrust Block (V):

Vertical thrust block shall be designed to provide equilibrium by the weight of the block.

Required Volume, V

$$V = S_f T_y / W_m$$

$$= S_f PA \sin \Delta / W_m$$

Where,

S_f = Factor of Safety, Typically 1.5

T_y = Vertical Component of Thrust

S_b = Horizontal Bearing Strength

W_m = Density of Block Material

332.25.6 Restraint Pipe Joint

Joint restraint for pipes larger than 16-inches shall utilize integral, factory joint restraint systems.

Joint restraint shall be provided for all pipe bends and where necessary when joint deflection is utilized. A minimum safety factor of 1.5 shall be used when calculating restrained water pipe length. When joint restraint is required in intersections, extend the joint restraint, at a minimum, to the point of curvature (PC) of the curb line. Notes shall be placed in both plan and profile views and shall include at a minimum the type of restraint to be utilized and the beginning and ending stations of the restraint. Concrete thrust blocking may be approved on a case by case basis. In cases where concrete thrust blocks are utilized, at a minimum the Engineer shall include block dimensions and locations on the plans. The proximity of other utilities and structures must be considered when specifying the use of thrust blocking.

332.25.6.1 Applicability:

Restraint Pipe Joint shall be designed to transfer horizontal and vertical thrust force, as needed.

332.25.6.2 Design Consideration:

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most application.

332.25.6.3 Reference:

The following technical references shall be used for calculating thrust restraint system, as required:

- AWWA M9: Concrete Pressure Pipe by AWWA, Latest Edition
- AWWA M11: Steel Pipe- A Guide for Design and Installation, Latest Edition
- Thrust Restraint Design for Ductile Iron Pipe, 2002, or Latest Edition.

332.26 Manhole Frame and Cover

All manhole frames and covers must meet the minimum requirements as set in 30 TAC 217.55, and for manholes located within the AOA all FAA requirements must be met.

All manhole frames/covers, valve castings are standard steel castings with a special heavy-duty cover.

- Manhole covers for potable water mains shall be 36 inches diameter.
- Valve boxes for light traffic are the standard concrete box with a special cover.
- Valve boxes for traffic areas are of heavy-duty traffic design.

332.27 Water System Approved Product List					
BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	Reference Specifications (NCTCOG)	National Specifications
Automatic Flushers		Manufacturer			
AUTOMATIC FLUSHER	Smart Flush	The Kupferle Foundary Company	9800i-WC Eclipse		
Water Meters		Manufacturer			
Water Meters	All Meters	Badger	Badger Becon with HR-E encoders, LTE Endpoints		AWWA C700 & C701
Water Pipes		Manufacturer			
PVC Pressure Pipe	PVC 8"-12" DR14	Pipelife Jet Stream	DR14	501.9	AWWA C900
PVC Pressure Pipe	PVC 8"-12" DR18	Pipelife Jet Stream	DR18	501.9	AWWA C900
PVC Pressure Pipe	PVC 8"-12" DR14	Diamond Plastics Corporation	DR14	501.9	AWWA C900
Corporation Stop		Manufacturer			
CORPORATION STOP *	QUICK JOINT BALL VALVE	FORD	FB-1000-x-Q-NL	502.5	AWWA C800
*MUST HAVE STAINLESS STEEL COMPRESSION GRIP RING.					
Fire Hydrants		Manufacturer			
FIRE HYDRANTS*		CLOW*	MEDALLION F2545	502.6	AWWA C502
FIRE HYDRANTS*		MUELLER	SUPER CENTURION 250	502.6	AWWA C502
FIRE HYDRANTS*		M & H	M & H 129	502.6	AWWA C502
* MUST HAVE FULL BODY GLANDS AND RED PRIMER.					
Fittings		Manufacturer			
FITTINGS, FULL-BODIED	DUCTILE IRON	AMERICAN CAST IRON PIPE		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	STAR PIPE		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	TYLER/UNION/UFC O		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	Sigma		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	US PIPE & FOUNDRY		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	SIP		502.6	AWWA C110
COMPACT FITTINGS AND GLANDS ARE NOT ALLOWED.					

Manhole Appurt.		Manufacturer			
MANHOLE RING & LID	32-INCH	BASS & HAYS	V1420		
MANHOLE RING & LID	40-INCH	BASS & HAYS	#1225-40		
MANHOLE RING & LID	40-INCH	NEENAH	R-1901		
Polywrap					
POLYWRAP	WRAP MUST BE LLDPE, t= 0.008", MANUFACTURED AND LABELED IN ACCORDANCE WITH AWWA C105.				AWWA C105
Service Saddles		Manufacturer			
SERVICE SADDLES	BRONZE DOUBLE STRAP	JAMES JONES	J-979	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	FORD	202B	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	McDONALD	3825	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	MUELLER	BR2B	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	SMITH-BLAIR	323	502.10	AWWA C 800
Tapping Sleeve		Stainless Steel		Manufacturer	
TAPPING SLEEVE	STAINLESS STEEL*	CASCADE	CST-EX	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	FORD	FTSS	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	JCM	432	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	MUELLER	H304	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	ROMAC	SST III	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	SMITH-BLAIR	665	502.10	AWWA C 800
*OUTLET FLANGES MUST ALSO BE STAINLESS STEEL. SHALL BE RESTRICTED TO PIPE SIZES 8" AND SMALLER AND SHALL NOT BE USED FOR TAPS GREATER THAN 75% OF THE MAIN SIZE.					
Air Valves		Manufacturer			
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	CLA-VAL		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VAL-MATIC		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VALVE & PRIMER (APCO)		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VENT-O-MAT	RBX SERIES	502.6	

Valve Stack	Covers and Lid	Manufacturer			
VALVE COVERS	LID	BASS & HAYS	#340-1	806.4	
VALVE COVERS	LID	SIGMA	VB1651M	806.4	
VALVE COVERS	COVER	SIGMA	VB1652M	806.4	
VALVE COVERS	Lid	Accucast	115002	806.4	
VALVE COVERS	Stack	Accucast	115000	806.4	
VALVE COVERS	Lid	Star Pipe Products	Shorty	806.4	
VALVE COVERS	Stack	Star Pipe Products	Shorty	806.4	
Valves	Vertical Resilient	Manufacturer			
VALVES, GATE*	VERTICAL, RESILIENT WEDGE	MUELLER	2360, 2362	502.6	AWWA C509
VALVES, GATE*	VERTICAL, RESILIENT WEDGE	M & H	4067, 4068	502.6	AWWA C509
* MUST HAVE 316 SS BOLTS. BOTH RED EPOXY OR BITUMINOUS EXTERIOR COATINGS ARE ALSO ACCEPTABLE. AWWA C-515 RSGVs WITH REDUCED WALL THICKNESSES ARE NOT ACCEPTABLE.					
Water Meter Vaults	Large Services	Manufacturer			
WATER METER VAULTS	CONCRETE	AMERICAN INDUSTRIAL PRECAST	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	BROOKS/OLDCASTLE PRECAST	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	CONCRETE PRODUCTS (CPI)	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	HANSON	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	NEW BASIS (DALWORTH QUICKSET)	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	TURNER	MUST HAVE APPROVED LIFTING DEVICES		

Water Meter Boxes	Small Services	Manufacturer			
WATER METER BOXES FOR 1" SERVICES	PLASTIC WITH DI RING & LID & AMR Lids	ACCUCAST	846211 COMPLETE, 842100 BOX, 872065 LID, 872061 RING		
WATER METER BOXES FOR 1" SERVICES	PLASTIC WITH DI RING & LID & AMR Lids	BASS & HAYS MID STATES	MS18DAL BOX, BH-3PD LID, BH-4PD RING		
WATER METER BOXES FOR 1" SERVICES	PLASTIC WITH DI RING & LID & AMR Lids	SIGMA	MB151-DFW-18DAL		
WATER METER BOXES FOR 1 1/2" & 2" SERVICES	PLASTIC WITH DI RING & LID & AMR Lids	BASS & HAYS MID STATES	MS30DAL BOX, BH-5PD LID & RING		
WATER METER BOXES FOR 1 1/2" & 2" SERVICES	PLASTIC WITH DI RING & LID & AMR Lids	ACCUCAST	846215 COMPLETE, 843000 BOX, 872071 RING AND 872070 LID		
* GALVANIZED BOXES ARE NOT ACCEPTABLE.					
<p>•Engineer of record shall conform the applicability of these approved products in AOA and CTA area. This standard product list has been developed only for projects located outside the AOA and CTA area. When technical specification for specific products, are included as part of the construction contract documents, the requirements of the Technical specifications will override these approved product list. It is engineer of record (EOR)'s responsibility to approve the product submittal. DFW utility group recommend EOR to coordinate with DFW Utility group prior to approval.</p>					

SECTION 333

SANITARY SEWERAGE UTILITIES

333.1 DFW Airport Sanitary Sewer Systems

Wherever possible, disposal of sewage shall be by gravity to the Sanitary Sewer System (SSS). Airport mains shall be extended as required to establish gravity flow disposal. The DFW Airport (DFW) owns and maintains a complete Sanitary Sewer System (SSS), and the following information is presented as criteria for expansion of the system, or modifications to the existing system. All new connections and modifications shall be in accordance with 30 TAC §217, "Design Criteria for Domestic Wastewater Systems"

333.2 Sanitary Sewer Main Sizing

The sanitary sewer mains shall be sized based on 30 TAC §217.53, with the following additional requirements. The Engineer of record shall complete an analysis of the initial and future flows of the area to be served. The collection and interceptor main shall be sized for the peak hr. flows, which is based on the estimated average daily flow. When site-specific data is unavailable, designer shall use the most conservative data while meeting or exceeding the following criteria for sizing sanitary sewer mains:

Sanitary sewer lines shall be designed to minimize turbulence to prevent release of sulfide gases and subsequent corrosion.

Velocity: The velocity of gravity sanitary sewer main shall be maintained between 2 and 10 ft/sec. (No Variances are allowed) Velocity shall be determined by the Manning Equation:

Size: For sewer mains, 15 inches in diameter or smaller, use the larger size as determined below:

- The main shall be designed such that the Peak Dry Weather Flow (PDWF) shall not exceed 65% of the capacity of the pipe flowing full. The main shall be designed such that the Peak Wet Weather Flow (PWWF) shall

not exceed 85% of the capacity of the pipe flowing full.

- For sewer mains, 18 inches in diameter or larger, the main shall be designed such that the Peak Wet Weather Flow (PWWF) shall not exceed 80% of the capacity of the pipe flowing full.
- Service: The size of the services must be at least one standard size smaller than the proposed and existing sanitary sewer main.

333.2.1 Minimum Pipe Sizes

The minimum pipe diameter for any public gravity sanitary sewer collection main shall be 8 inches for maintenance and easy cleaning.

333.2.2 Minimum and Maximum Slope

Refer to 30 TAC §217.53, for selecting sanitary sewer main slopes.

333.3 Sanitary Sewer Pipe Materials and Embedment

333.3.1 Pipe Material Selection

- Designers are responsible for specifying the type of pipe to be used in any sanitary sewer main design. Typically, minimum 150-psi pressured rated sanitary sewer pipes is preferred for small diameter (<15") gravity mains.
- The Engineer of Record shall present a technical memorandum, addressing the pipe material, geological conditions and embedment requirements to DFW Utilities with the design plans for all sanitary sewer main projects.

333.3.2 Embedment Requirements

- Designers shall specify the class of embedment on the design drawings. The type of embedment to be used is determined by pipe material and the depth of cover. The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe.
- The engineer of Record shall prepare a Technical memorandum that includes the maximum pipe deflection anticipated

by the pipe. Pipe deflection shall not be more than 50% of manufacturer recommendation.

General terminology of a typical pipe trench is as follows:

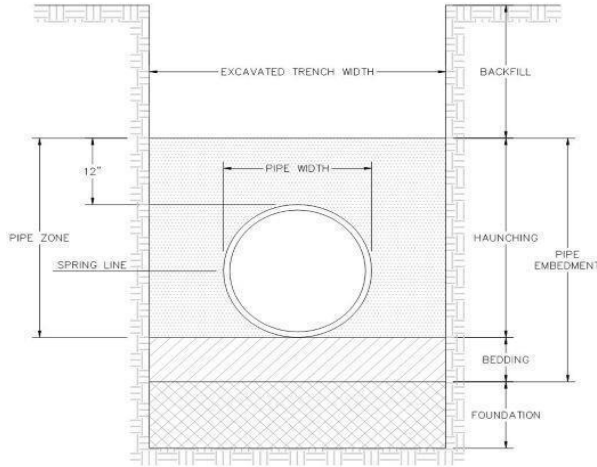


Figure 333.3.2: Typical Pipe Trench

Table 333.3.2 Pipe Material and Joints

Pipe & Material Specification	Min. Pipe Stiffness (PS)	Allowable Size (in)	Joint Specification
PVC-Pressure Rated* AWWA C-900 (DR-25)	PS= 165	4"–15"	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477 Fusible Fusible C 900(R) Certa-Lok Certa-Lok C900/RJ(TM) EAGLE LOC
PVC-Pressure Rated* AWWA C 900(DR 21)	PR= 200	18"– 48"	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477 Fusible Fusible C 900(R)
PVC-Pressure Rated* AWWA C 900(DR 18)	PR= 235	18"– 48"	EAGLE LOC Eagle Loc 900 Certa-Lok Certa-Lok C900/RJ(TM)
HDPE-Pressure Rated AWWA C906 (DR-11) PE 4710 or	PS= 200 psi	8"- 36"	Fusible Fusion ASTM F2620
Pressure-Rated RTRPα & Pressure-Rated-RPMPβ ASTM D 3754 (Fiberglass)	SN≥ 150 psi	18"–60"	Bell & Spigot Joints: ASTM D3212 Gasket: ASTM F477

333.4 Depth of cover

The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe. The main must be deep enough to serve adjacent properties. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction methods where high groundwater conditions are anticipated.

If fill or embankment placed over existing sanitary sewer mains exceeds six (6) feet

above the existing ground, DFW Utility Group approval is required. If cuts exceed the minimum depth of cover stated below, DFW Utility Group approval is required. The minimum depth of cover over the upper-most projection of the main shall be as follows table.

Table 333.4 Pipe Size and Depth of Cover

Size of Main	Min. Depth of Cover (ft)		
	Normal installation	Highway/Roadway	Runway Taxiway
12" and smaller	6	6	Engineering Evaluation & FAA Regs
12"-16"	6	6	
20" and larger	7	7	

333.4.2 Minimum cover

The above guideline applies to sanitary sewer main installation in public right-of-way:

333.5 Locations

Mains shall be located outside of the roadway footprint within the ROW and should follow the roadway.

- Sanitary sewer manholes shall not be located in the flowline of an existing creek or drainage area.
- Install the replacement main in the same trench as the existing main at six (6) to twelve (12) inches below the existing grade, if feasible
- Install the replacement main three (3) feet parallel to the existing main, as measured from the outside edge of both pipes.

333.6 Horizontal alignment

The horizontal alignment must meet the minimum requirements as set in 30 TAC §217.53, with the following additional requirements.

- All mains should be laid as straight as possible.
- Stations shall be to the tenth of a foot (Ex: STA. 10+11.4).

333.7 Vertical alignment

The vertical alignment must meet the minimum requirements as set in 30 TAC §217.53., with the following additional requirements.

- Vertical bends are not typically allowed unless otherwise approved by DFW.
- Design slopes shall be to the nearest hundredth of a percent (Ex: Slope 5.20%).
- Elevations shall be shown to the nearest hundredth of a foot (Ex. El. 495.95).

333.8 Separation Distance between Sanitary Sewer and Reclaimed and Water Mains

When a sanitary sewer main is built near an existing water facility, conveyance, or appurtenances, 30 TAC §217.53, governs the minimum separation distances,

333.9 Connections to Existing Mains

- The connection, shall always be at a manhole, including all laterals.

333.10 Sanitary Sewer Service Lateral

- Each lease property must have its own sanitary sewer service lateral which must not cross any existing or projected lease line(s).
- Sample and inspection ports are required for service lines when industrial waste monitoring is required. They shall be located at the lease line within the public right-of-way (ROW) to indicate the line of responsibility of the utility.
- They shall not be located in traffic areas, paved parking areas or sidewalks, these areas shall require manholes.

333.10.1 Location

- Sanitary sewer service lateral should be located ten feet downstream of the water service.
- A sanitary sewer clean-out shall be installed at least line as a demarcation between public and private line.
- Sanitary sewer clean-outs are not allowed in sidewalks, paved areas, load bearing pavement, or driveways, these areas will require a manhole.

333.10.2 Size

- The minimum size of the sanitary sewer service lateral from the main to the property line shall be six (6) inches unless other conditions warrant a larger size. The following criteria may be used as a guide:

Table 333.10.2: Sanitary sewer Lateral Sizing Criteria

Fixtures	Flow (gpm)	Size (in)
0- 720	0- 180	6
720- 2640	180- 4000	8
2640- 4680	4000- 7000	10
4680- 8200	7000- 11600	12

333.10.3 Depth

- The sanitary sewer service lateral should be at a depth sufficient to insure the dwelling to be connected, will be served using a preferred lateral grade of 2 % (min. 1%) and minimum cover of 4 feet.
- The top of the downstream manhole should be a minimum of 18 inches below the finish floor (FF) elevation of the dwelling to be connected. In cases where this is not achievable approval must come from DFW and will generally require a backwater valve device and damage waiver from the user.

333.11 Inverted Siphon

The inverted siphons/sag pipes must meet

the minimum requirements as set in 30 TAC §217.53, with the following additional requirements.

333.11.1 General

- Design flow shall be the hydraulic capacity of the upstream flow or the future projected flow.
- All siphons shall be completely buried with a minimum of 48" of cover when going across a natural or man-made depression,
- Maximum slope of the downstream (rising) leg of the siphon shall be 15%.
- The total computed head loss should be increased by 10% as a factor of safety.

333.11.2 Components

A typical siphon consists of the following components.

333.11.2.1 Conduits:

- The siphon shall consist of two or more conduits with a minimum pipe diameter of 8 inches.
- The arrangement of inlet and outlet details must divert the normal flow to one conduit and allow overflow into the second conduit. Usually, the conduit taking the overflow will be right above the point where the approaching conduit is carrying the flow that the first conduit is able to carry at full flow.
- When multiple conduits are to be used, all conduits should be arranged so that additional conduits can be brought in service as sanitary sewer flows increase.
- Pressure rated pipes and fittings shall be used.

333.11.2.2 Inlet and Outlet Structures Two manholes or junction structure must be designed including one upstream and one downstream with adequate clearance for cleaning equipment, inspection, and flushing.

333.12 Aerial Creek Crossing

Aerial crossing may be used only when all other alternative have been evaluated and other options are either not available or not feasible. The engineer of record shall get

approval from AVP Utilities for aerial crossing design. The Engineer of record shall use steel encasement pipe or ductile iron pipe around all aerial carrier pipe.

All aerial crossings when allowed must meet the minimum requirements as set in 30 TAC §217.53. (o), "Bridged Sections".

333.13 Force Mains

Force mains are required whenever lift stations are required, and will be in full compliance with 30 TAC §217, with the following additions.

Lift station/force main systems shall be evaluated for their sulfide generation potential and their ability to achieve scouring velocities during average dry weather flow periods. If the evaluation indicates that sulfide concentration of greater than two (2) ppm and solids deposition are likely, the design shall:

- Define a workable sulfide control technique that will minimize sulfide formation in the force main,
- Include "pig" launching stations and recovery points to allow cleaning of the force main, and
- Protect the gravity main and manholes downstream of the force main from corrosion. The length of pipe to be protected shall be determined on a case-by-case basis.

The maximum time required to flush the force main shall be calculated on the basis of average dry weather flow. Flush time shall be calculated for average dry weather flow. Design Engineer shall provide the calculated flush time for DFW Utility Group approval.

The force main shall discharge into its own distinct manhole. (I.e. multiple force mains shall not discharge into a single manhole.)

Thrust restraint when required shall be shown on the plan view.

333.13.1 Pipe Materials:

All force main piping must meet the minimum requirements as set in 30 TAC §217.64, and the pipe joints shall comply with 30TAC §217.65, with the following additional requirements.

All force mains shall be approved PVC or an approved HDPE with a minimum diameter of four (4) inches. Force main pipe within the station shall be flanged. Flexible fittings shall be provided at the exit wall.

333.13.2 Identification of Force Main Pipes:

All force main piping must meet the identification requirements as set forth in 30 TAC §217.66, and section 331.11 of this manual.

333.13.3 Velocities:

All pipe velocities shall meet requirements as set in 30 TAC §217.67, with the following additional requirements.

Force mains shall be sized so that the flow velocity is between three (3.0) and six (6.0) feet per second at initial and ultimate development.

333.13.4 Detention Time:

The detention time requirements shall meet the minimum requirements as set in 30 TAC §217.67.

333.13.5 Connection to Gravity Main:

- Shall meet the minimum requirements as set in 30 TAC §217.67.
- A force main must terminate in an appropriate structure and either at a manhole.
- The discharge end of a force main inside a manhole must remain steady and produce non-turbulent flow.
- A receiving sanitary sewer collection system must accept the maximum pump discharge without surcharging.

333.13.6 Odor Control:

Odor control shall be in accordance with the

requirements as set in 30 TAC §217.67.

333.13.7 Air Release Valves in Force Mains:

All force main air release valves must meet the minimum requirements as set in 30 TAC §217.67, with the following additional requirements.

Location and size of all air release valves shall be evaluated for odor or nuisance potential to adjacent property by the design engineer. The use of air release valves shall be restricted to installations where there are not possible alternatives.

333.13.8 Valves:

All force main valves must meet the minimum requirements as set in 30 TAC §217.67.

333.13.9 Force Main Testing

All force main testing must meet the minimum requirements as set in 30 TAC §217.68,

333.13.10 Water Meter.

A water meter shall be installed along with reduced pressure back-flow preventer, hot box, electric, and signage.

333.14 Sanitary Sewer Lift Stations

All sanitary sewer lift stations shall be designed strictly in accordance with 30 TAC §217.59-63. Lift stations utilizing dry wells will not be allowed. All concrete utilized in lift stations shall be polymer concrete.

- Engineer of Record shall submit maximum wet weather flow, maximum dry weather flow, average dry weather flow and minimum dry weather flow to DFW Utility Group for approval. Lift station shall be designed to handle the maximum wet weather flow for its service area.
- Force main pipe size shall be per maximum dry weather flow. Average dry weather flow shall be used to determine the average detention time in the wet well. Minimum dry weather flow shall be used to determine the maximum detention time in the wet well.

- The bottom of the wet well shall have a minimum slope to the intake of two (2) vertical to one (1) horizontal. There shall be no projections in the wet well, which would allow deposition of solids.
- The wet well volume shall be sized to provide adequate storage volume at peak design flows and a pump cycle time of sufficient duration to prevent pump short cycling and consequential motor damage. Pump cycle time, defined as the sum of "pump off" time plus "pump on" time, shall be as follows:

Table 333.14 Motor Size and Cycle times

Motor (H.P.)	Minimum Cycle Time (Min)
2 to 50	10
51 to 75	15
76 to 250	30
251 to 1500	45

333.14.1 Preliminary Design Submittal

A preliminary design submittal will be required for each lift station. The submittal report shall be prepared by professional engineer register in the State of Texas. The report shall include a brief summary of project scope, plans, a basin map, influent hydraulic calculation, wet well volume calculation, pipe size calculation, velocity, ground water levels in proposed site area, proposed system's effect on existing system's capacity, and opinion of probable construction cost for lift station, force main and annual operating and maintenances cost.

Engineer of record shall provide the odor control measure. The potential odor determination must include the estimated flows immediately following construction and throughout a system's 50-year expected life cycle.

- Lift stations will only be considered a viable option if the cost analysis clearly shows that the gravity sanitary sewer mains are not economically feasible.
- All lift station designs shall consider the potential for future expansion. The design of lift station shall incorporate a

wet well sized for the final capacity of the lift station.

333.14.2 Wet Well Detention Time

Design Engineer shall calculate the detention time in the wet well for the maximum wet weather flow. The static head shall be calculated for "pump on" and "pump off" elevations in the wet well.

333.14.3 Site Selection

Lift station sites must meet the minimum requirements as set in 30 TAC §217.59,

333.14.4 Wet Well and Valve Vaults.

The design of all wet wells valve vaults must meet the minimum requirements as set in 30 TAC §217.60.

333.14.5 Lift Station Pumps

All lift stations pumps must meet the minimum requirements as set in 30 TAC §217.61, with the following additions.

- A minimum of two (2) pumps shall be required for all lift station. The capacity of the pumps shall be such that the maximum wet weather flow can be handled with the largest pump out of service.
- All "pump on" levels shall have a minimum separation of one (1) foot between levels. All "pump off" levels shall be at least six (6) inches above the top of the pump casing. For more than two (2) pumps, the "pump off" levels shall be staged with a minimum separation of one (1) foot between levels. At minimum, design engineer shall provide the pump staging sequence for High level alarm, lag pump on, lead pump on, lag pump off, lead pumps off, and low-level alarm. The high level alarm shall be at least one (1) foot above the last (highest) "pump on" level in the wet well and also at least one (1) foot below the flow line of the lowest influent line into the wet well.
- The net positive suction head (NPSH) required by the pump selected shall be compared with the NPSH available in the system at the eye of the impeller. The engineer shall consult the pump

manufacturer for the NPSH required values for that pump and compare them with calculated values for the NPSH available. The NPSH available should be greater than the NPSH required for a flooded suction pump. Design engineer shall provide the NPSH calculation to DFW Utility Group for approval.

333.14.6 Lift Stations Piping

All lift station piping must meet the minimum requirements as set in 30 TAC §217.62, with the following additional requirements.

All suction piping shall be flanged ductile iron and have a minimum diameter of four (4) inches. Each pump shall have a separate suction pipe.

- Suction piping shall have a velocity of three (3) to five (5) fps.
- All suction pipes inside the wet well shall be equipped with a flare type, down-turned intake. The distance between the bottom of the flare and the floor of the wet well shall be between $D/3$ and $D/2$ where D is the diameter of the flare inlet.

333.14.7 Electrical Requirements

All electrical appurtenances and equipment must meet the minimum requirements as set in 30 TAC §217.63, and §217.326, and the latest adopted National Electrical Code (NEC).

333.14.8 Head Loss Curves

Data points for the system capacity curve shall be provided in tabular form and graphed with pump head capacity curve on the same graph. Two system capacity curves shall be plotted using the Hazen Williams coefficient values of $C = 100$ and $C = 140$.

- Pump output in gpm at maximum and minimum head shall be clearly shown on the system curve for each pump and combination of pumps.
- For stations with two (2) or more pumps operating in parallel, multiple and single operation points shall be plotted on the system curve.
- Pumps with the highest efficiencies at all operating points shall be used.
- If pumps are equipped with smaller

impellers during start up to handle lower than design flows, impellers sized to handle the design flow shall also be provided.

333.14.9 Buoyancy Calculations

The lift station design shall include a complete analysis of buoyant forces on the entire lift station structure.

333.14.10 Water Hammer

Design Engineer shall calculate water hammer showing maximum pressures, which would occur upon total power failure while pumping.

333.14.11 Suction Specific Speed.

Suction specific speed should be below 9,000 rpm to ensure that the pump will not cavitate because of internal recirculation.

333.14.12 Stiffness Ration

In order to ensure that the pump shaft does not bend an excessive amount, the engineer shall calculate the stiffness ratio of the shaft. The stiffness ratio shall not exceed 60.

333.15 Abandonment of Sanitary Sewer Mains and Appurtenances

Sanitary sewer mains shall be removed from the ground whenever possible, when not possible, the line will be abandoned in place by filling the main with class B concrete.

333.15.1 Manhole, Cleanout and Sanitary sewer Access Device:

- Manhole, cleanout and sanitary sewer access devices shall be abandoned by filling with sand and/or gravel compacted to 90% (95% in pavement) of maximum standard proctor dry density.
- The bottom of manhole, cleanout and sanitary sewer access device shall be filled with class B concrete up to the top of sanitary sewer pipe(s).

333.16 Corrosion Control

For corrosion control of Sanitary Systems, refer to section 332.10 of this manual. In addition to the soil reactivity for corrosion control, consideration shall be given to

corrosion control for exposures to the gases produced by the sanitary sewer system.

333.17 Pre and Post CCVT

- Prior to testing, all new sanitary sewer lines must be inspected with a video system and a copy of the tape submitted to DFW for approval.
- Modifications to existing lines or replacement of existing mains shall be inspected both pre construction, and post construction.

333.18 Testing Procedures

All installed SSS pipe must be tested in accordance with the provisions of 30TAC §217.57.

333.19 Manholes

All manholes shall meet the minimum requirements as set in 30 TAC §217.55, with the following additional requirements.

Manholes shall be located and spaced so as to facilitate inspection and maintenance of the sanitary sewer main. All manholes must be accessible to maintenance equipment, including 2½ ton straight trucks, dump trucks, vacuum trucks, and standard (not compact) sizes of backhoes and loaders. In isolated cases, construction of all-weather access roads may be necessary for manhole and/or Sanitary sewer line access. Manholes shall be placed at the following locations

- Intersections of mains.
- Horizontal alignment changes.
- Vertical grade changes.
- Change of pipe size.
- Change of pipe material.
- The point of discharge of a force main into a gravity sanitary sewer main.
- For commercial developments containing more than 4,000 square feet of air-conditioned space and requiring a water meter greater than two (2) inches, a manhole is required on the main at the point of connection to the Sanitary sewer service.
- At the upstream end of mains.

Manholes shall be constructed of a corrosion

resistant material. Where new construction ties into an existing manhole, the existing manholes must be lined, coated, or replaced with a corrosion resistant material. The Design Engineer shall provide Manhole Inspection report for sanitary sewer Manhole replacement or rehabilitation for both CIP and non-CIP projects to DFW Utility Group. Where concrete is utilized all concrete shall be polymer concrete.

Manholes constructed on existing sanitary sewer mains may have a cast-in-place base. All other manholes shall have a pre-cast base.

Manhole and junction box inverts shall have a minimum slope of 2.5% between the inlet and outlet pipe inverts.

333.19.1 Manhole Spacing

All manhole spacing must meet the minimum requirements as set in 30 TAC §217.55, with the following additional requirements.

Manholes may be spaced no further apart than the distance specified in the following table:

Table 333.19.1: Manhole Spacing Criteria

Pipe Diameter (in)	Max. Manhole Spacing (ft)
8- 15	500
18 & Larger	800

The maximum allowable manhole spacing for collection systems with horizontal curvature is 300 feet. A manhole must be at point of curvature (PC) and the point of termination of a curve (TC).

333.19.2 Manhole Frames and Covers

All manhole frames and covers must meet the minimum requirements as set in 30 TAC §217.55, with the following additional requirements.

- For all manholes located within the AOA, all FAA requirements must be met.

- All sanitary system manhole covers must be clearly marked with “Sanitary Sewer” visible on the cover.

All manholes must include a concrete pad around the frame and cover with an ID number clearly marked on the upstream side of the manhole pad. The Design Engineer shall co-ordinate with DFW Utilities for Manhole ID number. Design engineer shall provide the detail for manhole ID.

333.19.3 Manhole Sizes

All manholes shall be sized to meet the minimum requirements as set in 30 TAC §217.55, except that deep manholes shall be required to be a minimum of 60” in diameter when over 15’ deep, and a minimum of 72” in diameter when the depth is over 25 ft. deep.

Design Engineer shall check following scenario prior to sizing the manhole:

In the event a structure is utilized inside a manhole, the clear space between the structure and the manhole wall shall be a minimum of 48”.

If more than two mains connect to a manhole, or if two mains connect to a manhole at an angle other than 180 degrees from each other, a larger diameter manhole may be required in order to accommodate mandrel insertion and hydraulically efficient flow.

New pipe connections to existing manholes shall provide a minimum of 12” clearance between the existing pipe ID and the new core hole ID measured on the inside surface of the manhole, regardless of the orientation of the pipes with respect to one another. New precast manholes and manholes with cast-in-place bases shall have holes for pipe penetrations in the manhole wall separated by a minimum of seven (7) inches, designed by the manhole manufacturer and as measured from the inside diameter of the cored holes on the inside wall of the manhole to ensure the structural integrity of the manhole wall. A Junction structure should be used where a standard 8’ diameter pre-cast manhole is not adequate

The vertical distance between the highest point of the invert shelf and the bottom of any horizontal or near-horizontal surface protruding into a manhole or junction box, shall be at least six (6) feet, when the depth of the main is sufficient.

333.19.4 Drop Manholes

This can be used where the incoming pipe(s) is 2' or higher than the outgoing pipe:

- Manhole with 2 to 10 ft. Drop: External (preferred) or internal drop connection shall be used
- Manhole with > 10 ft. Drop: Shall be evaluated on case-by case basis.

333.19.5 Meter Manholes

In all manholes used for metering purposes, all metering devices, electrical equipment, and or electrical wiring shall be “intrinsically safe” to prevent any electrical spark in the presence of potential sewer gas.

333.19.6 Concrete Pad

When manholes are to be located within a public street, concrete manhole pads shall be used around the manhole frame.

MH Size (in)	Collar Size (ft)	Collar thickness (in)
48	6x6	10
60	8x8	12
>60	Engineering Evaluation	Engineering Evaluation

333.20 Sanitary Sewer Junction Structure

A sanitary sewer junction structure is generally required where two or more sanitary sewer pipelines cannot be connected at a manhole due to inadequate separation distance between the outer diameters of the mains. The following items, but not limited to, must be considered for designing a sanitary sewer Junction structure:

333.20.1 General

- Junction structures are used typically

where a standard 8' diameter pre-cast manhole is not adequate.

- The separation distance between pipes must be at a minimum of 1 foot inside junction structure.
- All pipes entering a junction structure must be at right angle at the junction wall.

333.20.2 Structural Consideration

- Roofs of junction structures must be structurally designed for AASHTO loading standard M-306. Except in AOA areas, where FAA requirements shall be used.
- Non-shrink grout shall be used between the junction structure and sanitary sewer mains along structure wall.

333.20.3 Corrosion Protection

- Corrosion protection provisions shall be considered for all junction structures
- All moving components of structure must be Stainless Steel 316 unless otherwise approved by DFW.

333.20.4 Manhole and Junction boxes located below ground water

- When the interior surface of a concrete manhole or junction box is coated with a urethane, polyurethane, or epoxy liner, the exterior surface of that portion of a manhole or junction box located below ground water level shall be water proofed using a flexible system applied to the exterior surface. The drawings shall indicate which structures must be water proofed and the elevation to which water proofing must be applied (two (2) feet above ground water level).
- Manhole joints below the ground water level and/or located in the 100-year floodplain shall be sealed by installing a joint wrap material over the joint on the manhole exterior.
- Construction joints in cast-in-place junction boxes shall be water proofed using water stops.

333.21 Sanitary sewer Access Devices and Cleanouts

Manholes shall be used at all sanitary sewer access points, Cleanout will not be allowed.

333.22 All-Weather Access Road for Manhole, Junction Structure, and Lift Station.

- All-weather access roads should be at least 14 feet wide. It is intended for emergency use by maintenance equipment. This 14 foot maintenance access road should be outside the toe of any fill slope and the top of any cut slope and shall not have a post construction longitudinal slope greater than 15% nor a post construction transverse slope greater than 5%, shall not have a vertical grade break of greater than 12%, should have an inside turning radius of no less than 35 feet, an outside turning radius of no less than 50 feet, shall be cleared of all vegetation and graded, and should maintain a horizontal and vertical clearance from existing and proposed vegetation and all other objects of no less than 20 feet.
- The access road shall include a means for equipment to turn around when located more than 200 feet from a paved public roadway. Turn around shall meet the above listed design criteria. Access roads for manhole and junction structure shall be cleared, graded and stabilized with stones.
- The Access roadway for lift station shall have a concrete or asphalt concrete pavement as the roadway's surface. Base material and sub-base material as recommended by Geotechnical Report for the site specific soil and load condition. Roadway shall include a means for equipment to turn around.

333.23 Sanitary Sewer Approved Products List

Mainline- Pipeline (Material)	Manufacturer	Pipe Standard	Joint Specification	Gasket Specification	Notes	Reference Specification (NCTCOG)	National Specification
PVC-Pressure Rated 8"-15"	JM Eagle or Diamond Plastics	AWWA C-900	BELL AND SPIGOT-ASTM D3139	ASTM F477	PS= 165 psi	501.15	AWWA C 900
PVC-Pressure Rated 18"-48"	JM Eagle or Diamond Plastics	AWWA C-900 (SDR 21)	BELL AND SPIGOT-ASTM D3139	ASTM F477	PS=200 psi	501.15	AWWA C 900
PVC-Pressure Rated 18"-48"	JM Eagle or Diamond Plastics	AWWA C-900 (SDR 18)	BELL AND SPIGOT-ASTM D3139	ASTM F477	PS= 235 psi	501.15	AWWA C 900
HDPE-Pressure Rated	Performance Pipe	ASTM F 714 (DR 11)	FUSION ASTM F2620	ASTM F2620	Specify DIPS Only with Min. PS= 200 psi		ASTM F 714
RTRP-Pressure Rated	Hobas or Ameron	ASTM D3754	BELL AND SPIGOT-ASTM 4161	ASTM F477	Min. SN=150 psi	501.24	ASTM D3262
RTRP-Pressure Rated	Hobas or Ameron	ASTM D3754	BELL AND SPIGOT-ASTM 4161	ASTM F477	Min. SN=150 psi	501.24	ASTM D3262

NOTE: DESIGN PLANS DESIGNATE ONLY ACCEPTABLE MATERIALS FOR PROJECT

Pipe/Manhole Corrosion Protection	Manufacturer	Standard/Model		Notes	Reference Specification (NCTCOG)	National Specification
Protective Liner-Epoxy	Raven Lining Systems	Raven 405		Existing MHs Only	502.9	
Precast Concrete Additive	Conshield Technologies	E.P.A. registration number 75174-2-47000		For use on 4.0' Pre-cast MH only	502.9	
Precast Concrete Additive	BASF Corp	MasterLife AMA 100		For use on 4.0' Pre-cast MH only	502.9	
Protective Liner-Polyurethane	SprayRoq Lining Systems	ASTM D639/D790		N/A	502.9	ASTM D639/D790
Protective Liner-Polyvinyl Chloride	Ameron International	T-Lock		For diameters of 30" and above. All PVC liners must be white or close to white in color.	502.9	

Manholes	Manufacturer	Standard		Notes	Reference Specification (NCTCOG)	National Specification
Precast	Thompson Pipe Group				502.1	ASTM C478
Precast	Turner				502.1	ASTM C478
Fiberglass	LF Manufacturing			Non traffic areas only	502.1	ASTM 3753
Precast Steel Reinforced Polymer Concrete Structure	U.S. Composite Pipe			Use only when recommended by Engineer	502.1	ASTM D 6783 and ASTM C 478
ALL NEW MANHOLES SHALL HAVE CORROSION PROTECTION						
Manhole Lid/Cover/Frame	Manufacturer	Standard/Model		Notes	Reference Specification (NCTCOG)	National Specification
Standard 32"	Bass and Hays	V1420DRING, V1480LID			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 40"	Bass and Hays	122540RING, 122540LID			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 32"	Bass and Hays	V1420DW T			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 40"	Bass and Hays	122540W T			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 32"	Accucast	211007			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 32"	Accucast	211009			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating

Pressure 32"	Accucast	210024			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 32"	Accucast	211023			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 32"	East Jordan Iron Works	V1420/1480Z(Frame) 1480A(Cover)			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 40"	East Jordan Iron Works	BH 1225 40(Frame & Cover)			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 32"	East Jordan Iron Works	V1420/1480ZPT (Frame), 1480APT (Cover)			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 40"	East Jordan Iron Works	BH 1225 40PT(Frame & Cover)			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Standard 32"	Star Pipe	MH32DW W CL35			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Pressure 32"	Star Pipe	MH32DW TCL35			806.4	ASTM A48 Class 35B, Cast Iron Only Must have Bituminous Coating
Cleanouts	Manufactruer	Standard/Model		Notes	Reference Specification (NCTCOG)	National Specification
Cleanout Lid	Bass and Hays, Star	339LID			502.2/806.4	
Other	Manufacturer	Standard/Model		Notes	Reference Specification (NCTCOG)	National Specification

Drop Bowl	Reliner/Duran, Inc	Inside Drop Bowl				
Manhole to Pipe Connectors	A-LOK	A-lok Series				ASTM C923
Manhole to Pipe Connectors	NPC Kor-N-Seal	106/406 series		Precast Manholes Only		ASTM C923
PVC Adapter Coupling	JM Eagle or Diamond Plastics	NA		For PVC Pipe		
Manhole Insert	Doug Meadows	No Flow-Inflow Manhole				ASTM D 1248
NOTES						
UNLESS OTHERWISE IDENTIFIED BY SPECIFICATION OR STANDARD, NCTCOG STANDARDS APPLY TO INSTALLATION						
FOR STANDARD DRAWING AND/OR SPECIFICATIONS NOT LISTED OR LISTED AS NA, REFER TO MANUFACTURER'S SPECIFICATIONS						
ALL ITEMS NOT ON THIS LIST NEED APPROVAL BY OWNER BEFORE PLACEMENT INTO SYSTEM						
<ul style="list-style-type: none"> • Engineer of record shall conform the applicability of these approved products in AOA and CTA area. This standard product list has been developed only for projects located outside the AOA and CTA area. When technical specification for specific products, are included as part of the construction contract documents, the requirements of the Technical specifications will override these approved product list. It is engineer of record (EOR)'s responsibility to approve the product submittal. DFW utility group recommend EOR to coordinate with DFW Utility group prior to approval. 						

SECTION 334
STORMWATER DRAINAGE UTILITIES

334.1 Design Criteria

The following documents shall be used as a guidance for stormwater drainage design:

- AC 150/5320-5D Airport Drainage Design (most recent version)
- AC 150/5200-33B Hazardous Wildlife Attractants On or Near Airports (most recent version)
- ACRP Research Report 174 Green Stormwater Infrastructure (most recent version)
- NCTCOG Integrated Stormwater Management (iSWM) Criteria Manual (most recent version) and associated Technical Manuals

Any conflict between these referenced documents and the criteria shall be brought to the attention of DFW for resolution.

334.2 Drainage Design and Report

A drainage study is required of all projects which involve the change in runoff coefficient for an area greater than one acre and shall include a Preliminary iSWM Plan, completed in accordance with the iSWM Criteria Manual Section 2.2, for review and approval by DFW. All drainage designs shall be contained in a Drainage Study which shall be submitted to DFW for review and approval. The Drainage Study shall be in such form as to provide the basis for timely and consistent review and will be made a part of the permanent record for future drainage evaluations. The Drainage Study shall, at a minimum, contain the following:

- Description and plan of existing drainage facilities.
- Description and plan of proposed drainage facilities with iSWM Criteria

Manual Section 3.6.1 compliance.

- Drainage area map.
- Description of the analysis conducted for meeting the following four storm event criteria per iSWM:
 - Storm Water Quality
 - Streambank Protection
 - Conveyance
 - Flood Mitigation -The analysis shall also include addressing the following questions as outlined in iSWM for acceptable downstream conditions to determine the requirements of any non- structural or structural controls:
 - Are the post-development discharges greater than the pre- development discharges?
 - Are the post-development velocities greater than the pre- development discharges?
 - Are the post-development velocities greater than the velocities allowed for the receiving system?
 - Does the development in the floodplain increase the base flood elevation more than 0.1 foot for the 100-year design storm event?
- A drainage design that includes a sufficient hydrologic analysis to determine the existing and proposed drainage conditions such that the post development drainage design meets existing conditions in regard to the four iSWM storm event criteria listed above.
- All calculations associated with the determination of runoff coefficients, volume of runoff, time of concentration, inlet size, culvert or pipe size and elevation of hydraulic gradient and any other items pertinent to the drainage design.

- Stormwater drainage analysis for the 1-, 10-, 25-, and 100-year design storms.
- Consideration of drainage alternatives and recommended facilities.
- Description of measures taken for velocity dissipation to ensure non-erosive velocities at points of discharge, thereby, complying with iSWM Criteria Manual Section 3.3 – Acceptable Downstream Conditions and iSWM Technical Manual: Hydrology Section 2.4 – Methods for Downstream Evaluation.
- Flood mitigation designs shall meet the iSWM Criteria Manual Section 3.5.2 – Flood Mitigation Design Options, Option 3 with detention, storage or staging to meet pre-development conditions.
- Floodplains or 100-Year inundation zones shall have a 25-foot buffer, which shall not be encroached by any structure. The buffer shall not be landscaped but instead left in its natural state.
- All pre- and post-development calculations associated with the drainage design to include, in tabular form, in the final design plans.
- A drainage area map with no smaller than a 1 inch equals 200 feet scale, and show all streets, building pads and other existing and proposed features. The drainage area map shall show the boundary of the drainage area contributing runoff into the proposed system. The area shall be further divided into numbered sub-areas to determine flow concentration points or inlet location(s). Drainage area maps shall show streets, land-use and land-use boundaries, existing ground elevations on 1-foot contours, and a summary table of peak design flows for sub-areas with acreage, runoff coefficient, and inlet time shown.
- The quantity and direction of design flow within streets, alleys, natural and manmade drainage ways and at all system intersections clearly shown on the drainage area map. Existing and proposed drainage inlets, storm drainage systems and drainage channels shall be clearly shown and differentiated on the drainage area map.
- All data used to create the drainage area maps should be submitted including but not limited to existing and proposed changes in contours, proposed impervious surfaces such as buildings, parking, roadways, or other paved surfaces, stormwater and first-flush stormwater pipes, channels, inlets, manholes, outfalls.
- The Drainage Study and drainage design drawings shall be sealed and signed by a Licensed Professional Engineer in the State of Texas, which will be reviewed by DFW for compliance with the requirements of these criteria. A Determination on the drainage design will be issued by DFW.

334.3 Determination of Design Discharge
 In order to properly determine the design storm runoff for a given installation, consideration must be given to the design storm rainfall, the runoff coefficient as affected by the surface condition and by the geometry of the watershed, plus the influence of the time of concentration. The runoff coefficients and minimum inlet times (time of concentration) to be used in determining runoff shall be documented for review and approval by DFW. Adjustments to the runoff coefficients may be required to account for future build-out conditions. Hydrologic methods to be utilized for drainage analysis shall be selected based on

iSWM Criteria Manual, Table 3.2 – entitled “Constraints on Using Recommended Hydrologic Methods” and iSWM Technical Manual - Hydrology, Table 1.1 entitled “Applications of the Recommended Hydrologic Methods”.

334.4 Design of Closed Storm Drainage System

In the preparation of hydraulic designs, a thorough investigation shall be made of all existing structures and their performance on the waterway in question. The design frequency for all new closed drainage systems shall be in accordance with the iSWM Criteria Manual Section 3.6.2 – Hydraulic Design Criteria for Streets and Closed Conduits, except as noted below. The total capacity of the drainage facility, including surface flow within limits of available right-of-way or easements, shall be equal to or greater than the runoff of a storm of 100-year design frequency. Shall the 100-year storm runoff exceed the capacity of the above design, then the closed storm system shall be designed based on a minimum 25-year frequency, or larger, to develop a 100-year emergency overflow system. The hydraulic gradient shall be calculated for all storm drain lines, culverts and inlets and shall not be designed above the entrance flowline of any inlet. The permissible difference between the hydraulic gradient and top-of-curb shall not be less than 2 feet.

Storm drains shall be designed to have a minimum mean velocity of 2.5 fps flowing full. Velocities equal to or greater than 10 feet per second shall not be acceptable.

334.5 Design of Open Channels
For each individual project, the iSWM Criteria Manual Section 3.6.3 – Hydraulic Dallas Fort Worth Airport
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Design Criteria for Structures/Open Channels shall be adhered to except as noted below. Backwater analysis is to be developed for major channels to establish water surface elevation and to avoid adverse impacts on adjacent properties. All new channels shall be designed using the design storm events and methods outlined in iSWM or as approved by DFW. Channels shall not be concrete lined, therefore, other means acceptable to DFW to manage velocities over 4 feet per second must be considered. A 2-foot freeboard will be incorporated into the design calculations. Velocities in excess of 4 fps will not be allowed to enter an unlined channel without energy dissipation measures to reduce flows below 4 fps.

To provide positive drainage, a slope of not less than 2 percent for turf areas is desirable. Slopes shall be designed to ensure non-erosive runoff velocities. Turf banks, where required, shall be graded to permit the use of gang mowers, providing a maximum slope of 4 horizontal to 1 vertical. The tops and bottoms of all slopes shall be gently rounded in a transition curve for optimum appearance and ease of maintenance.

Unlined channels shall use a temporary mat of jute, straw or curled wood in order to reduce erosion and sediment during the vegetation establishment phase unless sod is used to facilitate vegetation growth.

Channel rehabilitation shall incorporate restoration measures that include low and high flow sections that mimic natural channel dimensions.

334.6 Design of Culverts
Drainage culverts shall pass storm flow from the upstream side of highway, road or

railroad to the downstream side without causing excessive backwater head and without creating excessive downstream velocities. The Designer shall keep the discharge velocities within safe limits (usually 4 fps) while selecting the most economical structure that will provide satisfactory service. Methods outlined by iSWM shall be used with the 100-year design frequency.

334.7 Flow in Gutters

The permissible spread of water into the street or thoroughfare shall in all cases govern the hydraulic capacity of a given street. On multiple lane roadways, the permissible spread of water will not close more than one travel lane in each direction. For two-lane roadways, the water shall be limited to one-half of each lane width.

334.8 Design of Storm Drain Inlets

Various charts are available in the Drainage Manual that shall be used to determine the capacity and efficiency of the particular type of inlet chosen. When designing inlets, freedom from clogging or from interference with traffic shall take precedence over hydraulic considerations. Precast units may be used for load bearing applications only with the approval of DFW.

334.9 Design and Placement of Manholes and Inlets

Manholes or combination manholes and inlets shall be placed wherever necessary for clean-out and inspection purposes. Place manholes at changes in direction, junctions of pipe run, and at intervals of 300 to 500 feet in long pipe runs where the size or direction is not changed as well as follow iSWM guidelines. The invert of the manhole section shall be rounded to match the inverts of the pipes entering the

manhole in order to reduce eddying and resultant head losses. For manholes that are larger than the incoming or outgoing pipes, expansion losses can sometimes be significant. The use of heavy duty or aircraft rated manholes and covers may be required in some cases depending on location and shall be coordinated with DFW.

334.10 Drainage of Unpaved Areas Adjacent to Buildings

Unpaved areas adjacent to buildings shall be sloped to direct surface water and roof drainage away from buildings at a minimum slope of 5 percent in the first 10 feet of horizontal distance. Unpaved areas shall be permanently stabilized with vegetative cover to prevent erosion and soil loss. Surfaces paved with concrete or bituminous pavement shall have a slope of not less than 0.5 percent in the direction of drainage, to prevent ponding.

334.11 Drainage of Unpaved Areas not Occupied by Buildings

Portions of the site not occupied by buildings or pavement shall have adequate continuous slopes to drain toward watercourses, drainage swales, roadways, and storm drainage inlets. Drainage swales or channels shall be sized and sloped to accommodate the design runoff. Sheet flow across sidewalks is allowable. The concentrated runoff shall be carried under walkways in pipes or by suitable sidewalk drains. Swales shall be used to intercept water at the top and bottom of banks where large areas are drained. To provide positive drainage, a slope of not less than 2 percent for turf areas is desirable. Slopes shall be designed to ensure non-erosive runoff velocities. Turf banks, where required, shall be graded to permit the use of gang mowers, providing a maximum slope of 4 horizontal to 1 vertical. The tops and bottoms of all slopes shall be

gently rounded in a transition curve for optimum appearance and ease of maintenance.

334.12 Runoff Reduction

The use of parking pavers and porous pavement/asphalt is encouraged to reduce stormwater runoff volumes in vehicle parking and waiting areas.

334.13 Design of Detention Structures

Open surface detention structures shall comply with iSWM Criteria Manual Section 3.6.3 – Hydraulic Design Criteria for Structures/Detention Structures. However, detention structures shall include water quality measures such as an infiltration trench or filter strip as referred to in Section 334.14 – GI/LID Strategies, which captures a First Flush Stormwater Quality Volume (WQv) with the first 0.25 inch of rainfall.

Underground detention structures will be designed to capture and store the WQv, for release after 24 hours after the storm event, to the First Flush Stormwater System (FFSW) described in Section 334.16. Stormwater capture beyond the WQV will discharge into a Stormwater System. If the underground detention structure cannot discharge into the FFSW, the structure must incorporate filtration media to filter the WQv prior to discharge into the Stormwater System. Detention structures shall also be designed to meet the Streambank Protection Volume (SPv) criteria set forth in iSWM Section 3.4 Option 3.

334.14 GI/LID Strategies

Green Infrastructure or Low Impact Development (GI/LID) strategies is a selection of stormwater drainage management approaches and technologies that utilize and/or mimic the Dallas Fort Worth Airport

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natural hydrologic cycle methods of infiltration, evapotranspiration and reuse. Every development shall use GI/LID strategies as an aid to meet pre-development conditions for the 1-Year storm event as well as treat the FFSW WQv. A few applicable GI/LID strategies are

- Infiltration trench
- Rain garden
- Bioswale
- Permeable pavement
- Filter Strip
- Rainwater harvesting

ACRP report on “Green Storm water Infrastructure Strategies for Airports” and EPA’s Manual: “Technical Guidance on Implementing the Storm water Runoff Requirement for Federal Projects under Section 438” can be used as a references for designing GI/LID strategies for storm-water drainage management.

Roadway developments or expansions shall incorporate GI/LID strategies in compliance with iSWM Criteria Manual Appendix A.

334.15 Storm Utility Drainage Piping

334.15.1 Pipe Material (latest edition)

- Reinforced Concrete Pipe: ASTM C 76
- Reinforced Concrete D-Load Pipe: ASTM C 655
- Reinforced Concrete Arch Pipe: ASTM C 506
- Reinforced Concrete Elliptical Pipe: ASTM C 507
- Glass Fiber Reinforced Thermosetting Resin Pipe: ASTM D3262
- Precast Reinforced Concrete Box Sections: ASTM C 789 and C 850
- PVC Pipe minimum pressure rating DR 21: ASTM D 1784, 3139, 3212 & F477, UL 157; solvent weld joints ASTM D2855-90, 2564-90 and/or 2235-90

[Type here]

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- Corrugated Polyethylene Drainage Tubing: AASHTO M 252
- Corrugated Polyethylene Pipe 12 to 24 Inches in Diameter: AASHTO M 294
- Polyethylene Pipe Large Diameter: ASTM F894

334.15.2 Pipe Bedding

334.15.2.1 Rigid Pipe. Bedding for rigid pipe shall conform to one of the following classes:

- Class A: Continuous concrete cradle.
- Class B: Bed of granular materials having a thickness of at least 6 inches below the bottom of the pipe and extending up around the pipe for a depth of not less than 30 percent of the pipe's vertical outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10 percent of the pipe's vertical diameter and shall have recesses shaped to receive the bell of bell-and-spigot pipe. The bedding material shall be sand or selected sandy soil conforming to the following:

Sieve	% Passing
2 inch	100
1 inch	90-100
½ inch	50-80
No. 4	30-60
No. 100	0-5

- Class C: Class C bedding shall consist of bedding the pipe in its natural foundation to a depth of not less than 10 percent of the pipe's vertical outside diameter. The bed shall be shaped to fit the pipe and shall have recesses shaped to receive the bell of bell-and-spigot pipe.

334.15.2.2 Flexible Pipe. Pipe bedding for flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Pipe Corrugation Depth	Minimum Bedding Depth
½ inch	100
1 inch	90-100
2 inches	50-80
2 ½ inches	30-60

334.15.2.3 PVC and Polyethylene Pipe. PVC connections to RCP pipe must be installed with Inserta Tee fittings.

For PVC and polyethylene pipe, the bedding material shall consist of coarse sands with a maximum particle size of ¾-inch.

For pipe installed under paved areas, no more than 12 percent of the material shall pass the No. 200 sieve.

For all other areas, no more than 50 percent of the material shall pass the No. 200 sieve.

The bedding shall have a thickness of at least 6 inches below the bottom of the pipe and extend up around the pipe for a depth of not less than 12 inches.

334.15.3 Pipe Joints

334.15.3.1 Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C 43. Rubber gaskets for PVC shall conform to the requirements of ASTM F 477.

334.15.3.2 Plastic Gaskets. Plastic gaskets shall conform to the requirements of AASHTO M 198 (Type B).

334.15.3.3 Mortar. Pipe joint mortar shall

consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

334.15.3.4 Poured Filler. Poured filler for joints shall conform to the requirements of ASTM D 1190.

334.15.3.5 Oakum. Oakum for joints in bell and spigot pipe shall be made from hemp (Cannabis Sativa) line, or Benares Sunn fiber, or from a combination of these fibers. The oakum shall be thoroughly corded and finished.

334.15.3.6 Formed Concrete Collars. All formed collars will have a minimum 6"x12L around connection with #3 rebar.

334.15.4 Pipe Deflection. Longitudinal deflection at each pipe joint shall not exceed one degree in any direction

334.15.5 All storm sewer pipes shall be inspected with a video system after installation is complete.

334.16 First Flush Stormwater System The First Flush Stormwater System (FFSW), formerly referred to as the Pretreatment Waste System or Industrial Waste System, shall be used only for the handling of stormwater. The design shall take into consideration the usage charges associated with all discharges to the FFSW and construction of conveyances which only transport authorized discharges. Authorized discharges are defined as storm water discharges, allowable non-storm water discharges, and other individually permitted non-storm water discharges. Individually permitted non-storm water discharges will be determined by Environmental Affairs on a case- by-case

basis, whereby pre-approval from specified regulatory bodies may be required.

Process water discharges to the FFSW are explicitly forbidden. Process water is defined in the Clean Water Act, and includes, but is not limited to, apron and ramp wash-down, fuel spills, sanitary sewage, deicing pad runoff, and aircraft and vehicle wash water.

The FFSW may handle discharges that contain excessive pollutant concentrations that would otherwise be directed to the main Stormwater System. Typically, the system is used to transport first flush storm runoff that contains elevated levels of pollutants. The FFSW has occasionally handled non- permissible discharges (e.g., emergency overflow relief line for deicing storage tanks), such uses shall only be allowed by written authorization of the EAD Vice President.

Prior to any connection to the FFSW, an engineering analysis shall verify that there is available incremental capacity in the system to handle the proposed discharges for all nonemergency discharge conditions. The anticipated characteristics of the discharge shall be compliant with the Pretreatment Rule contained in the Airport's Code of Rules and Regulations.

Lift Stations shall be located with due consideration for screening, maintenance access and emergency access.

334.16.1 Design Criteria

334.16.1.1 Pipe. FFSW pipe shall meet the requirements of AWWA C900 PVC, C905 PVC or designed and manufactured in accordance with the applicable provisions of ASTM D 2680 and D 3212. The pipe will be joined using Elastomeric gasketed joints meeting ASTM D 3212 or solvent weld

joints meeting ASTM D 2855-90, ASTM D 2564-90 and/or ASTM D2235- 90 or latest edition. The AWWA C900, C905 or P303 RCCP is required for all pressurized applications. All pressurized pipe shall be installed within casings under roadways, taxiways and runways. Casing pipe shall be installed with RACI-spacers or equivalent on 4-foot centers. Steel casing pipe can be used with proper cathodic protection.

Corrugated steel pipe shall not be used as casing pipe.

334.16.1.2 Manholes and Covers. Manholes shall be cast-in-place reinforced concrete without embedded steps. Manholes shall be installed at every 300 feet, at connections to mains and at 45 degree and 90 degree changes in runs. Ring and cover shall be cast iron, 24-inch diameter and adjusted to finish grade or existing ground elevation, as appropriate. Covers shall have "First Flush System" imprinted on them. Joints shall be sealed to prevent infiltration and exfiltration. Existing FFSW system manhole covers may be stamped "Industrial Waste",

"Industrial Waste System", "PTWS" or "Waste System." Old covers shall be replaced as encountered with new covers stamped as indicated above.

334.16.1.3 Pumps. FFSW Lift Stations shall include a minimum of two submersible electrically operated sewage pumps with low level shutoff, high level alarm and intermediate level sensors required for pump cycling. Pumps shall be manufactured to safely pump wastewater.

334.16.1.4 Wet Pits. Wet-pits shall be concrete, cast-in-place with access for inspection and pump maintenance.

334.16.1.5 Testing. All FFSW pipe installed will be tested so that the completed pipe system will have a zero exfiltration loss per 2 hours, where the hydrostatic head at the design hydraulic grade line is not less than 4 feet of test stack with the height of the test stack matching the highest level of the FFSW. A pneumatic test may be substituted for the hydrostatic test to substantiate exfiltration criteria. Maintain 3 PSIG for 5 minutes with zero PSIG drop.

SECTION 338 RECLAIMED WATER SYSTEM

338.1 DFW Airport Reclaimed Water System

DFW has decided to use highly treated effluent or reclaimed water to augment other sources of water to meet current and future water demands. A reclaimed water system is currently in use by DFW throughout the airport where reclaimed facilities are available.

- Reclaimed water main shall be designed in conformance with “30 TAC §210: Use of Reclaimed Water”, “30 TAC §217.70: Reclaimed Water Facilities”, and with all applicable laws, regulations, codes and standards. Before the Permit is issued the Engineer of Record (EOR) shall submit the letter stating that the plans are designed per TCEQ Chapter 210 and Chapter 344.
- Engineer will need to submit a cross connection control plan for the contractor to follow to assure no connections between Potable and Reclaim water. This will need to be sent to DFW Utility Inspector to upload into impact.
- Before the Certificate of Occupancy is approved, the Landscape Contractor will need to submit letter stating that the irrigation was placed and operates per design documents. EOR will need to visually observe the system functioning and submit a letter stating that the system was placed and operates per design documents. This will need to be sent to DFW Utility Inspector to upload into impact.

338.2 Reclaimed Water Main Sizing

The reclaimed water mains must be sized based on engineering analysis of initial and future demand of the reclaimed water user(s). The designer shall meet or exceed the following minimum criteria for sizing reclaimed water mains:

- Velocity: The velocity of a reclaimed water main shall be maintained between 2 and 10 feet per second.

- Service: The size of the services must be at least one standard size smaller than the proposed and existing raw water main.

338.2.1 Pressurized Main:

Reclaimed water pressure mains shall be designed in accordance with 30 TAC §210.25.

338.3 Depth of Cover

The depth of cover shall be the same for water mains as covered in Section 332.3 of this manual.

338.4 Location

Location of all new reclaimed water mains shall be in accordance with section 332.4 of this manual.

338.5 Horizontal Alignment

Horizontal alignment of reclaimed water mains shall be conducted in accordance with Section 332.5 of this manual relating to horizontal alignment of water main.

338.6 Vertical Alignment

Vertical alignment of reclaimed water mains shall be conducted in accordance with Section 332.6 of this manual relating to vertical alignment of water mains.

338.7 Reclaimed Water Pipe Material and Embedment

Designers are responsible for specifying the type of pipe to be used in any design. Typically all reclaimed water pipes shall be pressure rated with a minimum working pressure rating the same as if the main was being used for potable water. Refer to section 332.7.1 for requirements. Although PVC is the preferred material for smaller mains, there are some restrictions on its use. PVC may not be used within the following areas or circumstances:

- Elevated crossings or situation where pipe will be permanently exposed

- Encased pipes where the method of anchoring is by means of hold-down jacks

When a metal pipe including concrete cylinder, or steel is specified, the pipe must be protected from corrosion. In addition, all reclaimed water mains must be designated with a purple coloration. They may be fabricated from purple base materials, painted purple, or encased in a purple polyethylene sleeve. In addition to the purple color or purple sleeve all pipe materials shall have the words “Non-Potable” painted on them in 2” high letters every two feet.

338.7.1 Fittings:

All PVC pipe shall use ductile iron fittings with a minimum working pressure rating of 250 psi. Compact fittings are not allowed. All 90 degree bends shall be avoided in the system, if possible.

338.7.2 Embedment Requirements:

Designers shall specify class of embedment on design drawings, and shall be in compliance with an engineering analysis of the pipe location and geological conditions.

The following table summarizes recommended pipe material for different reclaimed water mains:

Table 338.7.2 Pipe Material and Joints

Pipe & Material Specification	Allowable Size (in)	Joint Specification
Purple PVC AWWA C900 (DR-14)	8 – 16	Bell & Spigot Joints: Certa-Lok C900/R (TM) J

Pipe & Material Specification	Allowable Size (in)	Joint Specification
RCCP w/Purple Tape Coating**	24 – 42	Welded Joints

338.8 Separation Distance between Reclaimed Water and Water/Waste Water Mains

- When a reclaimed water main is built near an existing water/wastewater facility, conveyance, or appurtenance, 30TAC §210.25 as enforced by TCEQ, governs the minimum separation distances:

338.9 Connection to Existing Reclaimed Water Mains

Typically service lines from individual properties are not allowed to be connected to a reclaimed water main unless otherwise approved by DFW. The following type of connections however are permitted:

- 338.9.1** Tapping Sleeve and Valve
- 338.9.2** Cut in Connection
- 338.9.3** Standard Connection
- 338.9.4** Four Way Connection

All connections shall comply with the same requirements as per section 332.9 of this manual, except that all connections shall include fittings and pipe that comply with reclaimed water criteria, i.e. purple in color.

338.10 Corrosion Control

This section shall be governed by section 332.10 contained in this manual.

338.11 Cross Connections:

No physical connection shall be made between a reclaimed water line and potable

water or wastewater line. All appurtenance shall be designed and constructed so as to prevent any possibility of cross contamination. The engineer of record shall submit a cross connection testing plan with all reclaimed water system design documents.

338.12 Testing Procedures

- All reclaimed water mains shall be hydrostatically tested in accordance with §332.14 of this manual before being put in service, in addition all reclaimed water lines will be dye tested. However, no chlorination will be required unless otherwise requested by DFW.
- Hydrostatic testing of all reclaimed water mains must also be in accordance with the NCTCOG Standards, Latest Edition.

338.13 Reclaimed Water Isolation Valves

Isolation valves on reclaimed water lines shall meet the requirements of section 332.15.

338.14 Reclaim Water Meters

All meters in the distribution system for the reclaimed water will meet the requirements for potable water as required in section 332.19, except that each meter will have purple covering and be clearly marked as non-potable water. Water meters shall be installed at all irrigation service taps, and at all flushing taps.

338.15 Outlets

Blind flanges or plugs, as applicable, shall be furnished and installed on all valves located at outlet points or terminal points where the reclaimed water main does not continue. Dead-end main structures shall be avoided whenever possible. If unavoidable, dead-end mains shall be designed to include a flush point and the end of the main. Each flush point shall be clearly marked as non-potable water, and painted purple.

338.16 Air Release, Air/Vacuum, and Combination Air Valves

Air and vacuum valves must be provided in high points according to section 332.21 of this manual.

All below ground appurtenances for blow-off and air and vacuum valve assemblies must be consistently color-coded purple and clearly marked to differentiate recycled water facilities from potable water and/or wastewater facilities.

338.17 Thrust Blocking

Thrust blocking for reclaimed water mains must be provided in accordance with section 332.25 of this manual

338.18 Backflow Prevention Device

Backflow prevention Device shall be installed at each delivery tap.

338.19 Reclaimed Water Blow off Assembly

Either an in-line or end-of-line blow-off drain assembly must be installed to remove water or sediment from the reclaimed water pipeline. Blow-off assemblies must be installed in a low point of the pipeline. The pipeline tap for the assembly must be no closer than 18 inches from a valve, coupling, joint, or fitting unless it is at the end of the pipeline.

- The reclaimed water blow off assembly will require two (2) vaults.
- First vault from reclaimed water main will house valve, water meter and second valve with by pass.
- Second vault will house gate valve, back flow preventer, and second gate valve.

The discharge from blow-offs should be designed to drain into the sanitary sewer system. Discharge of recycled water to storm drains is restricted. If there is no sanitary sewer that can receive the discharge from a

blow- off, DFW Utilities must be consulted regarding acceptable alternatives.

338.20 Manhole Frame and Cover

All manhole frames/covers, valve castings shall comply with section 332.26 of this manual with the following addition, covers must be painted purple, and be clearly denoted as non-potable.

338.21 Reclaimed Water System Approved Product List					
BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	Reference Specifications (NCTCOG)	National Specifications
Water Meters		Manufacturer			
Water Meters	All Meters	Badger	Badger Becon with HR-E encoders, LTE Endpoints with Purple covers for Reclaimed water		AWWA C700 & C701
Water Pipes		Manufacturer			
PVC Pressure Pipe	PVC 8"-12" DR14	Pipelife Jet Stream	DR14	501.9	AWWA C900
PVC Pressure Pipe	PVC 8"-12" DR18	Pipelife Jet Stream	DR18	501.9	AWWA C900
PVC Pressure Pipe	PVC 8"-12" DR14	Diamond Plastics Corporation	DR14	501.9	AWWA C900
Corporation Stop		Manufacturer			
CORPORATION STOP *	QUICK JOINT BALL VALVE	FORD	FB-1000-x-Q-NL	502.5	AWWA C800
*MUST HAVE STAINLESS STEEL COMPRESSION GRIP RING.					
* MUST HAVE FULL BODY GLANDS AND RED PRIMER.					
Fittings		Manufacturer			
FITTINGS, FULL-BODIED	DUCTILE IRON	AMERICAN CAST IRON PIPE		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	STAR PIPE		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	TYLER/UNION/UFC O		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	Sigma		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	US PIPE & FOUNDRY		502.6	AWWA C110
FITTINGS, FULL-BODIED	DUCTILE IRON	SIP		502.6	AWWA C110
COMPACT FITTINGS AND GLANDS ARE NOT ALLOWED.					
Manhole Appurt.		Manufacturer			
MANHOLE RING & LID	32-INCH	BASS & HAYS	V1420		
MANHOLE RING & LID	40-INCH	BASS & HAYS	#1225-40		
MANHOLE RING & LID	40-INCH	NEENAH	R-1901		
All Manhole lids will be visable as to non-potable water					

Polywrap					
POLYWRAP	WRAP MUST BE LLDPE, t= 0.008", MANUFACTURED AND LABELED IN ACCORDANCE WITH AWWA C105, and shall be purple for reuse water				AWWA C105
Service Saddles		Manufacturer			
SERVICE SADDLES	BRONZE DOUBLE STRAP	JAMES JONES	J-979	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	FORD	202B	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	McDONALD	3825	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	MUELLER	BR2B	502.10	AWWA C 800
SERVICE SADDLES	BRONZE DOUBLE STRAP	SMITH-BLAIR	323	502.10	AWWA C 800
Tapping Sleeve		Stainless Steel		Manufacturer	
TAPPING SLEEVE	STAINLESS STEEL*	CASCADE	CST-EX	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	FORD	FTSS	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	JCM	432	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	MUELLER	H304	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	ROMAC	SST III	502.10	AWWA C 800
TAPPING SLEEVE	STAINLESS STEEL*	SMITH-BLAIR	665	502.10	AWWA C 800
*OUTLET FLANGES MUST ALSO BE STAINLESS STEEL. SHALL BE RESTRICTED TO PIPE SIZES 8" AND SMALLER AND SHALL NOT BE USED FOR TAPS GREATER THAN 75% OF THE MAIN SIZE.					
Air Valves		Manufacturer			
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	CLA-VAL		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VAL-MATIC		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VALVE & PRIMER (APCO)		502.6	
VALVES, AIR	AIR RELEASE AND VACUUM BREAKER	VENT-O-MAT	RBX SERIES	502.6	
All valves will be marked visible as to non-potable water					
Valve Stack		Covers and Lid		Manufacturer	
VALVE COVERS	LID	BASS & HAYS	#340-1	806.4	
VALVE COVERS	LID	SIGMA	VB1651M	806.4	
VALVE COVERS	COVER	SIGMA	VB1652M	806.4	
VALVE COVERS	Lid	Accucast	115002	806.4	
VALVE COVERS	Stack	Accucast	115000	806.4	
VALVE COVERS	Lid	Star Pipe Products	Shorty	806.4	
VALVE COVERS	Stack	Star Pipe Products	Shorty	806.4	
All Valve lids will be marked visible as to non-potable water					

Valves	Vertical Resilient	Manufacturer			
VALVES, GATE*	VERTICAL, RESILIENT WEDGE	MUELLER	2360, 2362	502.6	AWWA C509
VALVES, GATE*	VERTICAL, RESILIENT WEDGE	M & H	4067, 4068	502.6	AWWA C509
<p>* MUST HAVE 316 SS BOLTS. BOTH RED EPOXY OR BITUMINOUS EXTERIOR COATINGS ARE ALSO ACCEPTABLE. AWWA C-515 RSGVs WITH REDUCED WALL THICKNESSES ARE NOT ACCEPTABLE.</p>					
Water Meter Vaults	Large Services	Manufacturer			
WATER METER VAULTS	CONCRETE	AMERICAN INDUSTRIAL PRECAST	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	BROOKS/OLDCASTLE PRECAST	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	CONCRETE PRODUCTS (CPI)	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	HANSON	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	NEW BASIS (DALWORTH QUICKSET)	MUST HAVE APPROVED LIFTING DEVICES		
WATER METER VAULTS	CONCRETE	TURNER	MUST HAVE APPROVED LIFTING DEVICES		
<p>• Engineer of record shall conform the applicability of these approved products in AOA and CTA area. This standard product list has been developed only for projects located outside the AOA and CTA area. When technical specification for specific products, are included as part of the construction contract documents, the requirements of the Technical specifications will override these approved product list. It is engineer of record (EOR)'s responsibility to approve the product submittal. DFW utility group recommend EOR to coordinate with DFW Utility group prior to approval.</p>					

DIVISION 34

Transportation

SECTION 341 SPECIAL AIRFIELD DESIGN STANDARDS

341.1 General Information

This section covers all applicable facilities within the AOA that shall be planned, designed and constructed in accordance with current FAA standards and criteria. These consist of Federal Aviation Regulations (FARs) and current editions of ACs. Copies may be obtained from the FAA Southwest Regional Office and U.S. Department of Transportation.

An AC will establish minimum standards to be used at the airport. If there are design criteria decisions to be made which are not covered in the respective AC or this Manual, the project Designer will make recommendations to the Airport Contact on a case-by-case basis.

341.2 Construction Specifications

All airfield construction contract documents shall be prepared in accordance with AC 150/5370-10A. The Division 01 portion (including Notice to Bidders, Instructions to Bidders, Proposal Forms, Bid Schedule Forms, Bond Forms, General and Special Provisions, etc.) of the contract documents shall be prepared based on guidance and direction from the Airport Development Department and as coordinated with the Airport Contact.

341.3 Design Guidelines

341.3.1 Critical Design Aircraft. The Critical Design Aircraft (CDA) shall be identified for each project however the standard is Airplane Design Group (ADG) VI per AC 150/5300-13 (current edition). Changes from this standard may be made pertaining to any of the following elements:

341.3.1.1 Runway Length: The CDA will be furnished by the Airport Contact.

341.3.1.2 Width, Clearances and Separations of Runways, Taxiways and Parking Aprons: The CDA, or its associated Airplane Design Group per AC 150/5300-13, will be recommended by the Designer based on traffic forecasts furnished by the Airport Contact or Tenant Airline.

341.3.1.3 Pavement Design: The CDA will be furnished by the Airport Contact.

Review by the Director of Operations of all AOA ADG standards shall be accomplished prior to final design.

341.3.2 Geometrics. All airfield geometry shall conform to the current ALP.

Detailed geometry not included or referenced on the ALP shall conform to the requirements in AC 150/5300-13 and other relevant AC's. All filets for "Cockpit-over Centerline steering will be designed in accordance with AC 150/5300-13.

341.3.3 Line of Sight. All runways and runway safety areas shall conform to the line-of-sight criteria of AC 150/5300-13. Taxiways under the control of the Air Traffic Control (ATC) Towers shall be in full view of the tower cab full length and width. An ATC Tower Line-of-Sight (Shadow) Study shall be prepared to determine the line-of-sight acceptability. Ramp control towers may require line-of-sight studies for aircraft parking areas and taxi-lane intersections.

Line-of-sight considerations may also be required when facilities are planned and designed near, or in the vicinity of, FAA Navigational Aids (NAVAIDS). Prior to commencement of airfield construction, a

“DFW Airport Board Airspace Review Application” shall be completed with appropriate information and exhibits required by the FAA on which FAA can conduct an Aeronautical Study of the proposal – (reference AC 70/7460-2 and FAR Part 77). Non-AOA projects will require an Airspace Form for staging areas, batch plants, construction cranes and other related items. Construction activities (temporary stationary objects) shall be reviewed through the Airports Local Airspace Review Program administered by the Airport Board.

No construction activity shall commence until the Airspace Study is completed and comments have been incorporated into the project plans and specifications.

341.3.4 Gradients and Slopes. All paved and turfed areas on the airfield AOA shall conform to the requirements of AC 150/5300-13, and as supplemented by the following criteria:

- Side slopes on excavation (cut) and embankment (fill) areas outside of runway and taxiway safety areas shall have a slope no steeper than 4 horizontal to 1 vertical.
- All topography and above ground objects, except those required by function for navigation, shall be clear of the imaginary surfaces of FAR Part 77 and shaped or designed to avoid line-of-sight problems and interferences with Airport navigational instruments and facilities. Objects that are within safety areas shall comply with FAR Part 139.
- The standard crowns (transverse slope) on runways and taxiways shall be one percent, except where flatter grades are necessary due to intersection transitions, in which case they shall be a minimum of 0.5 percent.
- All paved runway shoulders and taxiway shall be paved with a minimum of one percent to a maximum of 5 percent surface gradient. The desirable slope is 2 percent. The maximum slope shall not be used without approval of the Airport Contact. The edge of pavement to edge of shoulder

conform joint shall be at the same elevation (no pavement lip).

- Pavement gradients on aircraft parking aprons shall be 0.5 percent min., except where conforming or transitioning to existing facilities, and except for 50 feet from Terminal buildings at the gate and parking positions which shall be 1 percent to conform to NFPA Standard 415 on “Aircraft Fueling Ramp Drainage.”
- Gradients, slopes, and object clearing criteria for “Obstacle Free Zones”, “Runway and Taxiway Safety Areas,” and “Runway Protection Zones” shall conform to the standards of AC 150/5300-13 for the respective critical aircraft or mix of aircraft.

341.3.5 High Speed Exit Taxiway (Acute Angled Taxiways). Locations shall be as shown on the Airport Layout Plan. The geometric layout shall either match existing high speed exit taxiways on the Airport or conform to AC 150/5300-13. Larger-than-standard fillet radii shall be investigated where traffic “backturns” are anticipated.

341.3.6 Right Angle Connector Taxiway. Right angle intersections shall meet the requirements of cockpit-over-centerline steering and shall conform to the requirements of AC 150/5300-13.

341.3.7 Runway and High Speed Exit Taxiway Grooving. All runway and taxiway grooving shall conform to AC 150/5320-12C (current edition). Slurry from sawing must be vacuumed as part of the sawing operation and disposed

of off the Airport property. Final cleanup shall include flushing by water.

341.3.8 Aprons. Where holding aprons are included in the project scope, the overall location and geometric layout will be furnished by the Airport Contact. Widths, clearances, fillet radii and other details not furnished shall conform to AC 150/5300-13, or as recommended by the Designer and approved by the Airport Contact.

Aircraft parking aprons shall be based on an "Apron Utilization Plan". Apron utilization criteria, including wingtip clearance, shall be approved by the Airport Contact and must be within the maneuvering limits of the Aircraft Characteristics Manual of the Critical Design Aircraft. Aircraft service pits shall be located to minimize impact on PCC pavement joint performance.

All pavements in and around apron areas should be rigid pavement.

341.3.9 Pavement Design. Pavement design for all aircraft worth pavements shall be based on FAA methodology and requirements in AC 150/5320-6 (current edition). Standard sections exist for the various aircraft pavements encountered at the Airport. Deviation from these standard sections required the submittal of a pavement report prepared by a qualified geotechnical and materials engineering firm and a pavement section design sealed by a professional engineer registered in the State of Texas and the approval of ARFF roads, tenant (tug) roads and other service roads shall conform to the design criteria in Section 2.4 - Roads.

341.3.10 Pavement Type. All airfield pavements shall be rigid (PC) pavement, except blast protective pavement shoulders and blast pads. Blast protective pavement type shall be recommended by the Designer based on an occasional pass by the critical maintenance or ARFF equipment.

341.3.11 Sub-grade, Soils and Pavement Testing Investigation Program. Each project Designer shall prepare a recommended soils program for Airport Contact review and approval. A final soils report shall be submitted with the final construction documents.

341.3.12 Sub-grade Treatment. All sub-grades shall be lime-treated. The thickness of the treated sub-grade and quantity of lime shall be specified in the soils report submitted by the Designer.

341.3.13 Under-drains. An under-drain/edge drain system is required on all pavement sections unless recommended otherwise by the Designer. If under-drains are not recommended, the Designer shall present the basis on which they are not recommended and submit to the Airport Contact for approval. System layout, elements, and design shall be designed based on soils investigation results, pavement function, and other relevant factors and parameters.

341.3.14 Sub-base and Base Course. All full strength airfield pavements shall include a 9-inch Cement Treated Base course as a minimum.

341.3.15 Portland Cement Concrete Pavement. PCC shall be designed based on 750 psi flexural strength at 28 days. All pavements shall be reinforced with steel. Keyways will not be allowed. Surface texture may be burlap drag, broom, or other approved micro-texture, except that all runways and high speed exits shall be grooved by sawing.

341.3.16 Asphalt Pavement. Asphalt pavement shall not be used except as blast protective pavement on shoulders and blast pads. Mix design proportions and criteria may be either FAA P-401 (AC 150/5370-10) or Texas Department of Transportation Specification No. 340 with approval. All joints between concrete and asphalt shall be sawed and sealed to retard moisture intrusion and vegetation growth.

341.3.17 Pavement Marking. Pavement marking of runways, taxiways, taxilanes and other paved areas within aircraft operations areas shall conform to AC 150/5340-1 (current edition) and be approved by the Airport Contact and DFW Operations.

341.3.18 Turfing. Turf on the AOA shall consist of the Bermuda type. Composition and application of seed fertilizer and sod shall be coordinated with the Airport Contact. The placement of all turfing adjacent to paved shoulders and blast pavement shall be 1½ inches below the pavement surface. FAA AC 150/5370-10G item T-901 requires a good stand of grass with uniform color and density and no individual bare spots larger than 1 square foot, randomly dispersed and does not exceed 3% of the seeded.

341.3.19 Site Preparation for NAVAIDS. Design criteria for NAVAID critical areas shall conform to AC 150/5300-13. FAA NAVAIDS access roads shall be a minimum of 10 feet wide. Airport facilities will be checked for compliance with FAA electromagnetic standards. See FAA Advisory Circular AC 70/7460-2.

341.3.20 Safety and Security during Construction. The Designer shall coordinate with DFW Operations and DPS through the Project Manager, regarding all safety and security provisions of the project. Other considerations, depending on the project scope, include interim or temporary pavement marking and lighting, and required Special Provisions to fit the project. Provisions must be made for and included in all contract

documents pertaining to safety during construction, construction sequencing, access to the site, Contractor's staging area, haul routes, barricades, fencing, traffic control, etc. AC 150/5370-2, FAA Southwest Regional Order 5200.5b, and DFW Rules and Regulations for Maintenance and Construction on the AOA contains the means by which construction may be accomplished within the AOA.

341.3.21 Aircraft Rescue and Fire Fighting Roads. This roadway should follow guidelines in Section 34.1. All shoulders should be continuously reinforced concrete.

341.3.22 Load Limits. The minimum vehicle load limit for Fire Apparatus Access Roads is 53,000 pounds. The minimum vehicle load limit for AOA fire apparatus access roads is 113,000 pounds. All bridges and elevated roads shall conform to this requirement.

341.3.23 Turning Radius. The external turning radius (wall to wall) shall not be less than 57 feet. The internal radius shall be no less than 35 feet. The turn at no time will be less than 22 feet wide.

341.3.24 Grade. The maximum grade change of any portion of a fire apparatus access road shall not exceed 10 feet of rise per 100 feet of run.

SECTION 342 ROADWAY DESIGN GUIDELINES

342.1 General Information

The Roadway Design Guidelines reference the latest and most current editions of the publications listed below, but not limited to, and should be referenced to provide guidance in design methodologies and establishing project criteria:

- Roadway Design Manual, Texas Department of Transportation.
- Texas Manual on Uniform Traffic Control Devices (TMUTCD), Texas Department of Transportation

- Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Texas Department of Transportation
- Procedures for Establishing Speed Zones, Texas Department of Transportation
- Traffic Standards, Texas Department of Transportation
- A Policy of Geometric Design of Highway and Streets (Green Book), AASHTO
- Roadside Design Guide, AASHTO
- Transportation Impact Analysis for Site Development, Institute of Transportation Engineers
- Manual of Transportation Engineering Studies, Institute of Transportation Engineers
- American Concrete Institute
- Concrete Reinforcing Steel Institute

342.2 Roadway Classification

Classification	Pavement Width (between curbs)	***Driving Lanes	ROW	**Speed Limit
Regional Arterial	2 - 36 feet	6 - 12 feet	150 feet	45 miles per hour
Major Arterial	2 - 36 feet	6 - 12 feet	120 feet	45 miles per hour
Minor Arterial	2 - 24 feet	4 - 12 feet	100 feet	35 miles per hour
Collector	2 - 36 feet	6 - 12 feet	70 feet	30 miles per hour
Curbside Collector	48 feet	4 - 12 feet	60 feet	20 miles per hour
Terminal Collector	24 feet	2 - 12 feet	25 feet	15 miles per hour
*Freeway	multi-lanes	12-foot lanes		55 miles per hour
Ramp		14-foot lane		20-25 mph

* *Freeway* - International Parkway is designated as a Freeway within the Airport. International Parkway is a divided highway for moving through traffic with full control of

access. The posted speed limit on International Parkway is 55 mph.

** *Speed Limit* - The speed limit or posted speed limit is the maximum (legal) speed limit set by local authorities for a certain roadway classification based on appropriate the traffic studies. The design speed should never be less than the likely legal speed limit.

*** *Driving Lanes* - AutoTURN will examine turn movement maneuvers and driving lanes along the roadway network.

342.2 Design Vehicles

342.2.1 The WB-67 design vehicle should be the design vehicle considered for arterials and roads that carry moderate to high volumes of traffic or that provide local access for large trucks. The WB-62 may be used in design for turning movements when authorized and approved by the Airport.

342.2.2 Driveway width will need to be designed in order to allow an Interstate Semitrailer the ability to effectively negotiate a turning movement into a driveway with a privately-owned vehicle (POV) within the driveway throat. The throat width and radii should be designed to incorporate AASHTO's standard commercial design vehicle for industrial areas, the WB-67. The WB-67 design vehicle is an appropriate design vehicle model for a DPS Fire Department emergency vehicle responding to an incident and to adequately turn into the driveway with an uninterrupted turn movement onto the driveway apron and into the facility.

342.2.3 Horizontal Geometrics

342.2.3.1 Horizontal Curves and Super-elevations - Reference the latest editions of the Roadway Design Manual and AASHTO's Green Book for guidelines and design criteria. In addition, the following design criteria will be followed unless otherwise specified by the Airport:

- Reverse Curves without an intervening tangent will not be permitted. Minimum length of tangent should be 400 feet.
- Compound curves will not be permitted.

342.2.3.2 Turning Lanes - Minimum width for a turning lane will be 12-feet to afford maximum safety and service to Airport emergency vehicles.

342.2.4 Vertical Alignment

342.2.4.1 Vertical Curves - Reference the latest editions of the *Roadway Design Manual* and AASHTO's Green Book for guidelines and design criteria. In addition, the following design criteria will be followed unless otherwise specified by the Airport:

- Vertical curves should be used where the change in rate of grade exceeds the maximum allowable grade break on centerline of 0.5 percent.
- Rates of Grade will be shown for all grades longer than 50-feet and for all tangents to vertical curves from the P.I.

342.2.4.2 Street Grades are required to assure proper flow of surface drainage toward inlets:

- Maximum allowable grade break is 0.5 percent. Desirable is 0.4 percent.
- Minimum grade is 0.3 percent.
- Vertical curves should be used where the change in rate of grade exceeds the maximum allowable grade break on centerline of 0.5 percent.
- Driveway Aprons—Driveway vertical profiles should provide a smooth transition between the roadway and the driveway approach. Grades over 6 percent will not be allowed. Grades over 6 percent create grade breaks that affect vehicles turning into a parking lot facility. Severe changes in grades will force drivers to make the driveway entry and exit maneuvers at an angle so as to keep the front or rear of the vehicle from dragging. Also, if the driveway profiles are too steep, the drivers may not conveniently and comfortably make 90-degree turn movements in and out of the facility.

- No roads shall be designed or (constructed) with grades in excess of 4.5 percent.

342.2.4.3 Cross Slopes:

- Cross slopes should be 2 percent.
- Maximum allowable cross slope is 5 percent.
- Minimum cross slope is 1.0 percent.

342.2.5 Structural Clearance

342.2.5.1 Clear Zone (Horizontal Clearance) - The Clear Zone should provide a clear, flat traversable and unobstructed (4:1 slope or flatter) area beyond the edge of traveled way that includes usable shoulders and extends laterally to prevent overturning or encountering a hazard. Reference the latest edition of the *Roadside Design Guide* and TMUTCD for guidelines and design criteria that may affect roadside safety.

342.2.5.2 Vertical Clearance—Reference the latest editions of the *Roadway Design Manual* and AASHTO's Green Book for guidelines and design criteria. In addition, the following design criteria will be followed:

- Vertical clearance for all (new) separation structures shall be 16 feet 6 inches at any point between curbs or usable roadway including shoulders.
- For the resurfacing, restoration, rehabilitation and reconstruction of an area within an existing separation structure, the minimum vertical clearance shall be 14 feet 6 inches over the usable road and shoulders. The clearances must be verified in the early stages of design.

342.2.6 Sight Distance. Sight distance is important in the design and operation of various types of road facilities. Poor sight distance can adversely impact safety. Reference the latest editions of the *Roadway Design Manual* and AASHTO's Green Book for guidelines and design criteria.

342.2.7 Traffic Control Devices. The purpose of traffic control devices, as well as the principles for their use, is to promote highway safety and

efficiency by providing for the orderly movement of all road users on streets, highways, bikeways, and private roads open to public travel. Traffic control devices notify road users of regulations and provide warning and guidance needed for the uniform and efficient operation of all elements of the traffic stream. Reference the latest editions of the TMUTCD and *Roadside Design Guide* for guidelines and design criteria.

342.2.7.1 Roadway Signs (Regulatory, Warning, Guide) - The design of signs for roadways shall be in accordance with the TMUTCD, latest edition.

- The retro-reflective sheeting for all signage will be 3M Diamond Grade DG3 Reflective Sheeting.
- All signs will have a break-a-way feature. The post and mounting details will have a breakaway connection, a triangular slip base breakaway support.
- Post will be a 2½inch square 12-gauge "Telespar" powder coated (Bronze Tone 64) sign support.
- Placement of all traffic control signage will be within the road user's view so that maximum visual acuity is provided. To convey the proper sign message, signage shall be appropriately positioned with respect to location, orientation, height, and lateral clearance.
- Minimum size of Regulatory and Warning signs will be at 36 inches by 36 inches.
- For additional Guide Sign information, also reference the Signage Standards and Guidelines Volume 4: Roadways.

342.2.7.2 Markings - Markings provide guidance and information to road users for both daytime and nighttime use. Markings may also supplement other traffic control devices.

- Stop Bar (Stop Lines) will be 24' inches.
- The reflectorized pavement markings' materials will be thermoplastic.
- Grinding is not an acceptable method of marking removal.

342.2.7.3 Traffic Signals. DFW Airport utilizes an Advanced Traffic Management System to monitor traffic throughout the Airport.

342.2.7.4 Temporary Traffic Control. Sealed and signed temporary traffic control plans will be necessary for work that displaces the traffic stream during construction, maintenance, and utility related activities. This includes lane closures, shoulder closures, mobile closures and any work within the "clear zone".

342.2.8 Cross Section Elements. Reference the latest editions of the *Roadway Design Manual* and AASHTO's Green Book and *Roadside Design Guide* for guidelines and design criteria.

342.2.8.1 Pavement Width. The minimum standard lane width of a traveled lane will be 12-feet - see Roadway Classification.

342.2.8.2 ARFF Roads. The minimum standard lane width of a traveled lane will be 12-feet.

342.2.8.3 Turning Lanes. Minimum width for a turning lane will be 12-feet to afford maximum safety and service to Airport emergency vehicles.

342.2.8.4 Ramp - Minimum lane width for a one-lane ramp will be 14 feet with usable shoulder on both sides of the ramp.

342.2.8.5 Shoulders

- Low Speed (≤ 35 mph): 6 inch curb face or 6-foot shoulder.
- Transition Speed (40-45 mph): 10-foot shoulder to clear zone.
- High Speed (≥ 50 mph): 10-feet to 12-feet. Clear zone up to 30 feet.

342.2.8.6 Cross Slope - Design a 2 percent cross slope.

342.2.9 Structural Section

342.2.9.1 Roadway Structural Pavement Section—Option A (4400 psi)

- 10-inch thick CRCP
- 3-inch hot mix asphalt concrete (HMAC)

- 9-inch Lime Stabilized Subgrade at 8 percent lime by weight
- Curbs shall be poured monolithic with the roadway pavement

342.2.9.2 Roadway Structural Pavement Section—Option B (4400 psi)

- 9-inch thick CRCP
- 2-inch HMA
- 6-inch Cement Treated Base
- 9-inch Lime Stabilized Subgrade at 8 percent lime by weight
- Curbs shall be poured monolithic with the roadway pavement

342.2.9.3 Aircraft Rescue and Fire Fighting (ARFF) Roads (4,400 psi)

- 8-inch thick CRCP
- 9-inch Lime Stabilized Subgrade at 8 percent lime by weight

For CRCP, longitudinal reinforcing bars shall be adequately lapped at splices, and that the splices be staggered in arrangement that will not cause localized strain in the pavement or nearby construction joint.

Dowels are recommended when positive load transfer is required. For dowel size and spacing with respect to pavement thickness, reference ACI 302.1R-96, Table 3.2.7. Dowel Size and Spacing. Dowel bars should have a diameter consistent with the slab thickness and be placed at the mid-depth of the existing slab.

342.2.10 Land Development and Transportation

342.2.10.1 A Traffic Impact Analysis (TIA) will be required for all landside development projects that will generate, distribute and assign vehicular traffic to and from a proposed development onto the Airport's roadway network. The TIA will determine what impact a development will have on the existing and proposed roadway network. A Level of Service "C" or better is the desired objective for the airport's roadways and intersections.

342.2.10.2 A well-designed internal circulation system will accommodate the order of

movement from the adjacent road into the development and within the development.

342.2.10.3 For the principles of design that are common to developments and roadway/driveway intersection, reference the *Roadway Design Manual* and AASHTO's Green Book for guidelines and design criteria.

342.2.10.4 For proposed driveway locations, be cognizant of the "Functional Area of an Intersection."

342.2.10.5 The WB-67 design vehicle should be the design vehicle considered for arterials and roads that carry moderate to high volumes of traffic or that provide local access for large trucks. The WB-62 may be used in design for turning movements when authorized and approved by the Airport.

342.2.10.6 Driveway width will need to be designed in order to allow an Interstate Semitrailer the ability to effectively negotiate a turning movement into a driveway with a POV within the driveway throat. The throat width and radii should be designed to incorporate AASHTO's standard commercial design vehicle for industrial areas, the WB-67. The WB-67 design vehicle is an appropriate design vehicle model for a DPS Fire Department emergency vehicle responding to an incident and to adequately turn into the driveway with an uninterrupted turn movement onto the driveway apron and into the facility.

342.2.10.7 AutoTURN will be required to assess and design all turning movements from an adjacent road onto a facility's driveway throat.

SECTION 343 BRIDGES

343.1 Highway Bridges

This provision shall apply to structures with spans greater than twenty (20) feet and whose function is to carry roadway traffic. This section does not apply to parking structures or ramp systems within them.

343.2 Design Guidelines

343.2.1 Specifications. Highway bridges shall be designed in accordance with AASHTO's "Standard Specifications for Highway Bridges," with interim specifications.

343.2.2 Live Loads. All bridges on arterial roads shall be designed for an HS20-44 live load plus impact.

Bridges along secondary roads shall be designed for an HS20-44 live load plus impact unless waived by the Building Official, in which case the design live load shall be HS15-44 plus impact.

343.2.3 Bridge Widths. Generally, bridge width from face of rail to face of rail shall be at least as wide as the approach roadway's usable shoulder.

343.2.4 Clearances. For horizontal and vertical clearance requirements, see Section 341, Obstruction Clearances.

343.3 Bridge Materials

343.3.1 General. This section shall govern materials used in the construction of highway bridges and incidental items relating to these structures.

343.3.2 Concrete. Concrete materials, quality, classes of, and proportioning shall comply with the applicable sections of the TxDOT "Standard Specifications for Construction of Highways, Streets, and Bridges".

343.3.3 Structural Steel. Structural steel, forgings, castings, anchor bolts, pipe, tubing, bolting of and welding of shall comply with the applicable sections of the TxDOT "Standard Specifications for Construction of Highways, Streets, and Bridges".

343.3.4 Reinforcing Steel. Reinforcing steel material and bending shall comply with the applicable sections of the TxDOT "Standard Specifications for Construction of Highways, Streets and Bridges".

343.3.5 Pre-stressing Steel. Pre-stressing steel, packing, storing, handling, working drawings and construction methods shall comply with the applicable sections of the TxDOT "Standard Specifications for Construction of Highways, Streets, and Bridges".

SECTION 344 AIRCRAFT BRIDGES

344.1 General Information

This section shall apply to all bridges, tunnels, culverts, vaults and all other structures supporting aircraft or under runways, taxiways or aprons. Such structures shall conform to the minimum requirements set forth in this Manual and FAA AC 150/5300-13.

344.2 Airplane Design Group

Structures shall be designed and proportioned to accommodate ADG VI as defined in FAA AC 150/5300-13.

Each element of the structure shall be designed to accommodate the most demanding airplane under this design group. This may result in more than one airplane being used in designing a particular structure (i.e., bridge width may be controlled by the airplane with the longest wing span, whereas another airplane may have higher wheel loads, thus controlling beam design).

344.2.1 Live Loads. Structures shall be designed for the following airplane loads:

- Spans under 2 feet in the shortest direction, including manholes lids and grates - uniform live load of 250 psi.
- Span lengths 2 to 10 feet in the shortest direction, with the greater of a uniform live load varying between 250 and 50 psi in inverse proportion to the span length or the maximum number of wheel loads for the airplane which can be applied to the structure.
- Span lengths greater than 10 feet in the shortest direction, wheel loads for the design airplane.

344.2.2 Impact. For those elements listed in Group A (defined below), the live load shall be increased by the following percentages. This increase will account for impact loads and vibration:

- 30 percent: Parking aprons and low speed taxiways
- 40 percent: High speed taxiways and runways
- 100 percent: Touchdown areas of runways.

Live loads shall not be increased by impact for those items in Group B (defined below).

Impact for structures covered with fill shall vary from the percentage shown at ground level to 0 percent at a depth of 10 feet.

GROUP A	<p>Superstructure, columns and pedestals which support the superstructure with rigid, fixed or expansion bearings, or which are rigidly attached to the superstructure, and legs of rigid frames.</p> <p>The portions above the ground line of piers that are rigidly connected to the superstructure as in rigid frame or continuous structures.</p>
GROUP B	<p>Abutments, retaining walls, piers, pile caps and pilings which are not rigidly connected to the</p>

	<p>superstructure.</p> <p>Buried foundations, footings and supporting soil, and structures with 3 feet or more of earth cover.</p>
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344.2.3 Braking Force. Longitudinal forces due to braking shall be included in the design of all structures subject to direct wheel loads. This braking force shall be the following percentages of live load without impact:

- 30 percent: Parking aprons and low speed taxiways.
- 70 percent: High speed taxiways and runways.

344.2.4 Clearances. Vertical clearances for aircraft bridges over roadways and horizontal clearances to piers from these roadways shall be the same as those described in Obstruction Clearances.

344.2.5 Materials. Construction material specifications, strengths, handling, storage and testing shall comply with the latest version of the AASHTO "Standard Specifications for Highway Bridges."

344.2.6 Design Load Combinations. In addition to live and dead loads, the following loadings shall be taken into account: earth pressure, buoyancy, wind (including jet blast and uplift), shrinkage, temperature, longitudinal force, stream flow, construction loads and any special loads. Loads shall be applied in such a manner as to produce the maximum stresses.

Loading combinations shall be the same as those described in latest version of the AASHTO's "Standard Specifications for Highway Bridge's" and interim specifications.

SECTION 345 PARKING STRUCTURES

345.1 General Information

All criteria specified in Section 03 00 00, Concrete shall also apply to parking structures except as amended in the following.

345.2 Design Guidelines

345.2.1 Material Selection. Structural steel shall not be considered for the vertical and horizontal framing system unless approved by the Building Official.

345.2.2 Steel. All exposed miscellaneous steel used for concrete supports and connections shall be galvanized and retouched after installation.

345.2.3 Corrosion Protection. Calcium chloride and admixtures containing chlorides should not be used in concrete for parking structures. Admixtures shall be used with care and compatibility shall be verified by testing laboratories.

Protection of embedded metals including concrete cover over reinforcement, post-tensioning tendons, pre-tensioned connections for precast systems, dissimilar metals, and embedded metal conduit should meet or exceed the minimum ACI 318 requirements.

ACI 362.1R, Guide to the Design of Durable Parking Structures should be consulted for pertinent information concerning corrosion inhibitors, cathodic protection and protection of concrete.

The guidelines for applied sealers or membrane treatments shall be followed.

345.2.4 Expansion Devices and Materials. Expansion joint seals and isolation joints shall be designed to prevent the following defects or failures:

- Migration, bleeding into or staining abutting materials

- Deformation sufficient to become unsightly or cause leakage
- Chalking, picking up dust or excessive color change
- Adhesive or cohesive failures

In addition to ACI 318, the Designer should refer to ACI 504.R for various joint treatments and to ACI 224.R and ACI 224.1R for crack controls.

345.2.5 Elastomeric Bearings . Bearings shall be designed as a plain pad with a 70-durometer elastomer or laminated pads with a (60-durometer elastomer.

345.2.6 Parapet Systems. Systems which are integral or monolithic with supporting structural systems shall be designed such that damage to the parapet will not adversely affect the supporting system. The use of isolation joints and membrane protection is important at roof connections.

345.2.7 Drainage Systems. Systems shall be designed and located such that structural elements (i.e., reinforcing steel, tendons, beam flanges, lighting column base plates, etc.) shall take precedence. Use the least number of bends for unimpeded flow.

DIVISION 40

Process Integration

SECTION 401 GENERAL INFORMATION

401.1 General Information

These criteria shall be utilized in the design of corrosion control systems for new installations and/or maintenance and repairs to existing cathodic protection installations.

SECTION 402 DESIGN GUIDELINES

402.1 General

The design of new or refurbishment of existing cathodic protection systems shall be performed or supervised by a Corrosion Engineer. Corrosion Engineer refers to a person, who, by reason of knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control. Such people may be a licensed Professional Engineer or may be a person certified as qualified by NACE International, hereinafter referred to as NACE, if such licensing or certification includes suitable experience in corrosion control on buried or submerged metallic piping systems and metallic tanks.

This criteria is not intended to restrict creative engineering design. Should alternative materials or design concepts be deemed advantageous, they shall be presented to DFW Energy & Utilities Services for review and comment prior to approval.

402.2 Electrical Grounding Systems and DC Powered Equipment

Buried electrical ground rods shall be stainless steel, stainless steel-clad or galvanized steel. Buried cable shall be insulated, and cable-to-ground rod connections shall be coated.

DC powered equipment shall be insulated from other structures so that no DC current flows through the earth to other structures.

402.3 Nonmetallic Materials

In some instances, metallic and non-metallic materials are acceptable for the same service. In general, preference should be given to the non-metallic material if its durability is approximately equivalent to that of the metallic material.

Immersed or buried composite structures such as steel reinforced concrete should be made electrically continuous by appropriate bonding between sections. A minimum of 2 inches of concrete shall cover all ferrous materials used as reinforcement

402.4 Design Life

The following criteria have been established as a guide:

402.4.1 A maximum internal corrosion rate of 1 mil per year based on maximum depth of penetration is acceptable to permit realization of at least 50 years of service life free from major replacements for piping systems.

402.4.2 Corrosion control of exterior surfaces of equipment, piping, structural and miscellaneous steel shall be accomplished by providing a high-quality paint system. Buried piping and fittings shall be protected by electrically insulating coatings supplemented with cathodic protection. Concrete encasing shall not be an alternative to coating or cathodic protection.

402.5 Painting

In general, surfaces of equipment, piping, structural and miscellaneous steel shall be painted with a protective coating. All surfaces

shall be primed with a final coat applied in the field.

Aluminum, stainless or galvanized steel shall not be painted except as indicated otherwise.

SECTION 403 PROCESS PIPING AND EQUIPMENT PROTECTION

403.1 Process Piping and Equipment Insulation

403.1.1 Electrical Isolation. Structures requiring protection may require isolation from other underground metals by physical separation or by suitable dielectric materials. Above ground piping, fittings or equipment requires electrical isolation from underground connected and cathodically protected piping, fittings or other structures by the use of isolating pipe flanges. See Appendix B for specified manufacturer.

In general, dielectric fittings shall be installed to be accessible after backfilling. The preferred location is on the vertical riser 12) to 24 inches above grade, before wall penetration into a building. If it is not practical to install the isolating fitting in an accessible location, one set of two test wires shall be thermit welded to each side of the isolating fitting and extended to an at-grade test station to facilitate testing. The cathodically protected side of the isolating fitting shall have white test lead wires, the unprotected side shall have green test lead wires.

When necessary to install dielectric fittings inside a building, the pipeline shall be isolated from reinforcing steel, masonry, concrete, etc., by passing through a non-conducting sleeve of plastic, or a metal sleeve with an insulating modular rubber seal to support, center and isolate the pipe from structural steel. Dielectric fittings should be inside the building as close as practical to the building wall. These points shall be clearly labeled and accessible for inspection and repair.

Where it is necessary to interconnect dissimilar metals underground, dielectric fittings shall be installed at the connection point. All buried insulating fittings shall be coated with an approved coating material. Final decision of proper coating shall be made by a Corrosion Engineer. Painting of above-grade insulating fittings shall be done with electrically nonconductive paints. Aluminum or zinc-rich paints are not approved for this application.

All pipes entering meter vaults, penetrating building floor slabs and building walls shall be sleeved with modular rubber links to electrically isolate the pipe from contact with building/vault steel.

403.1.2 Bonding. Insulated copper cables for reinforced concrete cylinder pipe shall be welded or brazed across all mechanical joints in underground ferrous piping systems and at all isolated ferrous metal fittings such as 45s, 90s, Ts, gate valves, and fire hydrants that will be cathodically protected. Bolted connections are not acceptable.

Bonds shall consist of a #8 stranded copper wire with HMWPE insulation and shall be 12 to 18 inches in length with ample slack after all welds have been made.

Bonds may be installed between adjacent or crossing piping systems to allow protection of several systems from the same current source. Drain bonds shall be installed on any structures that may be subject to cathodic interference effects.

In the area of influence of an impressed current groundbed, reinforcing steel in buried nonmetallic structures should be bonded so that the structure is electrically continuous.

These structures include reinforced concrete pipe, prestressed concrete pipe and reinforced concrete cylinder pipe.

403.1.3 Casings. When a cathodically protected pipeline passes under a roadway,

runway or taxiway, it shall be placed inside a casing as required for mechanical strength. The carrier pipe (cathodically protected pipe) shall be electrically isolated from the casing. Casing insulators shall be specified for installation on the carrier pipe prior to placement in the casing.

Casings or rigid galvanized conduits shall be provided for all cathodic protection header cables under a roadway, runway or taxiway. Casing end seals shall be specified to prevent moisture from entering either end of the casing.

Casings shall not be coated. Ferrous metal carrier pipes inside the casing shall be coated with the same quality coating as is applied to the remainder of the piping system. Ferrous metal casings shall cathodically protect. Utilization of PVC casings is encouraged.

Test stations shall be installed at one end of each ferrous metal casing containing a cathodically protected pipe. Specify the test leads for the end of the casing that will be most accessible for future testing. Each test station shall have two white insulated lead wires from the carrier pipe and two red insulated lead wires from the casing.

403.2 Underground Piping Systems

403.2.1 Underground Piping Systems Protective Coatings. All buried, pressurized, ferrous metal piping systems (except pre-insulated pipe) shall be externally protected with a bonded pipeline type system of high dielectric strength. The purpose of this coating is to isolate the pipe from the soil. See Appendix B for specified manufacturer.

Cast iron and ductile iron pipe, fittings, valves and fire hydrants shall be coated specifically with 20 to 30 mils (dry) of a pipeline quality asphalt-based coating. In areas where the possibility of soil contamination by jet fuel exists, a mastic coating combining coal tar with asphalt materials shall be applied to the fitting to the same thickness. Coatings with one

hundred percent coal tar mastics are incompatible with the asphalt primers found on the fittings, and are therefore not acceptable.

Field joint repair on jet fuel lines shall be coated with a mastic coating, two-component systems such as coal tar epoxy or the pipe coating manufacturer's recommended repair coating. All coatings submitted for approval must have documentation on coating characteristics and application thickness.

Unbonded or loose fitting coatings such as poly bagging are not approved coatings. Equivalent coatings shall be reviewed by DFW Energy & Utilities Services for approval.

403.3 Corrosion Control of Process System Equipment and Piping

403.3.1 Systems. All equipment and piping in the following systems shall incorporate appropriate corrosion control methods:

- Boiler Feed Water
- Waste Water
- Steam and Condensate
- Condenser Water
- Potable Water
- Fire Protection Water
- Chilled Water
- Gas and Compressed Air
- Hot Water
- Fuel Oil

In the above services, copper base or aluminum alloys must not be attached to ferrous materials, or to each other.

Where the interconnection of different metals is necessary, they shall be electrically isolated using approved dielectric materials, or the cathodic metal shall be required internally coated where isolation is not practical.

Material selection shall be reviewed by a Corrosion Engineer to insure that acceptable durability shall be achieved.

403.3.2 Corrosion Inhibitors and Additives. Process systems such as boiler feed water, condensate, condenser water and chilled/hot

water require the addition of chemical additives that help to reduce internal iron pipe or tank corrosion. Provisions shall be made for conveniently and safely injecting these inhibitors and additives in these systems for maintaining the required protective residuals. Provisions shall also be made for sampling these processes for testing of residual levels. All corrosion inhibitors or additives shall be specified by or approved by a Corrosion Engineer. These systems shall not discharge to the storm sewer.

403.4 Impressed Current Systems

403.4.1 General. Impressed current systems shall consist of transformer-rectifier power sources, anodes placed in suitable backfill, and appropriate wiring to connect the rectifier(s) to the structures and the anodes. A complete, coordinated system must be provided.

403.4.2 Rectifier. The rectifier(s) selection shall be based on the field survey data and design calculations performed by a Corrosion Engineer during the design phase of the project. The rectifier shall be selected to operate at efficient settings, but shall provide surplus capacity for reasonable future expansion. As a minimum, provide at least 20 percent surplus capacity for protected structures.

The rectifier shall contain internal circuit breakers, an output ammeter and voltmeter, and shall be mounted in a suitable cabinet or enclosure.

All rectifiers shall be provided with a properly sized, NEMA 3R rated AC service breaker, which shall be placed in proximity to the rectifier.

403.4.3 Anodes. Impressed current anodes shall consist of either high silicon, chromium-bearing cast iron or linseed oil treated graphite, complete with high molecular weight polyethylene lead wires installed with the cable-to-anode connection properly sealed or encapsulated by the anode manufacturer.

Specialty anodes shall be approved by a Corrosion Engineer if conditions require their use.

403.4.4 Ground Beds. Anodes are installed in drilled, augured or trenched holes at depths commensurate with soil resistivity, water tables and the structure geometry. Anode holes shall be filled with the required quantity of a well compacted granular, low resistance coke breeze backfill, as specified, installed so as to uniformly surround the anode.

Where the groundbed is to be installed under concrete or asphalt, the anode holes shall be vented to permit the release of gas generated at the anode surface. Backfill above the coke breeze shall consist of pea gravel to assist in venting of generated gases and to permit percolation of water.

403.5 Galvanic Anodes

Galvanic anodes shall be installed at all isolated fittings, such as 45s, 90s, tees, gate valves and fire hydrants, clusters of up to four isolated fittings located within 10 feet of each other, short piping sections, small, well-coated structures and in areas where interference with other structures might result from the use of impressed current systems. The anodes shall consist of galvanized steel cored, magnesium or zinc rods packed in cloth bags containing a specially prepared backfill material.

All galvanic anodes shall be attached to the structure requiring protection through the connection of the anode lead wire to a calibrated 0.1 ohm shunt to one of the structure lead wires that are thermite welded to the structure. The top of all galvanic anodes are buried a minimum of 12 inches below the structure either vertically or horizontally.

403.6 Protective Potentials

403.6.1 Ferrous Metals. NACE Standard RP 01 69-92 shall be used to determine protective potentials for ferrous metals. While this Standard lists three primary criteria as

acceptable, the DFW Airport has selected only one that will meet their requirements.

The method selected for determining a protective potential shall be as follows:

- A negative polarized potential (immediate “off” potential) of at least 850 millivolts relative to a saturated copper-copper sulfate reference electrode.

Soil contact points (pavement inserts) over ferrous structures such as welded pipelines, valves and fittings shall be placed at intervals of 50 feet in areas where concrete or asphalt pavements prevent direct contact with the soil. If necessary, a more definitive spacing shall be determined on an individual basis by a Corrosion Engineer, where external factors that have an adverse influence on the line. Soil contact points shall be a molded polyethylene pavement insert $1\frac{3}{4}$ inches in diameter by 6 inches long.

Where temporary placement of a reference electrode in soil directly over the structure is not possible, a copper-copper sulfate permanent reference electrode shall be considered for installation.

403.6.2 Non-Ferrous Metals. Protective potentials for nonferrous metals shall be established by a Corrosion Engineer and shall be in accordance with NACE Standard RP 01 69-92.

403.7 Cathodic Process Corrosion Protection

The airport utilizes both impressed current and galvanic anode cathodic protection systems (CPS) to supplement coatings used for corrosion control. Impressed CPS shall have a design life of greater than 20 years. Maximum design life for galvanic anode systems utilizing magnesium or zinc anodes is greater than 15 years. Cathodic protection systems for immersed service shall be designed for a minimum 10 years. In all cases, provisions shall be made for replacement of anodes and reference electrodes.

The selection of the type cathodic protection system to be employed shall be specified by a Corrosion Engineer following preparation of preliminary piping layout drawings. Such selection shall be reviewed by DFW Energy & Utilities Services for approval.

All buried pressurized or immersed ferrous metal piping systems (except pre-insulated pipe) shall be properly coated, electrically isolated, bonded if necessary, and cathodically protected to prevent electrolytic corrosion.

Systems to be protected include but are not limited to:

- Jet Fuel Lines
- Interior of Aboveground Water
- Natural Gas or Heating Fuel Lines
- Storage Tanks (to include underground steel tanks and piping used for fueling)
- Potable Water Lines
- Fire Protection Water Lines
- Compressed Air Lines
- Pneumatic Lines
- Waste Oil Storage Tanks and Piping Systems
- Underground Fuel Storage Tanks and Appurtenances
- Hydraulic Elevators/Lifts and Piping Systems

Impressed current anodes shall be located to minimize stray current pick-up on unprotected or foreign metal structures. Care shall be taken to not place impressed current anodes near pre-stressed concrete pipe or reinforced concrete pipe, which could be damaged by excessive levels of cathodic protection current.

A sufficient number of test lead wires shall be installed on ferrous metal structures such as pipelines, so that interference situations can be analyzed and corrected. Cathodic protection interference problems and their solutions are rarely similar, precluding “rigid” or “set” specifications for mitigation. Multiple structures in an area of interference can be very complex,

requiring extensive coordinated testing under the direction of a Corrosion Engineer.

403.8 Water Storage Tanks

Steel water storage tanks shall be internally coated and provided with cathodic protection. The design of the cathodic protection system must not be detrimental to the applied coatings in the wetted area of the internal surfaces when the system is properly adjusted. The design life for the cathodic protection anodes shall be a minimum of 10 years.

Anodes shall be installed in the tank to provide uniform current distribution to all immersed surfaces.

DC current shall be supplied by a suitable transformer - rectifier power supply located adjacent to the tank. The rectifier shall be either a constant current, constant potential or 100% manually controlled unit, at the option of a Corrosion Engineer. Manually adjusted rectifiers are the least expensive to install, operate and maintain. Manually adjusted rectifiers shall be specified unless special conditions dictate otherwise.

A permanent copper-copper sulfate reference electrode(s) shall be installed close to the wall of the tank (between anode strings) for monitoring purposes.

The anodes shall be suspended from a roof mounted fiberglass deck mounts designed so that the anodes may be inspected or replaced without entering or draining the tank.

403.9 Above Ground Storage Tanks

403.9.1 Bottom Exterior. Tanks should be set on self-draining concrete or asphalt pads. If this is not done, external tank bottoms shall be sandblasted and coated with an approved coating system, and provisions shall be made to apply cathodic protection. All tanks not set on self-draining concrete or asphalt pads, shall have a minimum of one permanent reference electrode installed beneath the center of the tank.

When tanks are to be located on properly drained pads, one coat of an approved inorganic zinc coating shall be applied to the externally sandblasted surface prior to erection. The dry film coating thickness range shall be from 2.5 to 4.0 mils. Otherwise, cathodic protection shall be provided for the external tank bottom.

403.9.2 Tank Interior. The interior of all storage tanks shall be sandblasted and protected with an approved protective coating. If the tanks are equipped with floating roofs, the coating system shall have sufficient abrasion resistance to withstand movement of the roof.

403.9.3 Tank Exterior. The exterior surface of the tanks shall be coated with an approved coating.

403.10 Underground Storage Tanks

All metallic underground storage tanks (UST) or fittings shall be coated and cathodically protected or installed in containment piping systems in conformance with local, state and federal regulations. See Appendix B for specified manufacturer.

Ferrous metal USTs and appurtenances shall be coated with a protective coating.

If an approved (holiday free) factory fiberglass cladding system of at least 100 mils thick is applied, no cathodic protection is required. The appurtenances attached thereto shall be coated with a compatible coating and cathodically protected.

As an alternate, fiberglass reinforced plastic tanks may be installed. Ferrous metal appurtenances attached thereto shall be coated and cathodically protected or installed in containment piping systems. Where submerged turbine pumps are employed, a polarization cell shall be installed in the grounding circuit of the electrical power supply.

403.11 Hydraulic Elevators and Lifts

All direct buried hydraulic elevators or lifts shall be coated with a protective coating. The lift shall be isolated from all electrical equipment with insulating fittings. Cathodic protection shall be applied.

403.12 Fuel Hydrant Boxes

Flush mounted steel hydrant boxes to be located below grade shall be externally coated with a protective coating and cathodically protected. Cathodically protected piping entering and leaving the box shall be electrically isolated from the hydrant connection. All piping within the box shall be bonded together. Cathodic protection shall be provided to both the piping and fittings in contact with the soil.

403.13 Piling

Any steel in buried piles, directly exposed to the earth, shall be coated with a nominal 16 mil DFT single coat coal tar epoxy and cathodically protected if the strength of the full steel cross-section has been used in meeting structural requirements. The steel component of piles, if directly exposed to the soil, shall be bonded together by welding a reinforcing bar between all components or by provision of adequate bonding cables.

SECTION 404 PROCESS CONTROL INSPECTION AND TEST STATIONS

404.1 Test Stations

Test stations shall be installed flush to grade in a concrete slab, at predetermined locations to facilitate inspection of the system. Two test wires shall be connected to each buried structure or cluster of fittings by thermal welding and brought to the surface in an appropriate terminal box. All test stations shall be filled with clean native soil free of rocks, asphalt, or concrete.

When foreign structures are adjacent to protected structures, test wires shall be attached to both structures to facilitate interference testing and/or mitigation bonding, if necessary.

Aboveground test stations shall be specified wherever their use is permissible and will not conflict with aircraft or vehicular traffic. At-grade test stations shall be specified in locations where aboveground test stations are not appropriate.

404.1.1 Non-AOA Test Stations. All test stations installed that are not in the AOA, shall have a lockable cast iron lid with the cast-in legend "CP Test". A nonmetallic extension tube (minimum length of 18 inches), shall be attached to the head of each test station. Provisions shall be made for connecting the anode and structure lead wires inside the test station on a nonconductive terminal board.

404.1.2 AOA Test Stations. Test stations for installation in the AOA shall be an L-868 Class II ground support light base. The fixture shall include an adjustable base sufficiently long to extend through the concrete and into native soil. The fixture shall include a lockable steel lid with the welded legend "CP Test" in 1 inch high letters. See Appendix B for specified manufacturer.

404.2 Test Station Lead Wires

The test station structure and anode lead wires shall be black in color and a No. 12 AWG stranded copper wire with NFPA 70 type THW or equivalent insulation.

Copper sleeve adapters shall be used when thermit welding #8, or smaller, wires to structures.

Reference electrode lead wires shall be No. 14 AWG stranded copper wire with NFPA 70 type RHH-RHW insulation.

The following color code shall be used to identify test station lead wires:

STRUCTURE	WIRE COLOR
Protected Structure	white
Reference Electrode	yellow
Casing	red
Unprotected Side of Insulator	green
Anode Lead Wire	black
Foreign Structure	blue

404.3 Cathodic Protection Interference and Cooperative Testing

Where more than one independently cathodically protected structure is in the same area, currents flowing around one structure may affect another. This is particularly true when impressed current systems are used because of their greater operating current capacity and driving voltage. To overcome this problem, two lead wires shall be attached to each structure and brought to a surface test station.

Care must be taken to insulate DC powered equipment from ground or provide low resistance metallic paths for current return. Provision shall be made in the specification for interference testing by a Corrosion Engineer.

Coordination tests shall be carried out through local committees where they exist. These groups, representing all concerned area utilities and industries, coordinate testing and arbitrate solutions as required. As a rule, the organization owning a current source is responsible for the expenditures necessary for correction of a problem that it creates.

404.4 Access for Inspection

All equipment that may be subject to corrosion, or may require periodic maintenance, shall have reasonable access for inspection.

Boilers shall be equipped with firebox doors and access openings to superheat and preheat sections.

Flue gas ductwork shall be provided with reasonable access openings.

Appendix A
Green Building Standards

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Green Building Standards

Dallas / Fort Worth International Airport

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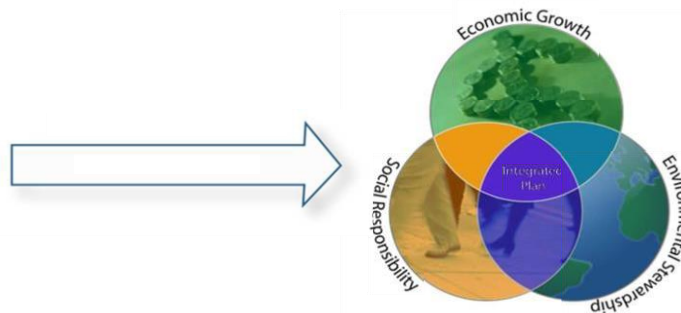
SECTION 1 Overview

Introduction

Dallas/Fort Worth International Airport (DFW) opened in 1974 and covers 29.8 square miles. DFW is the 3rd largest airport worldwide in terms of operations and 7th largest in terms of passenger volume. In addition to 5 terminals, a SkyLink, commercial centers, warehouses, offices, and hotels, the airport currently has 7 active runways and 174 gates. There are approximately 60,000 on-airport employees and a total economic output of \$16.6 billion is generated. In short, DFW is a major operation with ample opportunity to implement green building design. Though DFW has been executing sustainable best management practices for years, they have recently decided to formally adopt a structured sustainability program.

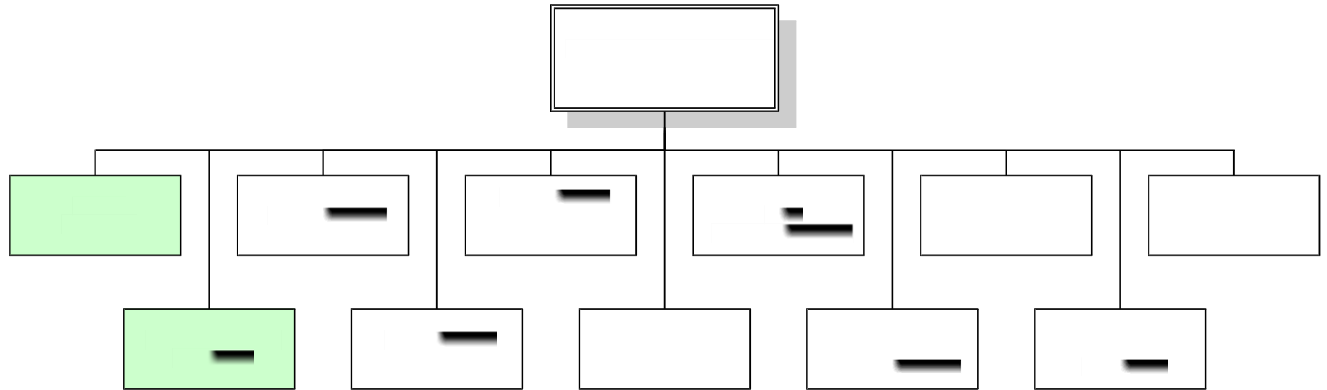
DFW Sustainability Program

In August 2008, DFW Airport launched an airport-wide Sustainability Policy and Program under the auspices of DFW's Executive Vice President Operation's Division. DFW's Sustainability Initiative is a key element in the Airport's Strategic Plan designed to positively affect the environment, the community, the Airport and its employees. DFW's Sustainability Initiative is about being environmentally friendly and being a strong corporate and community partner. Sustainability is a business approach that seeks to understand and balance economic, environmental and social objectives.



DFW's Sustainability Model

In order to implement DFW's Sustainability Initiative, a Green Building Team was assembled that established various focus areas in order to successfully implement sustainability throughout all airport activities.



This document, called the Green Building Standards (GBS), is the product of the work undertaken in the Green Buildings focus area. To aid the development of this work, the GBS Task Force (a subgroup of the Green Building Team) developed the following Charter Statement:

This interdepartmental group of stakeholders shall develop a “Green Building Program” for DFW Airport that: a) governs the design and construction of facilities constructed on Airport property, b) supports the Airport’s comprehensive sustainability strategy, and c) demonstrates the Airport’s commitment to environmental stewardship by utilizing “Best Business Practices” to effectively reduce the Airport’s consumption of natural resources.

GBS Intent

The Green Building Standards (GBS) was developed to provide project teams with sustainable design guidelines for infrastructure, interior/small renovation, major renovation, and new facilities. This document is intended to be used in conjunction with DFW’s “Design Criteria Manual”. All Board-controlled projects will implement the GBS. The GBS is not expected to be applied to Ground Lease Tenant projects and it is DFW’s intention to issue separate guidelines for these projects at a later date.

By developing a rigorous GBS framework, DFW will be able to measure and report over time on the implementation of sustainable design strategies at the airport.

GBS Development

The GBS was developed using the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) 2009 for Green Building Design and Construction rating system as the core standard. As the predominant market-based green building rating system in the U.S., LEED provides an internationally accepted and recognizable benchmark for sustainable design performance. Further, the following airport-specific guidelines were evaluated as notable airport sustainable design guidelines:

Chicago Department of Aviation Sustainable Airport Manual (SAM)

Los Angeles World Airports Sustainable Airport Planning, Design and Construction Guidelines

Port Authority of New York and New Jersey (PANYNJ) Sustainable Design Guidelines

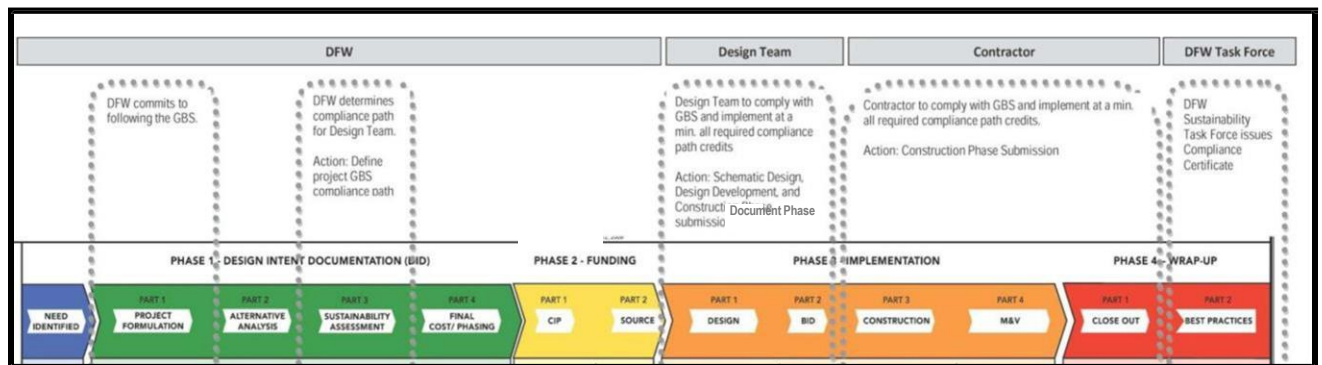
It is the deliberate intention that for all the LEED credits identified in the GBS, project teams will utilize the LEED Reference Guide and comply with the credit intent and requirements. The GBS also expressly goes beyond LEED by increasing the number of „required“ credits within the LEED system, and creating DFW Baseline Credits that emphasize sustainable project leadership, innovative design, and sustainable construction practices.

Within the GBS, four (4) compliance paths were established to reflect the wide-ranging types of projects that are typically undertaken at DFW Airport. Definitions and example projects are provided in Section 2 to assist project teams to correctly identify the appropriate compliance path for a project.

GBS and Project Development

The graphic below shows how the GBS process compliments the phases presented in the Project Development Procedure (PDP). The PDP is currently being developed by DFW as an integrated approach to sustainable airport development.

The top bar indicates the project team member that is responsible for implementing the GBS at the different phases of a project. The dashed boxes overlay the PDP process to identify the key actions during each phase.



Project Development Procedure (process portion only) produced by DFW with GBS overlay

GBS Structure

The GBS provides 5 succinct sections that steer a project team through the use of the GBS and the administrative procedures required to demonstrate GBS compliance.

Section 1 presents DFW’s sustainability objectives and introduces the Green Building Standards, including the document intent, development, and structure.

Section 2 presents the GBS applicability and administration for project teams to successfully comply with the process and documentation, including how to determine which compliance path should be followed for different types of projects.

Section 3 presents the GBS Checklist, which includes the compliance path for all four (4) types of projects and defines which credits are required and optional.

Section 4 presents the definition of all eight (8) required DFW Baseline Credits including credit intent, requirements, and documentation guidance.

Section 5 provides the required submission forms and templates that will be completed by the design and construction teams.

SECTION 2 Applicability and Administration

Applicability

All DFW Board-controlled projects must comply with the GBS and four compliance paths have been established to encompass the various types and sizes of projects that will be initiated. It is the responsibility of DFW to determine the appropriate compliance path during the Design Intent Documentation (DID) phase.

Compliance Paths – Types of Projects

The four project definitions are as follows.

Infrastructure (20 Required Credits): Infrastructure is defined as flat/civil engineering work and includes landscaping and utilities. *Examples: Runway paving, tree planting, surface parking, apron, waiting areas, park, etc.*

Interior/Minor Renovation (30 Required Credits): Interior and Minor Renovation projects are defined as projects where the scope of work either i) mainly comprises furniture, fixtures and equipment (FF&E) alterations, changes or upgrades, or ii) includes the replacement of up to two (2) system upgrades out of HVAC, electrical, plumbing and envelope upgrades. *Examples: Office reconfiguration, conference room remodeling, interior painting, ticket counter remodels, flooring, lighting upgrades, bathroom remodels, chiller replacement, window replacements, etc.*

Major Renovation (45 Required Credits): Major Renovation is defined as the replacement of more than two (2) systems out of HVAC, electrical, plumbing, significant envelope modifications and major interior rehabilitation. *Examples: Gut-rehab of terminal building, office building upgrade, etc.*

For major renovation projects that meet the LEED 2009 Minimum Program Requirements, the project team shall consider pursuing LEED certification.

New Facility (50 Required Credits): New Facility is defined as either a new building or a building addition or expansion. *Examples: New terminals, warehouses, distribution centers, control towers, information booths, fire stations, etc.*

For new facility projects that meet the LEED 2009 Minimum Program Requirements, the project shall achieve LEED-Silver certification.

Request for GBS Variance

If it is determined that a GBS compliance path is not feasible, the project team can submit a variance application to the DFW GBS Task Force. The variance application shall include:

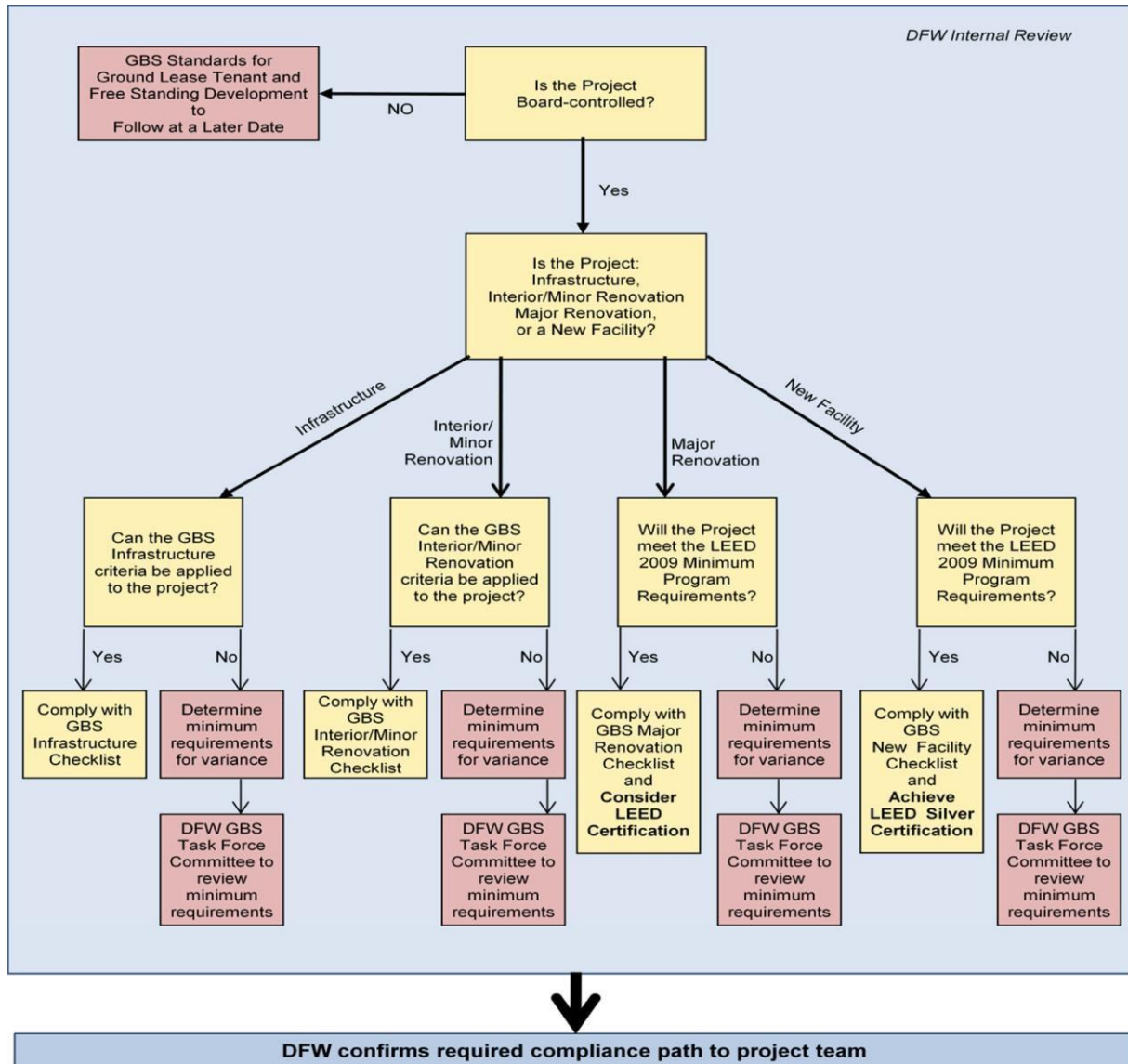
Project scope and budget

Reasons why each GBS required credit cannot be achieved

The DFW GBS Task Force will evaluate the application and issue a variance that will include confirmation of which credits, if any, the project is required to achieve.

GBS Project Compliance Path Flowchart

The following flow chart is provided to guide DFW’s decision-making process to determine the appropriate compliance path for each project.



LEED 2009 Minimum Program Requirements can be obtained at: <http://www.gbci.org/DisplayPage.aspx?CMSPageID=130>
 There are 7 requirements. 1) Must comply with environmental laws, 2) Must be a complete, permanent building or space, 3) Must use a reasonable site boundary, 4) Must comply with minimum floor area requirements (>1,000sqft), 5) Must comply with minimum occupancy rates (>1 FTE), 6) Must commit to sharing whole-building energy and water usage data, 7) Must comply with a minimum building area to site area ratio (gross floor area of the LEED project must be > 2% of gross land area within the LEED project boundary).

LEED Rating System Version

If the LEED rating system is updated or amended, the version that is current at the time of Design Intent Documentation (DID) shall be used. If the project team believes it is more favorable to utilize a later LEED version, during project development, the DFW GBS Task Force must be notified.

Codes and Regulations

The GBS shall not supersede any federal, state and local code or regulatory requirements.

Submissions

All submissions shall be emailed to the DFW GBS Task Force. Submissions are required at the completion of the following design milestones:

- Schematic Design
- Design Development
- Construction Documents
- Construction Phase

At each submission, the Project Team must submit/update the following documents (templates for both have been provided in Section 5):

- Project Description Form
- DFW GBS Worksheet

For LEED Projects: Regardless of whether or not the project pursues formal LEED certification, the GBS Worksheet must be completed for the Schematic Design and Design Development phases. For those credits that will be achieved through the LEED process, note in the Construction Documents and Construction Phase phases: "SEE LEED DOCUMENTATION".

Questions related to the GBS shall be emailed to the DFW GBS Task Force.

Review Process

The DFW GBS Task Force will review each submission and provide comments. The DFW GBS Task Force has two (2) weeks to provide comments/questions. If there are follow up actions, the design team will need to address each follow up action within one (1) week of issue. No confirmation of GBS compliance will be issued until completion of the project and all outstanding issues have been closed out.

Scoring and Rating

The GBS Checklist identifies all the credits that a project must achieve, which are denoted as „Required“. The number of required credits varies in each of the four compliance paths to reflect the different opportunities available to different types and scales of projects. Each project must achieve all the required credits. It is at the discretion of the project team whether or not to pursue additional credits that are denoted in the Checklist as „Optional“.

A project is compliant with the GBS when all required credits are achieved. There is no tiered rating system within the checklist. However, the Certificate of Compliance will indicate how many required and optional credits were achieved.

Compliance Certificate

After the Construction Phase submission is submitted and approved by the DFW GBS Task Force, a Certificate of Compliance will be issued (combining the design and construction of a project). The Certificate of Compliance will mark the achievement of environmental design and construction excellence as set forth by the DFW Green Building Standards.

The Certificate will indicate the number of achieved required credits out of the total number of required credits and will highlight where the project team has exceeded these requirements by achieving further optional credits. For example, an infrastructure project might achieve 17 out of the 20 required credits, plus 5 optional credits.

SECTION 3 Green Building Standards Checklist

Introduction

The DFW Green Building Standards (GBS) Checklist provides an overview of all the GBS sustainable design credits for each of the project type compliance paths, denoting which credits are required or optional.

There are four (4) project type compliance paths, which are defined in Section 2:

- Infrastructure (20 Required Credits)
- Interior/Minor Renovation (30 Required Credits)
- Major Renovation (45 Required Credits)
- New Facility (50 Required Credits)

The checklist is intended to be used as a framework for design teams to implement sustainable design on projects. There are a total of 64 credits that are either “required” or “optional”. The number of required credits varies depending on the project compliance path. However, sustainable design opportunities shall not be limited to the required credits only, and design teams are encouraged to evaluate the optional credits, as well as explore additional sustainable design opportunities, on all projects.

An example of the GBS checklist can be found on the following page. Forms can be acquired from the Skire/Unifier Document Manager location.

Types of Credits

DFW Baseline Credits were developed to address specific airport sustainable design issues. The intent and requirements for each DFW credit is explained in Section 4. All DFW Baseline credits are required for all projects.

DFW Requirements based on LEED 2009 are credits referenced directly from the LEED 2009 for Green Building Design and Construction rating system. In order to demonstrate compliance with these credits, project teams are required to follow the intent and requirements in accordance with the LEED Reference Guide. Formal LEED certification is only required for New Facility projects, but encouraged for Major Renovation projects.

LEED 2009 introduced Regional credits to highlight geographically significant environmental issues. There are 6 regional credits that have been identified next to the relevant credits in italics. Special attention should be given to achieving these credits.

Required/Optional Credits

- Required Credits “R” are credits that DFW has identified as being of particular importance, which include LEED prerequisite credits, and should be implemented on every project. It is understood that some projects, due to project scope or location, will not be able to achieve all required credits or that some credits may not be applicable. In these instances the Project Team shall include in the GBS Worksheet an explanation of why compliance was not possible.
- Optional Credits “O” are credits that the Design Team will evaluate on a project by project basis and will implement where feasible.

Document Title: Green Building Standards

Document Title: Green Building Standard Checklist
Version Date: 03/31/11

Credit		GBS Checklist Compliance Paths Required (R) / Optional (O)				Equivalent LEED 2009 Pts
		Infrastructure	Interior/ Minor Renovation	Major Renovation	New Facility	
DFW Baseline Credits						
DFW 1	Green Meetings	R	R	R	R	n/a
DFW 2	Sustainability Liaison	R	R	R	R	n/a
DFW 3	Integrated Design	R	R	R	R	n/a
DFW 4	Water Management Plan	R	R	R	R	n/a
DFW 5	Energy Management Plan	R	R	R	R	n/a
DFW 6	Material Durability	R	R	R	R	n/a
DFW 7	Acoustics and Noise	R	R	R	R	n/a
DFW 8	Construction Practices	R	R	R	R	n/a
DFW Requirements based on LEED 2009						
Sustainable Sites						
Prereq 1	Construction Activity Pollution Prevention	R	R	R	R	Prereq
Credit 1	Site Selection	O	O	O	O	1
Credit 2	Development Density and Community Connectivity	O	O	O	O	5
Credit 3	Brownfield Redevelopment (<i>Regional Credit</i>)	O	O	O	O	1
Credit 4.1	Alternative Transportation-Public Transportation Access	O	O	O	R	6
Credit 4.2	Alternative Transportation-Bicycle Storage and Changing Rooms	O	O	O	R	1
Credit 4.3	Alternative Transportation-Low-Emitting and Fuel-Efficient Vehicles	O	O	O	R	3
Credit 4.4	Alternative Transportation-Parking Capacity	O	O	O	O	2
Credit 5.1	Site Development-Protect or Restore Habitat (<i>Regional Credit</i>)	R	O	O	R	1
Credit 5.2	Site Development-Maximize Open Space	O	O	O	O	1
Credit 6.1	Stormwater Design-Quantity Control (<i>Regional Credit</i>)	R	O	R	R	1
Credit 6.2	Stormwater Design-Quality Control (<i>Regional Credit</i>)	R	O	R	R	1
Credit 7.1	Heat Island Effect-Non-roof	R	O	R	R	1
Credit 7.2	Heat Island Effect-Roof	O	R	R	R	1
Credit 8	Light Pollution Reduction	R	R	R	R	1
Water Efficiency						
Prereq 1	Water Use Reduction-20% Reduction	O	R	R	R	Prereq
Credit 1.1 - 1.2	Water Efficient Landscaping (Reduce by 50%, No Potable Water Use or Irrigation)	R At least 50%	O	R At least 50%	R At least 50%	2 to 4
Credit 2	Innovative Wastewater Technologies	O	O	O	O	2
Credit 3.1 - 3.3	Water Use Reduction - Reduce by 30%, 35%, 40%	O	O	R At least 30%	R At least 40%	2 to 4
Energy and Atmosphere						
Prereq 1	Fundamental Commissioning of Building Energy Systems	O	R	R	R	Prereq
Prereq 2	Minimum Energy Performance	R	R	R	R	Prereq
Prereq 3	Fundamental Refrigerant Management	O	R	R	R	Prereq
Credit 1.1-1.19	Optimize Energy Performance	O	O	R At least 10%	R At least 20%	1 to 19

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Document Title: Green Building Standards

Document Title: Green Building Standard Checklist
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Credit 2.1-2.7	On-Site Renewable Energy (1%, 3%, 5%, 7%, 9%, 11%, 13%) (Regional Credit)	O	O	O	R At least 1%	1 to 7
Credit 3	Enhanced Commissioning	O	O	R	R	2
Credit 4	Enhanced Refrigerant Management	O	O	O	O	2
Credit 5	Measurement and Verification	O	O	R	R	3
Credit 6	Green Power	O	O	O	O	2
Materials and Resources						
Prereq 1	Storage and Collection of Recyclables	O	R	R	R	Prereq
Credit 1.1-1.3	Building Reuse-Maintain Existing Walls, Floors, and Roof (Reuse 55%, 75%, 95%)	O	O	R At least 55%	O	1 to 3
Credit 1.4	Building Reuse-Maintain 50% of Interior Non-Structural Elements	O	O	R	O	1
Credit 2.1-2.2	Construction Waste Management (50%, 75% Recycled or Salvaged) (Regional Credit)	R At least 75%	R At least 75%	R At least 75%	R At least 75%	1 to 2
Credit 3.1, 3.2, 3.3	Materials Reuse (Reuse 5%, 10%)	O	O	O	O	1 to 2
Credit 4.1-4.2	Recycled Content (10%, 20% of Content)	R At least 20%	R At least 10%	R At least 20%	R At least 20%	1 to 2
Credit 5.1-5.2	Regional Materials: 10, 20% of materials (10%, 20% of Materials)	R At least 20%	R At least 10%	R At least 20%	R At least 20%	1 to 2
Credit 6	Rapidly Renewable Materials	O	O	O	O	1
Credit 7	Certified Wood	O	R	R	R	1
Indoor Environmental Quality						
Prereq 1	Minimum Indoor Air Quality Performance	O	R	R	R	Prereq
Prereq 2	Environmental Tobacco Smoke (ETS) Control	O	R	R	R	Prereq
Credit 1	Outdoor Air Delivery Monitoring	O	O	R	R	1
Credit 2	Increase Ventilation	O	O	O	O	1
Credit 3.1	Construction IAQ Management Plan-During Construction	R	R	R	R	1
Credit 3.2	Construction IAQ Management Before Occupancy	O	R	R	R	1
Credit 4.1	Low-Emitting Materials-Adhesives and Sealants	O	R	R	R	1
Credit 4.2	Low-Emitting Materials-Paints and Coatings	O	R	R	R	1
Credit 4.3	Low-Emitting Materials-Flooring Systems	O	R	R	R	1
Credit 4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	O	R	R	R	1
Credit 5	Indoor Chemical Pollutant Source Control	O	O	R	R	1
Credit 6.1	Controllability of Systems-Lighting	O	R	R	R	1
Credit 6.2	Controllability of Systems-Thermal Comfort	O	R	R	R	1
Credit 7.1	Thermal Comfort-Design	O	O	R	R	1
Credit 7.2	Thermal Comfort-Verification	O	O	R	R	1
Credit 8.1	Daylight and Views-Daylight	O	O	O	R	1
Credit 8.2	Daylight and Views-Views	O	O	O	R	1
Innovation and Design Process						
Credit 1.1-1.5	Innovation in Design: Specific Title	O	O	O	O	5
Credit 2	LEED Accredited Professional	O	O	R	R	1
Number of DFWGBS Required Credits		20	30	45	50	
Total Number of Required and Optional Credits		64	64	64	64	

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SECTION 4 DFW Baseline Credits

Introduction

DFW has established eight (8) airport-specific credits. These required credits have been included in the GBS to emphasize sustainable project leadership, innovative design, and sustainable construction practices.

DFW Baseline Credits

All projects that comply with the GBS are required to achieve all of the DFW baseline credits which are as follows:

DFW 1	Green Meetings
DFW 2	Sustainability Liaison
DFW 3	Integrated Design
DFW 4	Water Management Plan
DFW 5	Energy Management Plan
DFW 6	Material Durability
DFW 7	Acoustics and Noise
DFW 8	Sustainable Construction Practices

Definitions for each credit, including the credit intent, requirements, and documentation guidance, are provided in the following pages.

DFW 1: Green Meetings

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	n/a	n/a

Intent

To incorporate environmental considerations into the planning and conduct of meetings to minimize negative impacts on the environment.

Requirements

Where feasible, comply with the following green meeting requirements:

- Print all documents double-sided
- Utilize web-conferencing
- Minimize number of handouts
- Utilize recycled paper for printing
- Print in draft mode
- Use Video/phone conferences where feasible
- Promote public transport/carpool to meetings
- Recycle documents that are thrown away
- Engage with local companies for food/beverage services

Documentation Guidance

Provide a narrative to document all Green Meeting efforts in the GBS Worksheet for the following submission phases:

- Schematic Design
- Design Development
- Construction Documents
- Construction Phase

DFW 2: Sustainability Liaison

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	May contribute to LEED Innovation Credit	May contribute to LEED Innovation Credit

Intent

To ensure that sustainable design is implemented throughout the project during the design and construction phases of the project.

Requirements

Designate a Sustainability Liaison during both the design and construction phases of the project.

Design Sustainability Liaison:

- Individual is part of the Design Team
- Leads all Integrated Design Meetings
- Encourages Green Meetings
- Point Person for sustainability questions
- Must be familiar with the LEED rating system

Construction Sustainability Liaison:

- Individual is part of the Contractor Team
- Obtain the GBS Worksheet completed during the design phase
- Leads the Contractor Sustainability Liaison Meeting
- Encourages Green Meetings
- Develop contractor templates to track sustainability compliance for all LEED Material and Resource credits (i.e. VOC levels, recycled content, regional materials)
- Tracks all GBS contractor-driven credits to ensure compliance
- Point Person for sustainability questions
- Must be familiar with the LEED rating system

Documentation Guidance

Sustainability Liaison completes and submits the GBS Worksheet at the end of each phase:

- Schematic Design
- Design Development
- Construction Documents
- Construction Phase

Make a record in the GBS Worksheet if the Sustainability Liaison changes.

DFW 3: Integrated Design Meetings

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	May contribute to LEED Innovation Credit	May contribute to LEED Innovation Credit

Intent

To bring together all project stakeholders early on in the design process so that everyone is aware of the sustainability goals and project decisions can be made jointly and more efficiently.

Requirements

Hold at least one integrated design meeting, which includes the attendance of the entire design team (architect, electrical, mechanical, civil, structural engineers, landscape architect, commissioning authority, energy modeler, etc.) and all relevant stakeholders (DFW planning staff, facility managers, construction manager, contractor, etc.), at the beginning of each design phase and the construction phase.

All integrated design meetings shall be led by the Sustainability Liaison. The following tasks shall be undertaken during each of the phases:

Schematic Design

Discuss and identify project-specific sustainable design opportunities. Use the GBS Checklist as a framework for discussion.

Design Charette: Conduct at least one integrated design workshop with the full project team. The goal of the workshop shall be to optimize the integration of green strategies across all aspects of the building design, drawing on the expertise of all participants.

Design Development

Discuss and identify all of the sustainable design opportunities that will be implemented on the project. Assign a design team member to implement each credit that the project will pursue. Also discuss the required credits that cannot be achieved and provide an explanation for why the required credits are not applicable or not feasible.

Construction Documents

Discuss and ensure that all of the sustainable design criteria are implemented into the plans and specifications.

Construction Phase

Discuss how sustainable construction will be implemented and how GBS compliance will be monitored throughout construction.

Documentation Guidance

Document the dates of all Integrated Design meetings in the GBS Worksheet for the following submission phases:

- Schematic Design
- Design Development
- Construction Documents
- Construction Phase

DFW 4: Water Management Plan

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	n/a	n/a

Intent

To develop a water plan to evaluate the water and wastewater supply and demand of the project to understand and coordinate any synergistic opportunities to reduce and/or reuse water.

Requirements

Develop a Water Management Plan that addresses the following:

1. Identify all water demands:
 - Flush Fixtures
 - Flow fixtures
 - Irrigation
 - Cooling tower
 - Janitors sink
 - Showers
 - Others
2. Identify all potential water sources:
 - Graywater from flow fixtures
 - Reclaimed Water
 - Stormwater runoff
 - Municipal water
 - Others
3. Identify opportunities for water use reduction, capture, on-site treatment, and reuse.
4. Evaluate feasibility of implementing water reduction, capture, on-site treatment, and reuse strategies.

Documentation Guidance

Submit the Water Management Plan with the Design Development Phase submission only.

DFW 5: Energy Management Plan

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	n/a	n/a

Intent

To develop an energy plan to evaluate the energy use of all of the building systems to understand if there are opportunities to reduce energy consumption, identify available sources of energy and set future energy reduction targets.

Requirements

Develop an Energy Management Plan that addresses the following:

1. Identify all energy consuming systems. At a minimum:
 - HVAC & Refrigeration
 - Lighting (interior and exterior)
 - Domestic Hot water systems
 - Renewable energy systems (if applicable)
 - Baggage systems
 - Vertical transportation
 - Others
2. Identify opportunities for energy use reduction such as:
 - Lighting and Daylighting Controls
 - Building energy management system / controls
 - High efficiency equipment
 - Others
3. Consideration of purchased off-site green power.
4. Consideration of installing on-site renewable energy systems.
5. Understanding of baseline energy consumption, and establishment of annual energy saving targets for next 5 years.
6. Consideration of Preventative Maintenance and Operation & Maintenance procedures

Documentation Guidance

Submit the Energy Management Plan with the Design Development Phase submission only.

DFW 6: Material Durability

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	May contribute to LEED Innovation Credit	May contribute to LEED Innovation Credit

Intent

To evaluate the use of more durable, longer lasting materials and finishes to extend building life and reduce maintenance and replacement requirements.

Requirements

Develop a list of primary permanent building and finish material options and identify the factors that contribute to their durability. In particular, when less durable materials are chosen, explain the factors that have influenced this decision.

Evaluation should include:

- Expected life of material
- Affordability
- Availability
- Use of industry standard forms and sizes
- Replacement considerations
- Non-custom materials
- Operation & Maintenance considerations
- Contribution to sustainability of project (i.e. recycled, renewable, local materials)

Documentation Guidance

Document all materials options for the project and their durability considerations for the following submission phases:

- Schematic Design
- Design Development
- Construction Documents

DFW 7: Acoustics and Noise

Project Type	Infrastructure	Interior / Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	May contribute to LEED Innovation Credit	May contribute to LEED Innovation Credit

Intent

To improve the acoustics and noise levels in buildings to enhance indoor environmental quality for staff and passengers.

Requirements

- Design building envelope to diminish external sources of noise and vibration
- Locate mechanical equipment rooms away from occupied spaces
- Design interior separations to minimize transfer of noise
- Utilize dampening equipment to minimize noise
- Specify sound attenuation materials

Documentation Guidance

Provide a narrative in the GBS Worksheet on how the design/modifications have contributed to noise abatement for the following submission phases:

- Design Development
- Construction Documents

DFW 8: Sustainable Construction Management Plan

Project Type	Infrastructure	Interior/Minor Renovation	Major Renovation	New Facility
Points	Required	Required	Required	Required
LEED Equivalent	n/a	n/a	n/a	n/a

Intent

To ensure that sustainable construction practices are implemented to minimize pollution, noise, and vibration from construction activities and vehicles.

Requirements

In addition to achieving the Construction Activity Pollution Prevention credit (LEED SS Prerequisite 1) and Construction Waste Management credit (LEED MR 2.1-2.2), prepare a Sustainable Construction Management Plan that highlights all additional sustainable construction practices that will be implemented. The plan should consider the following best management practices:

Construction Practices

- Identify a Sustainability Liaison to track construction sustainable practices (DFW 2)
- Develop and implement sustainable construction training
- Implement an Integrated Pest Management plan
- Reduce potable water use during construction (e.g. use recycled water for vehicle wheel washing)
- Recycle and reuse temporary construction materials
- Evaluate earthwork storage and reuse opportunities
- Reduce construction light pollution and use energy efficient temporary lighting
- Purchase energy star appliances for all field offices
- Promote alternative fuel vehicles for contractor on-road vehicles
- Promote construction staff carpool programs
- Implement noise reduction strategies from temporary construction practices (interior and exterior noise)

Construction Vehicles

- Implement diesel retrofit technology where practicable on non-road construction equipment in accordance with EPA diesel retrofit recommendations
- Limit unnecessary idling times on diesel powered engines to 3 minutes
- Limit non-road diesel equipment of 60hp or greater to utilize ultra low sulfur diesel fuel (limit sulfur levels to 15ppm)
- Promote the use of biodiesel where feasible
- Promote the use of low-emission construction vehicles (e.g. diesel-electric hybrid vehicles)

Documentation Guidance

Provide a narrative to document sustainable construction efforts in the GBS Worksheet during the following submission phases:

Design Development and Construction Documents – The design team shall identify recommended sustainable construction practices and include in specifications

Construction Phase – The contractor shall prepare a Sustainable Construction Management Plan that highlights all implemented sustainable construction practices

SECTION 5 Submission Templates

Introduction

For each project, the designated Sustainability Liaison is required to complete and submit the following documents at the end of each design milestone:

1. Project Description Form
2. Green Building Standard Worksheet

The completed Project Description Form and the Green Building Standard Worksheet shall be submitted to the DFW GBS Task Force for review, comments, and approval.

Templates can be obtained electronically within the Document Manager section of Skire/Unifier.

GBS Worksheet Guidance

In summary, each milestone will require the following portion of the GBS Worksheet to be completed:

Schematic Design Identify Sustainable Design Opportunities

Task: Complete DFW checklist and identify the possible achievement of credits (Yes, Maybe, No, n/a).

Design Development Implement Opportunities

Task: For all „yes“ credits, provide a brief description of how the credit will be implemented. If a required credit (R) cannot be achieved, provide an explanation of non-compliance.

Construction Documents Provide narrative/drawing/specification reference

Task: For all „yes“ credits, provide a brief narrative of how the credit has been implemented or reference the relevant specification section or drawing to confirm implementation. If a required credit (R) cannot be achieved, provide a brief explanation of non-compliance.

Construction Phase Verify Sustainable Construction

Task: For all „yes“ credits, track and monitor credits implemented during the construction phase. Provide evidence (calculations, narratives, reference documents) that prove compliance.

LEED Projects

Regardless of whether or not the project pursues formal LEED certification, the Green Building Standard Worksheet must be completed for the Schematic Design and Design Development phases. For those credits that will be achieved through the LEED process, note in the Construction Documents and Construction Phase phases: “SEE LEED DOCUMENTATION”.

Document Title: Green Building Standards

Document Title: Project Description Form
 VersionDate: 03/31/11

SubmissionDate	
DFW Project Identification#	
ProjectName	
PrOject 1 rack (IntrastructureJintenorMinor Renovation/Major Renovation/NewFacility)	
Istheproject pursuing formalLEED certification (dateregistered)?	
Submission Milestone (SDDD,CD, Construction Phase)	
Datesof Previous Submissions	
Sustainability Liaison (Submission Completedby)	
SubmissionVerifiedby (Name and roleon Project)	
Lead Archtect/Engineer	
CommissioningAgent	
EnergyModeler	
Contractor	
Estimated construction cost and completion date	
Brief Project Scopeand Description	
Identify any Significant Changes since the lastsubmissionthataffectthe sustainabilityof the project	
ProjectArea (sqft)	
BuflingArea(sqft)	
PerviousArea (sqft)	
ImperviousArea (sqft) (Note parkingarea if applicable)	
Occupancy (Mae & femalebreakdown)	

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DOCUMENT TITLE: GREEN BUILDING STANDARD WORKSHEET
 SUBMISSION DATE: 03/31/11

Submission Date							Submission Milestone (SD, DD, CD, Construction Phase)					
DFW Project Identification #							Sustainability Liaison (Submission Completed by)					
Project Name							Submission Verified by (Name and role on Project)					
Project Track (Infrastructure / Interior/Minor Renovation / Major Renovation/New Facility)							Dates of Previous Submissions					
Credit	GBS Checklist Track Required/Optional					HEMATIC DESIGN				DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	CONSTRUCTION
	Infrastructure	Interior/Minor Renovation	Major Renovation	New Facility	Equiv. LEED 2009 Pts	IDENTIFY SUSTAINABLE DESIGN OPPORTUNITIES (update checklist with later submissions to correlate with compliance)				IMPLEMENT OPPORTUNITIES (If the design team cannot implement a required credit, an explanation must be provided).	PROVIDE NARRATIVE, DRAWING OR SPECIFICATION REFERENCE	
						Yes	Maybe	No	n/a			
DFW Baseline Credits												
DFW 1	Green Meetings	R	R	R	R	n/a						
DFW 2	Sustainability Liaison	R	R	R	R	n/a						
DFW 3	Integrated Design	R	R	R	R	n/a						
DFW 4	Water Management Plan	R	R	R	R	n/a						
DFW 5	Energy Management Plan	R	R	R	R	n/a						
DFW 6	Material Durability	R	R	R	R	n/a						
DFW 7	Acoustics and Noise	R	R	R	R	n/a						
DFW 8	Sustainable Construction Practices	R	R	R	R	n/a						
DFW Requirements based on LEED 2009 Sustainable Sites												
Prereq 1	Construction Activity Pollution Prevention	R	R	R	R	Prereq						
Credit 1	Site Selection	O	O	O	O	1						
Credit 2	Development Density and Community Connectivity	O	O	O	O	5						
Credit 3	Brownfield Redevelopment (Regional Credit)	O	O	O	O	1						
Credit 4.1	Alternative Transportation-Public Transportation Access	O	O	O	R	6						
Credit 4.2	Alternative Transportation-Bicycle Storage and Changing Rooms	O	O	O	R	1						
Credit 4.3	Alternative Transportation-Low-Emitting and Fuel-Efficient Vehicles	O	O	O	R	3						
Credit 4.4	Alternative Transportation-Parking Capacity	O	O	O	O	2						
Credit 5.1	Site Development-Protect or Restore Habitat (Regional Credit)	R	O	O	R	1						
Credit 5.2	Site Development-Maximize Open Space	O	O	O	O	1						
Credit 6.1	Stormwater Design-Quantity Control (Regional Credit)	R	O	R	R	1						
Credit 6.2	Stormwater Design-Quality Control (Regional Credit)	R	O	R	R	1						
Credit 7.1	Heat Island Effect-Non-roof	R	O	R	R	1						
Credit 7.2	Heat Island Effect-Roof	O	R	R	R	1						
Credit 8	Light Pollution Reduction	R	R	R	R	1						

Credit	GBS Checklist Track Required/Optional	SCHEMATIC DESIGN				DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	CONSTRUCTION PHASE		
		Infrastructure	Interior Minor Renovation	Major Renovation	New Facility	Equiv. LEED 2009 Pts	IDENTIFY SUSTAINABLE DESIGN OPPORTUNITIES (update checklist with later submissions to correlate with compliance)	IMPLEMENT OPPORTUNITIES (If the design team cannot implement a required credit, an explanation must be provided).	PROVIDE NARRATIVE, DRAWING OR SPECIFICATION REFERENCE	VERIFY SUSTAINABLE CONSTRUCTION (Narrative, tracking, monitoring, and compliance)
Water Efficiency										
Prereq 1	Water Use Reduction-20% Reduction	O	R	R	R	Prereq				
Credit 1.1 - 1.2	Water Efficient Landscaping (Reduce by 50%, No Potable Water Use or Irrigation)	R At least 50%	O	R At least 50%	R At least 50%	2 to 4				
Credit 2	Innovative Wastewater Technologies	O	O	O	O	2				
Credit 3.1 - 3.3	Water Use Reduction - Reduce by 30%, 35%, 40%	O	O	R At least 30%	R At least 40%	2 to 4				
Energy and Atmosphere										
Prereq 1	Fundamental Commissioning of Building Energy Systems	O	R	R	R	Prereq				
Prereq 2	Minimum Energy Performance	R	R	R	R	Prereq				
Prereq 3	Fundamental Refrigerant Management	O	R	R	R	Prereq				
Credit 1.1-1.19	Optimize Energy Performance	O	O	R At least 10%	R At least 20%	1 to 19				
Credit 2.1-2.7	On-Site Renewable Energy (1%, 3%, 5%, 7%, 9%, 11%, 13%) (Regional Credit)	O	O	O	R At least 1%	1 to 7				
Credit 3	Enhanced Commissioning	O	O	R	R	2				
Credit 4	Enhanced Refrigerant Management	O	O	O	O	2				
Credit 5	Measurement and Verification	O	O	R	R	3				
Credit 6	Green Power	O	O	O	O	2				
Materials and Resources										
Prereq 1	Storage and Collection of Recyclables	O	R	R	R	Prereq				
Credit 1.1-1.3	Building Reuse-Maintain Existing Walls, Floors, and Roof (Reuse 55%, 75%, 95%)	O	O	R At least 55%	O	1 to 3				

Credit	GBS Checklist Track Required/Optional	HEMATIC DESIGN				DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	CONSTRUCTION PHASE			
		Infrastructure	Interior Minor Renovation	Major Renovation	New Facility	Equiv. LEED 2009 Pts	IDENTIFY SUSTAINABLE DESIGN OPPORTUNITIES (update checklist with later submissions to correlate with compliance)	IMPLEMENT OPPORTUNITIES (If the design team cannot implement a required credit, an explanation must be provided).	PROVIDE NARRATIVE, DRAWING OR SPECIFICATION REFERENCE	VERIFY SUSTAINABLE CONSTRUCTION (Narrative, tracking, monitoring, and compliance)	
											Yes
Credit 1.4	Building Reuse-Maintain 50% of Interior Non-Structural Elements	O	O	R	O	1					
Credit 2.1-2.2	Construction Waste Management (50%, 75% Recycled or Salvaged) (Regional Credit)	R At least 75%	R At least 75%	R At least 75%	R At least 75%	1 to 2					
Credit 3.1, 3.2, 3.3	Materials Reuse (Reuse 5%, 10%)	O	O	R	O	1 to 2					
Credit 4.1-4.2	Recycled Content (10%, 20% of Content)	R At least 20%	R At least 10%	R At least 20%	R At least 20%	1 to 2					
Credit 5.1-5.2	Regional Materials: 10,20% of materials (10%, 20% of Materials)	R At least 20%	R At least 10%	R At least 20%	R At least 20%	1 to 2					
Credit 6	Rapidly Renewable Materials	O	O	O	O	1					
Credit 7	Certified Wood	O	R	R	R	1					
Indoor Environmental Quality											
Prereq 1	Minimum Indoor Air Quality Performance	O	R	R	R	Prereq					
Prereq 2	Environmental Tobacco Smoke (ETS) Control	O	R	R	R	Prereq					
Credit 1	Outdoor Air Delivery Monitoring	O	O	R	R	1					
Credit 2	Increase Ventilation	O	O	O	O	1					
Credit 3.1	Construction IAQ Management Plan-During Construction	R	R	R	R	1					
Credit 3.2	Construction IAQ Management Before Occupancy	O	R	R	R	1					
Credit 4.1	Low-Emitting Materials-Adhesives and Sealants	O	R	R	R	1					
Credit 4.2	Low-Emitting Materials-Paints and Coatings	O	R	R	R	1					
Credit 4.3	Low-Emitting Materials-Flooring Systems	O	R	R	R	1					
Credit 4.4	Low-Emitting Materials-Composite Wood and Agrifiber Products	O	R	R	R	1					
Credit 5	Indoor Chemical Pollutant Source Control	O	O	R	R	1					
Credit 6.1	Controllability of Systems-Lighting	O	R	R	R	1					
Credit 6.2	Controllability of Systems-Thermal Comfort	O	R	R	R	1					
Credit 7.1	Thermal Comfort-Design	O	O	R	R	1					
Credit 7.2	Thermal Comfort-Verification	O	O	R	R	1					
Credit 8.1	Daylight and Views-Daylight	O	O	O	R	1					
Credit 8.2	Daylight and Views-Views	O	O	O	R	1					

Credit	GBS Checklist Track Required/Optional	SIGN				DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	CONSTRUCTION PHASE
		Infrastructure	Interior Minor Renovation	Major Renovation	New Facility	Identify Sustainable Design Opportunities (update checklist with later submissions to correlate with compliance)	Implement Opportunities (If the design team cannot implement a required credit, an explanation must be provided).	Provide Narrative, Drawing or Specification Reference
		Yes	Maybe	No	n/a			
Innovation and Design Process								
Credit 1.1-1.5	Innovation in Design: Specific Title	O	O	O	O	1		
Credit 2	LEED Accredited Professional	O	O	R	R	1		
Total Credits						0	0	0

ADDITIONAL NOTES

Appendix B

List of Recommended Manufacturers

"This appendix is not a part of the requirements of this Design Criteria Manual but is included for informational purposes only."

APPENDIX B: List of Recommended Manufacturers

SECTION	PRODUCT	MANUFACTURER	MODEL
082.1 "Door Hardware"	Door Lock Cores	Cormax	Not Listed
082.2 "Lock Sets"	Lock Set Cores	Cormax	Best Brand
101.5 "Accessories"	Pull Paper Towel Dispenser	Kimberly-Clark	Professional model 09990 In-sight Sanitouch Hard Roll Towel Dispenser,,12 3/5 x 10 1/5 x16 1/10, Smoke/Approved equivalent.
213.2 "Safe-Type Box and Lock System"	"Safe" Type key Box & Lock	Knox Company	Not Listed
229.2 "Commercial Water Closets"	Flush Valve System for Water Closets in Terminal Buildings	Sloan	Royal 152-1.28 WB ES-S Flush Valve System.
229.2 "Commercial Water Closets"	Flush Valve System for Water Closets in Other Facilities	Sloan	"Optima" Automatic No. 152111 ES-S or equivalent wall mounted flush valves.
229.3 "Commercial Urinals"	Flush valves for Urinals in Terminal Buildings	Sloan	195-0.5-WB-ES-S Royal Optima Flush Valve System.
229.3 "Commercial Urinals"	Flush valves for Urinals in Other Facilities	Sloan	"Optima" Automatic No. 180-1.0 ES-S /Approved equivalent
229.4 "Commercial Lavatories"	Hand Washing Faucet for Commercial Lavatories in Terminal Buildings	Sloan	Optima System ETF-600 Electronic Hand Washing Faucet with a 0.5 GPM flow rate.
229.4."Commercial Lavatories"	Faucets in Terminal Building	Kohler/Approved Equal	**Self closing adjustable from five (5) seconds to fifteen (15) seconds.
229.7 "Electric Water Coolers"	Water Cooler	Halsey-Taylor	Wall hung electric water coolers/Approved Equal
233.1 Ductwork Insulation	Flexible Duct Outer Fiberglass Jacket	Thermaflex	M-KC or Equivalent
235.2.3 "Chilled Water From Central Plant"	Flow Rate Control Device	Griswold/Flow Design/Approved Equal	Not Listed
235.2.4 "Chilled Water From ESP"	Maximum Flow Control Device	Griswold/Approved Equal	Not Listed
265.2.4 "Primary (25kV) Duct Bank"	Spacers	Carlton	Snap-Lock/Approved Equal
263.1 "Manholes and Handholes"	Heat Sealing Tags	Scotch	HB-21/Approved equal
281.2 "Security Gates and Other Security Devices across Fire Apparatus Access Roads"	ACCESS CONTROL/Facilities	3M	Bi-directional Opticom system
284.1 "Operation and Fire Detection and Alert Notification System"	UL 864 UOJZ and UUKL listed Fire Alarm System Panel	Honeywell	Not Listed
285.2.2 "Fire Detection and Alert Notification System"	Fire Detection and Alert Notification System	Honeywell	Silent Knight 5104 Slave dialer, XLS1000 3-MODCOM DACT
286.7 "Post and Cable System"	Cable Safety System	Trinity Industries, Inc.	Not Listed
286.9 "Gate Barriers"	AOA Gate Barriers	Delta Scientific Corporation; Smith & Wesson	DSC7000;USRGRAB-spsystem/Approved equivalent.

APPENDIX B: List of Recommended Manufacturers

SECTION	PRODUCT	MANUFACTURER	MODEL
286.10 "Gate Locks"	Gate Locks - electronic lock and key system	Intellikey	Stand-Alone System compatible with ASC 4000 System or DPS approved equal
286.12 "AOA Guard Stations"	Guard House AOA Gates	Port-A-King Building Systems	Model DA75S/Approved equivalent.
289.3 "Special Equipment"	Announcement Control System	IED	1100ACS
289.3 "Special Equipment"	Message Server	IED	1100MSG
289.3 "Special Equipment"	Power supply for Announcement Control System	IED	1112PS
289.3 "Special Equipment"	Integrated Digital Power amplifier Mainframe	IED	T9160
289.3 "Special Equipment"	Digital Amplifier Card	IED	<ul style="list-style-type: none"> • 200W: T6472 • 400W: T6471
289.3 "Special Equipment"	Digital Communications Stations	IED	<ul style="list-style-type: none"> • Desktop Horizontal Station: 528HDT • Desktop Vertical Station 528VDT • Wall-Mount Vertical Station: 528VFM • Wall-Mount Horizontal Station: 528HFM • Wall-Mount Expansion Station: 528SK • Surface Mount Horizontal Station: 528HFM • Rack-Mount Station: 528RM2-H
289.3 "Special Equipment"	Ambient Noise Sensor Collector	IED	T9032NS
289.3 "Special Equipment"	Ambient Noise Sensor	IED	541S
289.3 "Special Equipment"	Background Music Hub	IED	T0516BGM
289.3 "Special Equipment"	I/O Collector	IED	T9064LVIO
289.3 "Special Equipment"	End-Of-Line filter Module	IED	596EOL
326.1 "Irrigation Equipment"	All Irrigation Materials	Rainbird	(Piping and Fitting must be 40 Purple PVC)

APPENDIX B: List of Recommended Manufacturers

SECTION	PRODUCT	MANUFACTURER	MODEL
326.3 "Irrigation Controllers"	Irrigation Controllers	Rainbird	Stainless Steel Cabinet Models - ESP-SAT-TW-SS controllers/Approved equivalent.
326.4 "Freeze Sensors"	Freeze Sensors	Hunter Industries	"Freeze-Clik" /Approved equivalent.
326.5 "Rain Sensors"	Rain Sensors	Rainbird	Rain Counter model number S-300/Approved equivalent.
326.6 "Wiring"	Wiring	3M	12 gauge-UF irrigation wire using "DBY" or "DBR" connectors
326.7 "Gate Valves"	Gate Valves	Mueller	four (4) inch or three (3) inch size with standard cube head on stem/Approved equivalent.
326.7 "Gate Valves"	Electric Remote Control Valves	Rainbird	GB-Series valves /Approved equivalent.
326.9 "Quick Coupler Valves"	Flush Lawn Quick Coupler Valves	Rainbird	33D/Approved equivalent.
3.26.10 "Maintenance Equipment"	Maintenance Equipment	Rainbird	Maxicom/Approved equivalent.
329.1 "Large Grass Areas"	Sprinklers	Rainbird	900 or 950 Eagle or Falcon heads/Approved equivalent.
329.2 "Small Grass Areas"	Pop-Up Spray Heads	Rainbird	1800 Series/Approved equivalent.
329.3 "Groundcover"	Groundcover underplanting for the Tree Crepe Myrtles	Rainbird	1812 Series
329.3 "Groundcover"	Rotor type heads for large open plantings of groundcover	Rainbird	5000 Series rotors, model 5004/Approved equivalent.
332.4 "Water Line Connection"	Tapping Water Main Standards and corporation stops	Mueller	H-15000/Approved equivalent.
332.6 "Water Utility Distribution Valves"	Manual Air Release Valves: main line corporation stop	Mueller	H-15025 brass service fittings as required
332.6 "Water Utility Distribution Valves"	Manual Air Release Valves: curb stop	Mueller	H-15275 and soft copper pipe with flared fittings.
332.6 "Water Utility Distribution Valves"	Surface Box for manual air release	Trinity Valley Iron and Steel	Cast iron box and lid, twelve (12) inches deep and twelve (12) inches in diameter Trinity Valley Iron and Steel No. 4465 /Approved equivalent.
332.7 "Water Utility Distribution Fire Hydrants"	Hydrant Outlet	Hydra-Shield Manufacturing, Inc.	Hydra-Storz five (5") inch "Quick Coupler Adapter"
332.8 "Water Utility Metering"	Water Meter	Badger	Not Listed
332.8 "Water Utility Metering"	Positive Displacement Meters with Electronics for Pit/Vault Applications	Badger	<ul style="list-style-type: none"> 5/8" x 3/4 M-25 Meter with RTR and Pit Electronics with 3' lead 1" M-70 Meter with RTR and Pit Electronics with 3' lead

APPENDIX B: List of Recommended Manufacturers

SECTION	PRODUCT	MANUFACTURER	MODEL
			<ul style="list-style-type: none"> 1-1/2" M-120 Meter with Test Plug and RTR and Pit Electronics with 3' lead 2" M-170 Meter with Test Plug and RTR and Pit Electronics with 3' lead
332.8 "Water Utility Metering"	Positive Displacement Meters with Electronics for Mechanical Room/Interior Application	Badger	<ul style="list-style-type: none"> 5/8" x 3/4 M-25 Meter with RTR and Outdoor Remote NOT PREWIRED 1" M-70 Meter with RTR and Outdoor Remote NOT PREWIRED 1-1/2" M-120 Meter with Test Plug RTR and Outdoor Remote NOT PREWIRED 2" M-170 Meter with Test Plug RTR and Outdoor Remote NOT PREWIRED
332.8 "Water Utility Metering"	Turbin Meters with Electronics for Pit/Vault Application	Badger	<ul style="list-style-type: none"> 1-1/2" T160 Turbo Meter with Strainer RTR and Pit Electronics 2" T200 Turbo Meter with Strainer RTR and Pit Electronics 3" T450 Turbo Meter with Strainer RTR and Pit Electronics 4" T1000 Turbo Meter with Strainer RTR and Pit Electronics 6" T2000 Turbo Meter with Strainer RTR and Pit Electronics 8" T3500 Turbo Meter with Strainer RTR and Pit Electronics 10" T5500 Turbo Meter with Strainer RTR and Pit Electronics 12" T6200 Turbo Meter with Strainer RTR and Pit Electronics 16" T6600 Turbo Meter with Strainer RTR and Pit Electronics
332.8 "Water Utility Metering"	Turbine Meters with Electronics for Mechanical Room/Interior Application	Badger	1-1/2" T160 Turbo Meter with Strainer RTR and Outdoor Remote NOT PREWIRED
337.6."Pipe Stiffeners"	Pipe Stiffeners	JMC Industries or pre-approved equal.	Not Listed

APPENDIX B: List of Recommended Manufacturers

SECTION	PRODUCT	MANUFACTURER	MODEL
403.1 Process Piping and Equipment Insulation"	Coating for Buried Insulating Fittings	Royston; Mavor-Kelly	R-28, A-51 Plus; B-50/Approved equivalent.
403.1 Process Piping and Equipment Insulation"	Modular Links	Thunderline	Link-Seals.
403.2 "Underground Piping System"	Cast Iron and Ductile Iron Pipe, Fittings, Valves and Fire Hydrant Coating	Royston	R-28
403.2 "Underground Piping System"	Cast Iron and Ductile Iron Pipe, Fittings, Valves and Fire Hydrant Coating w/ possibility of soil contamination by jet fuel	Royston	A-51 Plus/Approved equivalent
403.2 "Underground Piping System"	Field Joint Repair Coating	Royston	Mastic coating equivalent to Royston A-51 Plus, two-component systems such as coal tar epoxy or the pipe coating manufacturer's recommended repair coating.
403.10 "Underground Storage Tanks"	Polarization Cell	Kirk Cell	K-5 /Approved equivalent.
404.1 "Test Stations"	AOA Test Station	Crouse-Hinds, Inc.	L-868 Class II Ground Support Light Base/Approved equivalent.

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Appendix C

Standard Details

ELECTRICAL DETAILS

Detail Number	Description
26-1	Ballard Detail
26-2	Blast Structure Obstr. Lights
26-003	Cable Identification Label
26-004	Direct Buried Cable Install.
26-005	Cable Marker Installation
26-6	Cable Marker Details
26-7	Splice and Connector Detail
26-008	One-Way 2" PVC Conduit
26-009	Buried Conduit Section
26-10	Conduit Connector
26-11	Conduit Bet. Existing & New
26-012	Conduit in Existing Pavement
26-013	In-Pavement Conduit Install.
26-014	Multi-way Conduit Sections
26-015	Conduit In New Pavement
26-016	Termination of Elec. Conduit
26-017	Conduit Terminating Detail
26-018	4" Drain Discharge Embank.
26-019	Drain Pipe to Storm Drain
26-020	One-Way 2" PVC Elec. Duct
26-022	Two-Way 4" PVC Elec. Duct
26-022	Two-Way 4" PVC Elec. Duct
26-023	Duct Bank Section
26-24	4L4 Duct Bank Sections
26-25	Duct Conn. To Existing Duct
26-026	Conduit Out of Duct Bank
26-027	Typical Bore Detail 4L4 Duct
26-028	Incomp. Duct to Exist. Duct
26-029	Direct Buried Elec Duct Notes
26-030	Direct Buried Duct Install.
26-31	Electronic Duct Marker
26-32	Interface Duct and Manhole
26-033	Duct Marker Installation
26-34	Duct Marker
26-35	Vert. Placement Elec. Duct
26-036	Elevated Edge Mkr. & Lt. Fix.
26-037	Elevated Retrorefl. Edge Mkr.
26-038	Semiflush Retro. Edge Mkr.
26-039	Typ. Ground Rod Connection
26-040	Gnd. Rod / Counterpoise Inst.
26-041	Mechanical Ground
26-042	Electric Handhole Detail
26-043	Handhole Notes
26-44	Typical Handhold Plan
26-45	Typical Handhold Section
26-046	Junction Can Elevation
26-047	Junction Can Section
26-48	Junction Can Drain

ELECTRICAL DETAILS

Detail Number	Description
26-49	Type B Junction Can Plazas
26-050	Light Base Section-Class II
26-051	Light Base Section-Class II
26-052	Fixture Installation in Pvmnt.
26-053	Centerline Lts. and Clear. Bar
26-054	Centerline Light Location
26-055	Centerline Fixture Install.
26-056	Light Base & Conduit Drain
26-057	Elevated Light Fixture Section
26-058	Light Base Mtg. Flex. Pvmnt.
26-059	Light Base Sec. Flex. Pvmnt.
26-060	Light Base Section-Class I
26-061	Light Base Section-Class I 26-
62	Light Base Section-Class I 26-
63	Light Base Section-Class I 26-
64	Light Base Section-Class I 26-
65	Light Fixture General Notes
26-066	Inset Lights in Exist. Pvmnt.
26-067	New Base in Existing Pvmnt.
26-068	Lt. Base Mtg. Rigid Pvmnt.
26-069	Lt. Base Section Rigid Pvmnt.
26-070	Semiflush Light Fixture
26-71	Step 1 Installation L-868
26-72	Step 2 Installation L-868
26-73	Step 3 Installation L-868
26-074	Light Bar Plan
26-75	Light Bar Elevation
26-76	Clearance Light Bar Location
26-077	Airfield Lighting Circuit Sched.
26-078	Airfield Light Fixture Sched.
26-079	Airfield Light Fixture Sched.
26-080	Identification Marker
26-081	Fixture Mounting Detail
26-082	Stopbar Light Colors
26-083	Runway Guardlight Locations
26-084	Semiflush Fixture Installation
26-085	Manhole and Handhole Notes
26-086	Concrete Corner Bar Detail
26-087	Manhole Cover Notes
26-088	Electric Manhole Detail
26-089	Manhole Frame and Cover
26-090	Manhole Penetration Grout
26-091	Manhole Stack Ladder Inst.
26-092	Lifting Eye Section
26-93	Pulling-in Iron
26-94	Electric Manhole Riser
26-095	Electric Manhole Section
26-096	Electric Manhole Section

ELECTRICAL DETAILS

Detail

Number	Description
26-097	Electric Sec. Manhole Notes 26-
98	Terminators In Manhole Wall 26-
99	Typical Electric Manhole
26-100	Typical Manhole Plan
26-101	Typical Manhole Notes
26-102	Electric Manhole Plan
26-103	Pull Box Notes
26-104	Concrete Pull Box
26-105	Pull Box Section
26-106	Bar Bending Detail in Pvmnt. 26-
107	Edge Light Base Reinf. Cage 26-
108	Runway Centerline Circuit
26-109	Cleat Detail
26-110	Runway Edge Light
26-111	Runway Edge Fixture Install.
26-112	Runway Section
26-113	Sign Base Notes
26-114	Sign Base Plan
26-115	Sign Base Section
26-116	Sign Base Schedule
26-117	Sign Conduit Connector
26-118	Sign Dimension Tables
26-119	Sign Installation Notes
26-120	Lighted Guidance Sign
26-121	Ltd. Guidance Sign Section
26-122	Sign Schedule
26-123	Ltd. Guidance Sign Pwr. Con.
26-124	TD Zone Lighting
26-125	TD Zone Lights Installation
26-126	TD Zone Runway Section
26-127	TXU 4 Way Manhole Detail
26-128	TXU Manhole Apron
26-129	TXU Manhole Cov. Bolt Hole
26-130	Pentahead Bolt
26-131	TXU Manhole Cover 26-
132	TXU Manhole Cover 26-
133	TXU Manhole Notes 26-
134	TXU Manhole Plan
26-135	TXU Manhole Section
26-136	Taxiway Elevated Edge Light
26-137	Clearance Lt. Bar Section 26-
138	Elev. Runway Guard Lt.Inst.
26-139	Clearance Lt. Bar At Taxiway
26-140	Elev. Runway Grd. Lt. Class I
26-141	Taxiway Semiflush Edge Lt.
26-142	Taxiway Shoulder Section
26-143	Wind Cone Base Plan
26-144	Wind Cone Section

CATHODIC DETAILS

Detail Number	Description
26-145	Mag. Anode Alternate Install.
26-146	Test Station Concrete Pad
26-147	Mag. Anode Preferred Install.
26-148	Magnesium Anode Test Sta.
26-149	Typical Anode Installation 26-
150	Cable Conn. to Structure
26-151	Polarization Cell Installation
26-152	Cath. Protect. Buried Fittings
26-153	Cathodic Protection Notes
26-154	Perm. Reference Electrode
26-155	Insulating Flange Detail
26-156	Ground Rod Detail
26-157	Hardware Assembly
26-158	Mech. Joint Continuity Bond
26-159	Pipe Casing Installation
26-160	Leadwire Splice
26-161	Termit Weld Detail

PAVING DETAILS

Detail Number	Description
32-1	Airfield Section 225 to Edge
32-2	Airfield Section 225 Greater
32-003	Airfield Pavement Shoulder
32-004	Typical Airfield Section
32-005	Holding Apron Section
32-006	16 ft ARFF Road Section
32-7	24 ft ARFF Road Section
32-8	24 ft ARFF Road Section
32-009	Survey Monument Bollard
32-010	Typical Bollard
32-011	Blast Pad Area Section
32-012	Type A Timber Barricade
32-013	Type B Timber Barricade
32-014	Barricade Location
32-15	Raised Island
32-16	Mountable Curb
32-17	Monolithic Curb
32-18	Superimposed Curb
32-19	Delineator Post
32-20	Edge Sodding
32-21	Grooving at Runway CL
32-022	Runway Grooves
32-023	Grooving at TD Zone Lights
32-024	Airfield Ground Rod
32-025	Type A Airfield Pvmt Joint
32-026	Types A&B Expansion Joint
32-027	Type B Airfield Exp Joint
32-028	Type B ARFF Exp Joint
32-029	CRCP Thick. Edge Constr Jt.
32-030	Type D Const Joint
32-031	Type D Const Joint Long
32-032	Alt. Type D Joint
32-033	CRCP Doweled Construction
32-034	CRCP Thick. Edge Expan Jt.
32-035	Type F Const Joint
32-036	Type F Const Joint w/ Dowel
32-037	Typical Fillet Joints
32-038	Type H Sawed Dummy Joint
32-039	Type H Dummy Joint
32-040	Keyed Construction Joint
32-041	Conc Asph Pvmt Joint
32-042	Conc Asph Pvmt Jt Sealant
32-043	JRCP Transition
32-044	Cont Reinf Conc Trans Joint
32-045	Thick Edge for MH Stacks
32-046	Haul Road Section
32-47	De-ice Facility Road

PAVING DETAILS

Detail Number	Description
32-48	RVR Road Cross Section
32-049	Dowel Bar Assembly 32-
050	Cont Reinf Conc Notes
32-051	Jointed Reinf Conc Notes
32-052	JRCP Reinforcing
32-053	Jointed Reinf Conc Sched
32-054	Cont Reinf Conc Table 32-
055	Runway Pavement Section
32-056	Conc. Apron Tiedown Anchor
32-057	Taxiway Cross Section
32-58	Taxiway Long. Section
32-59	Taxiway Blockout at Lights
32-060	Taxiway Blockout Section
32-061	Taxiway Shoulder Section

PAVEMENT MARKING DETAILS

Detail Number	Description
32-62	Apron Tie Down
32-63	Clr.Bar and Runway Grd.Lts.
32-064	Fire Lane Edge Marking
32-65	Construction Flag
32-66	Construction Flag Support
32-067	Paint Around Ground Rod
32-068	ILS Hold Position Markings
32-069	Intake Fan Marking Detail
32-070	Lighted Cone
32-071	Move/Non-Move Boundary
32-072	ARFF Road Intersection Plan
32-073	24 ft ARFF Road Marking
32-074	Elevated Refl. Edge Marker
32-075	Elevated Refl. Edge Mkr. ISO
32-076	Reflective Marker Plan
32-077	Semiflush Refl. Edge Marker
32-078	Taxiway Edge Marking
32-079	Taxi CL And Edge Reflectors
32-080	Taxi To Runway Holdbar
32-81	Taxi To Taxi Hold Position

FENCING DETAILS

Detail Number	Description
32-82	Channel Reinforcement
32-83	Cornerpost Installation
32-84	Bracket B
32-85	General Fencing Notes
32-086	Fence Hardware
32-87	20 ft Crash Gate
32-88	20 ft Gate
32-89	Double Gate
32-90	Gate Keeper
32-91	Gate Latch
32-92	Gate Stop Elevation
32-093	Gate Stop Section
32-094	Swing Gate
32-095	Gate Stop Tongue
32-096	Temporary Line Post
32-097	Mow Strip
32-098	Typical Pull Post Installation
32-099	AOA Sign
32-100	Wood Fence Panel

DRAINAGE DETAILS

Detail Number	Description
33-001	Class A Bedding
33-002	Class B Bedding
33-3	Excavation Diagram
33-4	Bedding / Excavation Dims.
33-005	Hay Bale Backing Detail
33-006	Straw or Hay Bale Fence
33-007	Straw or HB Fence Notes
33-008	Hay Bale Section
3-009	Water Poll./Silt Control Notes
33-010	Silt Fence Detail
33-11	Strap Anchor
33-12	Grate Frame Type D
33-13	Grating and Frame Notes
33-014	Grate Frame
33-015	Grate Frame Section T
33-016	Grate Frame Section U
33-017	Lifting Lug
33-018	Grate Support Section E
33-019	Grate Support Section G
33-020	Steel Grate
33-22	Steel Grate Section
33-022	Steel Grate Type D
33-23	Headwall Corner Section A
33-024	Headwall Dimensions Table
33-025	Concrete End Section B
33-026	Concrete End Treatment
33-027	Concrete End Section A
33-028	Headwall Reinforcement
33-29	Headwall Section
33-30	Headwall Type 'B' Elevation
33-031	Headwall Type 'B' Plan
33-32	Inlet Concrete Apron
33-33	Inlet Types B & C Section C
33-034	Inlet Corner Wall Reinf.
33-035	Inlet Corner Wall Reinf. 33-
36	Inlet Corner Wall Reinf. 33-
37	Inlet Type D Beam Section
33-038	Inlet Type D Foundation Plan
33-039	Drainage Structure Notes 33-
040	Inlet Dowel
33-041	Storm Drain Inlet Protection
33-042	Inlet Reinforcement Bars
33-043	Inlet Type A Section A 33-
044	Inlet Type A Section B 33-
045	Inlet Type B Section D

DRAINAGE DETAILS

Detail Number	Description
33-046	Inlet Type C Section H
33-047	Inlet Type D Section A
33-048	Inlet Type D Section B
33-049	Inlet Perimeter Wall Top
33-050	Inlet Type A Plan
33-051	Inlet Type B Plan
33-052	Inlet Type C Plan
33-053	Inlet Type D Plan
33-54	Expansion Joint Detail
33-55	MH Type B1 Top Slab Plan
33-056	MH Type B2 Top Slab Plan
33-057	MH Type B3 Top Slab Plan
33-058	MH Type B4 Top Slab Plan
33-059	MH Type B5 Top Slab Plan
33-060	Manhole Cover
33-61	Manhole Frame
33-62	Manhole Type P Cons. Notes
33-063	Manhole Type P Gen. Notes
33-064	Manhole P Stack Typical
33-065	Manhole at RCP Penetration
33-066	Manhole Reinf. Schedule
33-067	MH Stack to MH Butt Joint
33-068	Manhole Section R
33-69	Manhole Section S
33-70	Manhole P Stack Reinf. Sch.
33-071	Manhole S and S1 Section B
33-72	MH Type S&S1 Const. Notes
33-73	Manhole Type S and S1 Plan
33-74	Manhole S and S1 Section A
33-75	Manhole Steps
33-076	Manhole Typical Plan
33-077	Pipe Plug
33-78	Pipe Strengthening 18"-27"
33-79	Pipe Strengthening 30"-120"
33-080	Pipe Strengthening Notes
33-081	Lateral Pipe Strengthening
33-082	Conc. Arch Reinf. Stl. Table
33-083	Sub Drain Cleanout Detail
33-084	Sub Drain Connection Detail
33-085	Sub Drain Section
33-086	Slotted Drain Plug & Cleanout
33-087	Slotted Drain Section A
33-088	Slotted Drain Section B
33-089	Slotted Drain Section C
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33-091	Slotted Drain Elevation

DRAINAGE DETAILS

Detail Number	Description
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33-93	Typical Taxiway Section
33-094	Grate Frame Notes 1
33-095	Inlet MH Det 5 Butt JT
33-096	Inlet MH S and S1 Notes
33-097	Inlet MH Reinf Sched
33-098	Inlet MH Section S
33-099	Lateral Pipe Strength
33-100	MH Stack Steps
33-101	Pipe Strength 27
33-102	Pipe Strength 120

WATER DETAILS

Detail Number	Description
33-120	Backflow and Pit Detail
33-121	Concrete Collar Detail
33-122	Concrete Collar Section
33-123	Concrete Collar Reinforcement
33-124	Grade Cleanout Detail
33-125	In-Pavement Cleanout Detail
33-126	Two Way Grade Cleanout
33-127	Two Way In-Pvmt. Cleanout
33-128	Embedment for Water Lines
33-129	Fire Hydrant Barricade - Elev.
33-130	Fire Hydrant Barricade - Plan
33-131	Blocking Detail Fire Hydrant
33-132	Fire Hydrant Cover
33-133	Flush Fire Hydrant Details
33-134	Fire Hydrant Concrete Pad
33-135	Vert. Hydrant Branch Stub
33-136	Fire Hydrant Installation
33-137	Gate Valve and Box
33-138	Contraction Constr. Joint
33-139	Manhole Adjustment Details
33-140	Manhole Apron Section
33-141	Manhole Cover
33-142	Manhole Section
33-143	Sump in Manhole Detail
33-144	Type C Concrete Stack
33-145	Manhole Step Details
33-146	Pavement Section
33-147	Reinforcement Bar Details
33-148	Duplex Sump Pump
33-149	Thrust Blocking

WATER DETAILS

Detail Number	Description
33-150	Thrust Blocking Section
33-151	Thrust Blocking Detail
33-152	Horizontal Bend Thrust Block
33-153	Plug and Tee Thrust Block
33-154	Plug Thrust Block Plan
33-155	Tee Thrust Block Plan
33-156	Vertical Bend Thrust Block
33-157	Temp. Contractor Water Serv.

STORM DETAILS

Detail Number	Description
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33-159	Retaining Bracket
33-160	Inlet Apron
33-161	Underdrain Inlet Connection
33-162	Pavement Underdrain Detail
33-163	PVC to RCP Pipe Connection
33-164	Trench Drain Grate Fr. – Elev.
33-165	Trench Drain Grate Fr. – Sec.
33-166	Trench Drain General Notes
33-167	Trench Drain Grate Fr. Plan
33-168	Trench Drain LD Grate Elev. 1
33-169	Trench Drain LD Grate Elev. 2
33-170	Trench Drain Grate Plan
33-171	Trench Drain Long. Plan
33-172	Trench Drain Long. Section
33-173	Trench Drain Section
33-174	Underdrain Y Connection

SANITARY DETAILS

Detail Number	Description
33-175	Sanitary Sewer Cleanout
33-176	Industrial Waste Line Embed.
33-177	Concrete Encasement
33-178	Sewer Connection to Manhole
33-179	Manhole Cover and Frame
33-180	Manhole General Notes
33-181	Manhole Stack Butt Joint
33-182	Manhole Section A
33-183	Manhole Section B

SANITARY DETAILS

Detail Number	Description
33-184	Manhole Type P Stack
33-185	Manhole Type A-1 Plan
33-186	Pipe Trench Excavation

FUEL DETAILS

Detail Number	Description
33-187	Low Point Drain MH Plan
33-188	Low Point Drain MH Section
33-189	Fuel Line Embedment
33-190	Fuel Hydrant Leaveout
33-191	Fuel Hydrant Pit Detail
33-192	Fuel Line In Concrete Pvmnt.
33-193	Cover Detail
33-194	Emergency Fuel Shutdown Sign
33-195	Fuel / Glycol Interceptor
33-196	Fuel Line Backfill
33-197	Fuel Line Loop Detail
33-198	Fuel Main Valve Pit Leaveout
33-199	Fuel Riser Leaveout Reinf.
33-200	14 in. Isolation Ball Valves
33-201	14 in. Isolation Ball Valves
33-202	14 in. Iso. Valve Drain MH
33-203	Isolation Valve MH Plan
33-204	Isolation Valve MH
33-205	14 in. Isolation Valve Pit
33-206	Full Slab Leaveout MH Reinf.
33-207	Pipeline Marker Detail

NATURAL GAS DETAILS

Detail Number	Description
33-208	Gas Service Entrance
33-209	Gas Regulator Detail