DENVER INTERNATIONAL AIRPORT

DESIGN STANDARDS MANUAL

Standards & Criteria

Design, Engineering, and Construction

Revised: Q4 2023

Printed in the United States of America

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Summary of Revisions

The following tables list the revisions made int he page year to the Architecture DSM.

2023 Revisions

Fourth Quarter

References	Revision Description
Throughout	Minor punctuation and grammar changes
20.2.3 Requirements	Added one-line diagrams requirements
20.6 Life Safety Design Submittal Requirements	Added section
21.2.4 Panelboard Schedules	Added information on noting panelboard schedules as new or existing
21.12.2.11 Lighting 21.12.3.10 Lighting 21.12.4.9 Lighting 21.12.5.9 Lighting	Added sequence of operations information

Second Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
1.2.2 Request Format	Added DSM Variance Request information
11.10 Specifications Requirement Checklist	Removed section

2022 Revisions

Fourth Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
Table 18-1: Submittal Requirements	Information presented in new table
Table 19-1: Submittals	Information presented in new table

Second Quarter

Reference	Revision Description
Throughout	Minor punctuation and grammar changes
12.1 Intelligibility and Legibility	New section
16.1.5 Roof Plans	Added requirement
17.2.3 Roof Plans	Added requirement
18.4.6 Mechanical Detials	New section
18.7.2.9 Controls and Sequences of Operations 18.7.3.10 Controls and Sequences of Operations 18.7.4.13 Mechanical Schedules 18.7.5.10 Controls and Sequences of Operations	Revised information
19.4.4 Plumbing Details	New section
20.4.6 Detailings	Added requirement
23.0.1.1 Public Area Signage 23.0.1.2 Non-Public Area Signage 23.0.1.3 Regulatory Signage	Revised information
32.1.1 Format 32.1.2 Specifications	Revised information

2021 Revisions

Fourth Quarter

Reference	Revision Description
7.2.1 Material and Substitutions	Added requirement
Table 11-1 - Part II Specifications	Updated table items
11.0.6 Coversheet, Index and Certification Page	Revised description
18.7.2.9 Controls and Sequences of Operations 18.7.3.10 Controls and Sequences of Operations 18.7.4.10 Controls and Sequences of Operations 18.7.5.10 Controls and Sequences of Operations	Revised information

Fourth Quarter

Reference	Revision Description
Figure 19-1 - Plumbing Piping Abbreviations and Line Types	Updated figure

Second Quarter

Reference	Revision Description
Throughout	Minor grammatical and layout changes
Table 11-1 - Part II Specifications	Updated table
11.0.5 DEN Technical Requirements	New section, providing description of the DEN Technical Requirements. New table added with cross-reference to technical requirements. **NOTE:** This information is part of a major process change for DEN design projects.
11.1.2 DEN Standard Technical Specifications	Updated requirements
11.9.13 Overstock Materials	New section

Revision Notation: Revisions made to this Manual during this revision cycle are annotated as shown in the example below:

A vertical line in the left-hand margin is used to annotate paragraphs that have been added or revised in the current publication. Revisions may include items such as new requirements, clarification of existing requirements, or removal of requirements that no longer apply to projects. Revision annotation is applied to each publication individually; revisions made in past publications are not annotated in subsequent publications.

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Purpose of Design Standards Manuals

The DEN Design Standards have been developed to ensure a unified and consistent approach to the thematic and technical design for DEN. These standards are for use and strict implementation by all consultants under contract to DEN, to tenants, and all other consultants under contract to any other entity for the design of projects at DEN.

The Standards Manuals are working documents, which will be revised and updated, as required, to address the general, conceptual, design, and technical standards for all areas of design for DEN.

This Design Standards Manuals (DSM) for DEN has been prepared for use by competent, professionally licensed architectural and engineering consultants under the direction of DEN Maintenance and Engineering or tenants of DEN.

The Design Standards shall not be quoted, copied, or referenced in any bidding or construction contract documents. Content contained in this Manual shall not be copied in any bidding or construction documents, except where specifically instructed to do so. All information contained in these standards must be fully explained and shown in all bidding and contract documents.

The Design Standards Manuals are intended to be used as a whole, as each manual is complimentary to the other DSMs. To understand the overall thematic and design standards for DEN, the applicable manuals must be utilized together and not separated from the Design Standards Manuals.

The Consultant shall not reproduce, duplicate in any manner, transmit to other consultants or other entities, or use in conjunction with other projects without the express written consent of DEN.

NOTE: This document is optimized for duplex (double-sided) printing.

VARIANCE FROM DEN DESIGN STANDARDS MANUALS

Requests for non-conformance or variance from DEN Design Standards manuals, for any DEN or Tenant Projects, must be formally submitted using the online DSM Variance Request form at the following website:

DEN DSM Variance Request Form

Variance requests may or may not be approved by DEN and response will be communicated to the requestor.

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Chapter 1 - Administration

1.0 Administration

1.0.1 References

The DEN Design Standards may be cited as such and are referred to herein as the Standards. The Design Standards Manuals are referred herein as DSMs.

City and County of Denver is referred to herein as the City or CCD.

Denver International Airport is referred to herein as DEN.

DEN is operated by the Department of Aviation of the City and County of Denver. More information about the organization and administration of DEN can be found at:

Denver International Airport Website

Denver Government Website

1.0.2 Purpose

The DSMs define a precise architectural and engineering vocabulary that serves as a basis for making decisions throughout the design and construction process. The DSMs provide direction without limiting the creative abilities of those who are governed by them.

1.0.3 Scope

The provisions of the DSMs apply to the design of any building, structure, infrastructure, or improvement on DEN property.

1.0.4 Format

Where specific formats are provided or referenced, those formats shall be used by the consultant.

1.0.5 Procedures

The procedural guidelines contained in these manuals are intended to supplement existing consultants' procedures and to establish a uniform basis for program control for DEN. Where the manuals are silent on a procedural matter, it is incumbent on the consultant to request specific direction from the DEN Project Manager. If no guideline is available, the consultant shall propose its existing corporate guidelines.

1.0.6 Exclusions

The DSMs are not all-inclusive, and there are areas of the DSMs that do not address design requirements. In these instances, the consultant shall use professional design judgment and expertise in preparing a proposed system design for those areas within the consultant's Scope of Work (SOW).

1.1 Compliance with Codes and Regulations

The DSMs are not to be used in lieu of codes or regulations that may be applicable to design or construction work. The user of the DSMs shall be solely responsible for the design product compliance with all codes and regulations.

In some cases, the DSMs contain requirements that are more stringent than codes or regulations. The user shall comply with the more stringent requirement unless the requirement conflicts with any code requirements.

1.2 Variance and Interpretation

It is recognized that these DSMs may not always contain the newest developments in technology. While airport construction is not to serve as an experiment for new, untested systems and technologies, the consultant should present to DEN any proven new developments in systems and alternate methods of technology which the consultant thinks are worthy and beneficial for consideration.

1.2.1 Request Submittals

Variance and interpretation requests must meet at least one of the following criteria:

A. Improvement to design
B. Improvement to public safety
C. Improvement to construction schedule
D. Construction cost savings
E. Operation and maintenance cost savings
F. Resolution of conflict of established standards
G. Design condition not covered by the DSMs
H. Lifecycle cost-benefit

Consultant shall submit the appropriate form to the Project Manager for approval. Consultant shall not proceed with any variance in design without written approval from DEN.

1.2.2 Request Format

Variance requests shall be submitted for stakeholder review using the DSM Variance Request form accessible from the link below

DEN DSM Variance Request Form

Approved DSM variances shall be submitted to DEN using the RFI process in Unifier, the current DEN Project Management Information Systems (PMIS). Requests shall include evidence of the stakeholder approval, such as an email record and shall contain the following information:

A. Project title and description
B. Applicable Design Standards by reference to manual, volume, part or chapter, section, subsection, and exhibit
C. Description of requested variance, including any applicable drawings and calculations to fully develop variance in question
D. Budget impact of proposed variance
E. Schedule impact of proposed variance
F. Other pertinent factors
G. Impact of variance on Design SOW

1.2.3 Consultant Notification

Variance requests shall be reviewed by DEN Design, Engineering, and Construction (DEC). The consultant shall allow a minimum of 14-day review time by DEC. The consultant shall be notified in writing of interpretations and/or the acceptance/non-acceptance of the submittal.

1.3 Pre-work Meeting

A pre-work meeting will be scheduled by DEN after issuing the consultant's Notice to Proceed (NTP). The purpose of this meeting is to introduce DEN's Representatives to their counterparts in the consultant's organization, establish lines of communication between these representatives, and outline some contract requirements. The consultant's Project Manager and Division of Small Business Opportunity (DSBO) shall attend this meeting.

1.3.1 Notice of Meeting

The Project Manager will distribute a notice of this meeting, along with an agenda of the subjects to be addressed. Meeting minutes shall be prepared and distributed by the Project Manager.

1.3.2 Meeting Agenda

The consultant will introduce consultant's representatives and briefly describe each person's responsibilities. The consultant shall provide the following:

A. List of all subconsultants, design disciplines, and a schedule for the first 90 days of work activities unless tasks have not been assigned.
B. Office locations, telephone numbers, and e-mail addresses.
C. Names of the Building Information Model (BIM) Project Execution Plan (BPXP), Leadership in Energy and Environmental Design (LEED), Commissioning Agent (CXa), and Design Analysis Report (DAR) coordinators.
D. Design administration methods and correspondence control.
E. Quality Control Plan
F. Project Phasing Plan
G. Procedures to coordinate the consultant's work with the work of other contractors and the procedures for sharing access to the worksite.

The DEN Project Manager will explain and discuss the responsibilities and authorities of the DEN organization. The DEN Project Manager will provide highlights of the following information at the meeting, as applicable to the project or task:

A. Communications control.
B. Security procedures, Sensitive Security Information (SSI), and access control/badging.
C. DSBO requirements.
D. Business Management Services (BMS)- Payment procedures, monthly pay estimate cutoff dates.
E. Authorizations and work submittal procedures.
F. Scheduling and coordination requirements.
G. Quality control/assurance procedures.
H. Environmental requirements and permits, protection of property and work in progress, protection of municipal and public service systems, protection of streets and roads, protection of drainage ways, protection of the environment, hazardous and explosive materials, archaeological and historical discoveries, and buried utilities.

Explanations provided by DEN will not amend, supersede, or alter the terms or meaning of any contract document, and the consultant shall not claim reliance on such explanations as a defense to any breach or failure by the consultant to perform as specified in the contract.

1.4 Progress Meeting

Progress meetings will be scheduled weekly or as deemed necessary by the DEN Project Manager to promote the competent and timely execution of the contract. The meetings will be held at DEN and will be chaired by the DEN Project Manager. The consultant shall be available in person at DEN or, subject to the approval of the DEN Project Manager, be available via telephone and/or web conference. The consultant, critical personnel, and/or subconsultants shall be present to assure timely transfer of information. The Project Manager will be responsible for publishing minutes of the meetings within three (3) days.

1.5 Work Schedule

1.5.1 Preliminary Schedule

The consultant shall prepare for each project or task a work schedule in Precedence Diagram Method (PDM), bar chart, or other media as required by the contract or task assignment. The schedule shall describe the consultant's plan and budget for completing the work and providing the necessary coordination with outside agencies, consultants, construction/ procurement contracts, tenants, and DEN. The SOW shall be delineated by project or task phase, task, and activity. Project or task budget elements and labor shall be assigned to activities and summarized by task and phase for program status reporting and invoice calculations. Consultant shall establish deliverable format with the Project Manager at the pre-work meeting. Consultant preliminary schedule shall be submitted within 14 days after NTP.

1.5.2 Final Work Schedule Submittal

The consultant, for each project, shall be required to submit a detailed schedule for design, construction, testing, and occupancy in a format that is consistent with the consultant’s contract requirements. Upon acceptance by DEN, the consultant's schedule shall be used by the consultant and DEN to monitor progress. From the final work schedule, the consultant shall also identify labor utilization, drawing, specification, production operation, cash flow requirements, and DSBO goal status. The consultant will also track variances in the original plan and changes to the work. Consultant shall establish the deliverable format with the Project Manager at the pre-work meeting.

1.5.3 Schedule Revisions

Schedule revisions shall be required when changes are made to the consultant's SOW, work plan, or schedule logic. Each schedule revision shall be submitted by written request, clearly showing the requested changes. The consultant shall not implement the revision until written authorization is received from the DEN Project Manager.

1.5.4 Schedule Update

The consultant must update the schedule at least monthly or as directed by DEN. Updating is the systematic incorporation in the schedule of progress data, additional details, as they become available and revised forecasts.

1.5.5 Other Schedule Requirements

For each project or task, the consultant shall coordinate with DEN to schedule:

A. Project procurement of long lead items
B. Project construction
C. Occupancy of project facilities

All requirements for the consultant's scheduling submittals are as established in the contract between the consultant and City.

1.6 Meeting Locations

At the discretion of DEN, the consultant shall attend any meeting at DEN or via web conferencing.

1.6.1 Meetings at DEN

The consultant shall attend any meeting at DEN at the request of DEN. The consultant shall be diligent in meeting planning and allow time for the following:

A. Parking and travel times from probable parking locations
B. Escorting through secure areas

1.7 Coordination and Administration

1.7.1 Procedures

The consultant shall follow DEN's procedures for coordinating and administering activities and for communicating among the consultant, subconsultants, tenants, City, and other consultants; payment submittals; reporting requirements; and consultant and City reviews and acceptances. To facilitate this coordination, consultant shall serialize all correspondence associated with the work it performs and shall maintain correspondence logs in accordance with instructions received from the Project Manager.

1.7.2 Coordination

The consultant shall coordinate the services and work provided by all its subconsultants working on the project. The consultant shall have primary responsibility of the program and processes utilized to eliminate any conflicts and inconsistencies within the final design packages prepared by the consultant and its subconsultants.

1.7.3 Design Standards

The consultant incorporates in design and construction documents, the applicable DEN design standards, and City criteria. If the consultant determines that an element of the design should be covered by a Design Standard, but one does not exist for that element, it shall notify DEN in writing and proceed as directed. If the consultant finds that deviation from any Design Standard may be appropriate, the consultant shall submit in a timely manner any proposed deviations in writing, accompanied by graphic information to DEN for review and/or acceptance. Design development of design for which a Standard modification or a new design is required shall not be considered an additional cost to DEN. The consultant shall fully cooperate with other consultants working at DEN, particularly those consultants whose work connects or interfaces with the consultant’s SOW.

1.7.4 Communications with the Consultant

DEN will transmit written instructions, responses, or other communications to the consultant. The consultant shall, by a letter to DEN, designate (by name) one or more assistant managers to receive oral and written communications when the consultant’s manager is away from the worksite and to act as the consultant’s designated representative. During the times that the consultant’s manager may be temporarily absent, an assistant consultant manager shall be authorized to act immediately on orders or instructions issued by DEN.

1.7.5 Budget Control

The consultant shall plan and control the work to manage the contract value. Work shall be divided into manageable sub tasks, which represent measurable units of the contract scope each with assigned budgets once established. The consultant’s task budgets shall be adhered to unless written authorization is provided by DEN. The consultant shall include monthly progress of work by task and discipline.

1.7.6 Design Review Committee

The Project Manager will provide Design Review Committee (DRC) process document that outlines requirements for making presentations for design review as applicable. Projects in public view generally require DRC review. More information on the DRC can be found on the Flydenver.com website,

DEN Design Review

1.7.7 Design Project Closeout

The consultant shall plan for project closeout from day one. By law and General Conditions of the contract, DEN requires any set of drawings and specifications in PDF form used to establish pricing or contract for work be delivered to the Project Manager. Additionally, as a part of the design project closeout, the Design consultant shall provide model information outlined in the BPXP as generated per the DFI DSM. The contract documents and models will be stored in Unifier and archived by the Project Manager.

End of Chapter

Chapter 2 - Design Phases

2.0 Design Phases

2.0.1 General

The design program shall be sequential by phases. Examples of typical phases for each project or task are illustrated below. Specific submittal requirements shall be as follows unless documented in the consultant's contract or by task:

Civil/Infrastructure

A. Design analysis programming
B. Preliminary design
    a. Preliminary BIM review
C. Contract documents
    a. 30% submittal
    b. 60% submittal
    c. 90% submittal
    d. 100% submittal
D. Bid phase
    a. Bid documents
    b. Bid evaluation
E. Construction
    a. Issue conformed document
    b. Construction overview (administration)
    c. Record documents

Architectural, Landscape Architecture, Signage, and Graphics

A. Design analysis programming
B. Schematic design
C. Design development
D. Contract documents
    a. 30% submittal
    b. 60% submittal
    c. 90% submittal
    d. 100% submittal
E. Bid phase
    a. Bid documents
    b. Bid evaluation
F. City plan review
G. Construction
    a. Issue conformed document
    b. Construction overview (administration)
    c. Record documents

For each deliverable, coordinate with DEN for requirements regarding quantities of documents and quantities of sealed and signed documents to be submitted.

2.1 Civil/Infrastructure Phases

This section generally applies to all horizontal work projects, which include paving, roadways, runways, utilities, and utility systems.

2.1.1 Design Analysis Programming Phase

The consultant shall prepare a DAR, which identifies all the design standards, parameters, and documentation of criteria for the project. This Design Analysis shall contain but shall not be limited to the content described in Chapter 3- Design Analysis Report and the consultant's contract.

2.1.2 Preliminary Design Phase

Based upon the accepted design analysis programming report, the consultant shall perform the engineering services and prepare the preliminary design documents described below:

2.1.2.1 Preliminary Design Drawings and Technical Specifications

Prepare preliminary design drawings and technical specifications as appropriate.

2.1.2.2 Preliminary Design Analysis Report

The preliminary DAR consists of the following information:

A. Preliminary cost estimate and total cost of ownership for each proposed or modified system.
B. Preliminary construction schedule.
C. Field investigations, engineering surveys, and soils and subsurface investigations.
D. Design and construction alternative analysis.
E. Value engineering participation.
F. Preliminary selection of manufacturers and suppliers based on design standards.
G. Required permits.
H. Required agency acceptances and agreements.
I. Long lead items and other equipment procurement plan.
J. Contract Data Submittal Requirements Report (CDSR).

2.1.2.3 Preliminary BIM Review

Conduct a preliminary BIM review.

2.1.3 Contract Documents Phase

Based upon preliminary design documents, which have been reviewed by DEN, the consultant shall prepare and submit the following items:

A. Contract documents for the project (bid forms)
B. Final contract specifications
C. Final contract drawings
D. Final Soils Reports (bound separately and issued with Bid documents for information)
E. Final DAR
F. Final BIM design model
G. Estimate

Each submittal shall be comprised of those elements of the documents begun in the preliminary design and additional documents/reports as necessary or requested. Refer to Chapter 32- Submittals for submittal quantities and review stages.
During this phase, the consultant shall also prepare and provide to DEN technical data or information that is required to complete any permit application, federal grant application, or any other applications for governmental acceptances associated with the project.
Consultant shall also file drawings, specifications, and addenda with DEN's Development Services for plan review in accordance with instructions received from the Project Manager.

2.1.4 Bid Phase

Upon completion of the final review submittal and DEN's written acceptance of the submittal, the consultant shall complete the contract documents. The contract documents shall be completed, checked, signed, and sealed by the consultant. DEN's comments from previous reviews shall be incorporated in the contract documents and all outstanding issues shall be resolved to the satisfaction of DEN. Refer to Chapter 7- Bid and Proposal Evaluation for required services.

2.1.5 Construction Phase

The construction phase shall begin at NTP to the contractor. Services during the construction phase shall include, but not be limited to:

A. Attend weekly construction meetings in accordance with City's instructions.
B. Visit project site at appropriate intervals; complete observation reports.
C. Review and process submittals and RFIs; adhere to standard procedures established by DEN regarding stamping and filing submittals.
D. Interpret contract documents.
E. Review and evaluate and update contract documents.
F. Review change orders.
G. Assist City in final acceptance reviews.
H. Complete record documents:

For additional information, refer to Chapter 9- Record Documents in this DSM and to the DFI DSM.

2.2 Architectural, Signage, and Landscape Architecture Phases

This section generally applies to all vertical work projects, which include structures, buildings, landscaping, signage, mechanical, electrical, plumbing, and other disciplines. The projects of this nature may include paving, roadways, runways, utilities, and utility systems associated with the project.

2.2.1 Programming Design Analysis Phase

The consultant shall prepare a DAR, which shall contain all the design standards, documents, parameters, programming, and criteria for the project. This DAR shall contain but shall not be limited to the content described in Chapter 3- Design Analysis Report.

2.2.2 Schematic Design Phase

Based upon information and data in the design analysis phase, which will be reviewed periodically by DEN as it is being prepared, the consultant shall perform certain field investigations and other design services and prepare schematic design documents described below:

A. Engineering surveys and soils investigations bound separately and issued with bid documents for information
B. Schematic drawings indicating design concepts and alternative solutions
C. Rough, to scale models of areas of the project, if required in the consultant contract or if required to fully demonstrate or describe the project
D. Schematic DAR
E. LEED checklist review
F. Preliminary BIM review

2.2.3 Design Development Phase

Based upon the schematic design phase and data in the design analysis phase, which will be reviewed periodically by DEN, the consultant shall prepare design development documents. These documents shall include:

A. Design development drawings
B. Outline Technical Specifications
C. Preliminary DAR
D. LEED checklist review

E. BIM review

2.2.4 Contract Documents Phase

The consultant shall be required to prepare a minimum of four submittals in the contract documents phase, a 30% submittal, a 60% submittal, a 90% submittal, and a final review submittal, unless otherwise required in the contract. Each submittal shall be comprised of those elements of the documents begun in the design development and additional documents/reports as necessary or requested. Based upon the accepted design development documents, which have been reviewed by DEN, the consultant shall prepare:

A. Contract drawings
B. Contract specifications
C. Engineering surveys and soils investigations bound separately and issued with bid documents for information.
D. DAR
E. LEED checklist review
F. LEED design phase submittal
G. BIM review

During this phase, the consultant shall also prepare and provide to DEN technical data or information that is required to complete any permit application, Federal grant application, or any other applications for governmental acceptances associated with the project.

For discipline-specific submittal requirements in the Contract Documents Phase, refer to the following discipline-specific chapters:

- Chapter 16- Architectural Drawings
- Chapter 17- Structural Drawings
- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems
- Chapter 23- Signage and Graphics Drawings
- Chapter 24- Specialty Systems
- Chapter 25- GIS/CADD Requirements

2.2.5 Bid and Proposal Evaluation Phase

Upon completion of the final review submittal and the Project Manager's written acceptance of this submittal, the consultant shall complete the contract documents, so they are ready for distribution to prospective bidders. The contract documents shall be completed and checked by the consultant. DEN's comments from previous reviews shall be incorporated in the contract documents and all outstanding issues shall be resolved to the satisfaction of DEN. Refer to for required services.

A. Final cost estimate with separate bid item list with estimated prices filled in.
B. Consultant shall prepare additional sets of contract documents for sale to prospective bidders.
C. Bid and proposal evaluation phase.

The consultant shall assist DEN in the bidding process by performing at a minimum the following services:

A. Participate in pre-bid meetings and pre-bid site.
B. Prepare, process, and print addenda.
C. Review requested substitutes.
D. Prepare bid tabulations, evaluate, and prepare written recommendations.

2.2.6 City Plan Review Phase

The contract documents shall be completed and checked, sealed, and signed by the consultant. The consultant shall file drawings, specifications, and addenda with DEN's Development Services for plan review in accordance with instructions received from the Project Manager. The consultant shall attend meetings with Development Services at the request of the Project Manager.

2.2.7 Construction Phase

The construction phase shall begin with preparation of the Issue for Construction (IFC) submittal. The consultant shall incorporate all addenda, bid, contract forms, substitutions, subcontracts, changes made prior to the NTP, and a conformed contract document (contract, technical specifications, and drawings) shall be issued for construction. The number of copies of contract documents required shall be established in the consultant's contract. If not established, quantities as indicated in shall apply. Services during the construction phase are identified in and shall include but are not limited to the following:

A. Attend weekly construction meetings or in accordance with City's instructions.
B. Visit project site at appropriate intervals; complete observation reports.
C. Review and process submittals, adhering to standard procedures established by DEN regarding stamping and filing of submittals.
D. Interpret contract documents.
E. review and evaluate and update contract documents.
F. Review change orders.
G. Review and respond to RFIs.
H. Assist City in final acceptance reviews.
I. Prepare LEED construction phase submittal.
J. Complete BIM model.

End of Chapter

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Chapter 3 - Design Analysis Report

3.0 Design Analysis Report

3.0.1 Summary of Work

The consultant shall develop and maintain for each project a DAR. The intent of the report is to present a clear, complete, and concise picture of the design of the facilities and systems. The content and format are defined below. The consultant shall coordinate with DEN on any additional requirements applicable to the project, which should be included in the design analysis. The design analysis shall be submitted for each required phase of work (programming, schematic design, design development, and contract documents). The consultant shall prepare DARs, which contain all DEN accepted program criteria, parameters, and criteria for each project or task. These manuals (design analysis) shall be periodically reviewed by the consultant. These manuals shall contain, but shall not be limited to, the following information, reviews, and recommendations.

3.0.2 Quality Control

The consultant shall submit a copy of the consultant's design quality control procedures and a draft quality control submittal log to DEN for review and comment. The quality control procedures shall be attached as an appendix to each submitted DAR.

3.1 Submittals of Design Analysis Report

3.1.1 Submittal

Submittal of the DARs shall be required as indicated in the consultant's contract or approved task. If not defined in the consultant's contract, the consultant shall submit DARs as defined in this chapter and shall apply.

3.1.2 Submittal Format Requirements

All submittals of the DAR shall be submitted in an electronic format in a single PDF file. The DAR format shall include cover sheets shall contain the following:

A. Title of submittal, project title, project number, consultant's name, contract number, and date.
B. Material shall be presented in 8 1/2" x 11" format.
C. The file shall carry identification including, volume number, project name, number, consultant name, consultant contract number, date of submittal, and the name of the design phase the submittal addresses.
D. Submittals shall be assembled into a single volume, if possible, except submittals for projects including more than one major facility or distinct part may be assembled into separate volumes, numbered sequentially, and indicating total number of volumes.
E. Each page of the submittal shall identify the project name, number, and date of submittal.

3.1.3 Table of Contents

The Table of Contents and subsequent division tabs shall divide the reports into the sections outlined in this chapter. Further subdivisions are at the discretion of the consultant.

3.1.4 Sheet Sizes

Sheets larger than letter size folded to the prescribed size may be utilized when reduction is not feasible. When automated data processing is used, printout material shall be trimmed or reduced to the standard sheet size. All side, top, and bottom margins shall be .75-inch minimum to permit side binding and head-to-head duplication. Folded sheets shall be placed in paper jackets and bound into each report.

3.1.5 Submittal Quantity

Submit the quantities as indicated in Chapter 32- Submittals shall apply.

3.2 Submittals During Design Phases

3.2.1 Overview

Submittal of the DAR shall be required at each phase of the design process. The consultant shall maintain and update the DAR on an on-going basis and shall not depend on benchmark or submittal dates for timeliness of formatting and update. Drawings and/or specifications delivered without the DAR may not be accepted by DEN.

3.2.2 Programming Submittal of Design Analysis Report

The consultant shall submit a programming report addressing all the items noted in. The level of completion of the work for each item shall be reviewed with DEN, at the outset of the project, to assure agreement with the submittal requirements.

3.2.3 Programming/Schematic Design Analysis Report

The preliminary DAR contains changes to the programming phase DAR and describes all design criteria, assumptions, design calculations, design coordination, cost estimates, schedules, and other items as itemized below. Appropriate backup material, i.e., product data, drawings, test data shall be included.

3.2.4 Design Development Design Analysis Report

The consultant shall prepare a design development DAR, which contains:

A. Changes to the schematic design phase and the design criteria.
B. Assumptions
C. Relevant design calculations.
D. A list of any deviations from the DEN DSMs or governmental agency design standards or requirements.
E. Design coordination items with technical study reports and appropriate back-up materials, including, but not limited to:
    a. Catalogue cuts.
    b. Product data sheets.
    c. Specifications data.
    d. Systems performance data.
    e. Other data or information used to prepare the design development documents.
F. List of utilities and their maximum capacities.
G. Capacities of these utilities that are required to supply each project.
H. Project systems
I. Tenant supplies systems
J. Horizontal and vertical locations where the utilities should enter each project.

3.2.5 Final Design Analysis

The final DAR is a complete document within itself, containing all information from the project inception to the final design of the project. The report summarizes the conclusions of the design, completing and updating design calculations, costs, projected operating and maintenance cost impacts, and other information presented in the previous reports. It is part of the final review submittal due at the end of the contract documents phase.

3.3 Contents and Organization of the Design Analysis Report

As is appropriate to the project, the content of each section shall be itemized by discipline, i.e., civil, architectural, structural, mechanical, plumbing, fire protection, electrical power, electrical lighting, security systems, paging systems, monitoring systems. Incorporate into the final DAR revisions made because of final review and amendments during advertising or bidding. The following paragraphs describe the content of each of the report sections.

3.3.1 Foreword

3.3.1.1 Cover Sheet

All Design Analysis Reports shall contain a standard coversheet. The standard coversheet is available as a template file from DEN.

3.3.1.2 Certification of Compliance

The consultant shall provide a written certification that indicates that to the best of the consultant's knowledge, information, and beliefs that all deliverables under this agreement conform to the DEN DSMs. All variances from the DSMs accepted in writing shall be included. Review all project elements and identify any elements that the consultant recommends variance from the DEN DSMs. Include a formal request for variance.

3.3.1.3 Program Statement

The consultant shall provide a program summary identifying the needs and analysis of the project. This shall include program conclusions and recommendations, and presentation of concepts based on evidence of design influencing factors, ideas, and strategies to accommodate the needs.

3.3.1.4 Logic Programs, Decision Matrices, Associative Diagrams, Functional Diagrams

The consultant shall provide all logic programs, decision matrices, associative diagrams, and functional diagrams as required by all DSMs. This shall include the decisions made and the reasoning behind those decisions, and the outcomes or expected outcomes of those decisions.

3.3.1.5 Interviews and Meetings

Conduct interviews and prepares meeting minutes of all interviews. The meeting minutes shall be reviewed by and commented on by DEN prior to any publication or incorporation into the manual.

3.3.1.6 Description of Services

A detailed description of engineering services such as soil tests, geo-technical data, surface and subsurface investigations, vibrations analyses, acoustical studies, lighting studies, seismic analyses, line-of-sight studies, vehicular and pedestrian traffic studies, surveys, and other technical studies that will be required to design each project.

3.3.1.7 Limits of Consultant Work

After consultation and coordination with DEN, describe agreed upon specific limits for the consultant's SOW for the projects and the work performed by other consultants who are designing and providing services for portions of DEN that are adjacent to, would be affected by, or which must connect or interface with the consultant's work.

3.3.1.8 Project Limits

Define the limits of the construction project by identifying the interfaces of its work with other design work and include the records of correspondence with other consultants, utility agencies, and code agencies in the

coordination of work involving interfaces. Provide a project layout including site plan, improvements, and general sections identifying the scope of the project and limits of work. Include approximate area calculations.

3.3.1.9 Design and Construction Schedule

Provide design and construction schedules for the project that comply with and are in a format accepted by DEN. Refer to Chapter 31- Construction Schedule for scheduling criteria and format.

3.3.1.10 Summary of Actions

Provide a summary of the required actions, acceptances, permits, or additional information from DEN (including City Building Department), governmental entities, and private entities, (1) which the consultant will require to complete its SOW in accordance with the master schedule and, (2) which DEN or construction contractor will require to complete each project.

3.3.1.11 Bid and Procurement Packaging

Consultant's recommendations for construction contract bid packaging for each of the projects. DEN may require the consultant to prepare separate bid packages to achieve the anticipated project delivery budget and schedule.

3.3.2 Design Requirements

The DAR shall include a written detailed discussion of design solutions, phasing, materials, risk assessment, compatibility with building systems, all building systems, design interfaces, equipment, performance criteria, maintenance considerations, operational compatibility, alternatives, construction scheduling, cost estimates, construction operation, Special Conditions, and other construction-related issues.

The consultant shall present factors considered and provided in the design of the project and project components. Supporting justification, i.e., design calculations, cost estimates and other data. Include discussion, itemized by discipline, at a minimum the following factors as appropriate to the project:

3.3.2.1 General Description

The general description identifies and describes the facilities and systems designed by the consultant and their relationship to codes, DSMs, and criteria. This shall include the detailed needs of the users and other requirements for a properly functioning facility.

A. Establish spaces, areas, adjacencies, and other relationship requirements including special equipment and systems. Identify existing systems, existing system capacities, and modifications required to those capacities.
B. If relocations are required, provide itemization of components, furnishings, etc., to be relocated to the new location.
C. Include a general review of the economic factors influencing the design alternatives of the systems and materials used in the project shall be provided along with an indication of how the initial and lifecycle costs are considered.

3.3.2.2 Design Criteria

Provide a list of general criteria that pertains to all disciplines used in the design, prescribed criteria, specific studies, and minutes of pre-design conference meetings. Specific criteria used by each particular discipline shall be completely documented in the text of that discipline. Such criteria shall be referenced accordingly.

Where redundant systems, equipment, or sequences of operation are required due to provisions in the Design Standards Manuals, codes and regulations, and/or project specific requirements or constraints, the Consultant shall provide a narrative describing what requires these redundancies.

3.3.2.3 Planning Study

Conform to requirements in Chapter 28- Planning Study.

3.3.2.4 Statistical Summary

The consultant shall prepare a statistical summary of the designed project areas in comparison to the total City approved tenant programmed project areas, including, but not limited to, the ratio of net designed project area to the gross building area. This statistical summary shall be updated periodically as each project progresses. This summary must accompany each service phase submittal.

3.3.2.5 Major Components

Provide a list of all components of the facilities and systems and the categorical systems of DEN, Federal Aviation Administration (FAA), Colorado Department of Public Health and Environment (CDPHE), and Colorado Department of Transportation (CDOT).

3.3.2.6 Code Analysis

Provide a complete code and standards analysis of the project including analysis of impact on adjacent work. The code analysis shall include options of compliance with codes or standards of those jurisdictions governing the work. If the project is to have occupied space, provide a code analysis that includes identification of occupancy types of proposed uses and occupancy types of adjacent uses. Include plan drawings of pedestrian exiting diagrams including contributory loads of various occupied areas, paths of egress with load factor, vertical egress paths with load factors, and opening/corridor size factors.

The code analysis shall also describe fire fighting vehicle access to the site and facility, standpipe coverage, if applicable, fire extinguisher locations, etc.

NOTE: The code analysis shall be and submitted to the building and fire departments with the design development package.

3.3.2.7 Life Safety, Security, and Communications Systems

Identify ALL life safety, security systems, and communications systems including their relationship to existing systems and capacity requirements. Include analysis of required storm shelters, warning systems, barriers, and required separations.

3.3.2.8 Systems Load Requirements

Identify design load requirements by listing all the systems associated with a project and their proposed calculated demand and contributing loading requirements.

NOTE: The support data and calculations for this summary shall be in a separate section or volume of the design analysis. These systems shall include but are not limited to gray water, potable water, storm water (surface and piped), dirty water, fire protection water, sewage conveyance, electrical power, natural gas, communications, fire alarm, paging, security, lightning protection, cathodic protection, roadways, exit corridors, etc.

3.3.2.9 Design Alternatives

Define design alternatives to explore potentials for improvements in the design and/or to accommodate potential future growth, expansion, or upgrade. Prepare a written description and analysis of the design alternatives for all or portions of the facilities and systems of the project. Review and analyze the potential of the following:

A. Alternate layouts, sizes, locations, and geometry.
B. Alternate materials with varying sizes and properties.
C. Alternate operation and maintenance requirements.

D. Alternate design requirements, i.e., code standards and loading criteria.
E. Opportunity to provide initial rough-in or substrate to provide for and accommodate future expansion, growth, or upgrade.
F. Schedule impacts.
G. Cost analysis of alternatives, including lifecycle.

3.3.2.10 Costs and Budget

Provide cost estimates for the construction project in compliance with Chapter 30- Construction Cost Estimates Account for discrepancies and propose design and budget alternatives to reconcile differences between cost and budget.

3.3.2.11 Value Engineering

As contracted, assist DEN in completing value-engineering studies as required to evaluate design alternatives by comparing performance criteria with initial and operating costs, scheduling, and load evaluations. If the project is federally funded, the consultant shall adhere to federal value engineering guidelines.

3.3.2.12 Operations and Maintenance (O&M) Criteria

Operations and maintenance criteria provide a compilation of design provisions made to enhance and to reduce the time and cost of operating and maintaining the facility when completed.

A. Describe the conditions, consideration, and requirements of the design and include essential input for future use, operation, maintenance, and planning activities.
B. Describe how the designed facilities and systems relate to the phasing outline in the Airport Master Plan. e. g., the fuel system designed represents X% of the total fuel capacity requirements of DEN.
C. Describe the control function involving inspections, monitoring, testing, maintenance, and security processes associated with the facilities and systems. The intent is to determine what control functions are involved, what agencies are responsible, and what control functions are deemed most critical to satisfactory operations.

3.3.2.13 List of Equipment and Long Lead Items

The consultant shall prepare a list of all long-lead-time items for each project for which procurement activity must be accelerated. If long-lead items are to be procured in advance of completion of contract documents for the individual projects, the consultant shall prepare procurement specifications, exhibits, schedules, and contract procurement documents. Included shall be a list and description identifying all major equipment, fixtures, systems, software, or accessories for the project that must be procured. Include any equipment, which DEN has notified the consultant it will furnish, and any equipment and systems that tenant has notified DEN that the tenant will furnish.

Long lead items are considered items that either have a delivery duration in excess of twelve (12) weeks from request or a delivery duration that is on the construction critical path, with a float of zero days per the Longest Path Calculation Method in the Consultant's proposed construction schedule.

3.3.2.14 Required Spare Parts

Consultant shall provide a list of specification required spare parts and identify all spare parts that cannot procured through standard methods in less than two days.

3.3.2.15 Critical Construction/Request for Proposal Activities

The consultant shall prepare a list of critical construction and manufacturing activities for the design-build projects that it will observe and monitor during the construction administration phase, which is described in Chapter 8-Construction and Administration. These activities shall also be identified in the contract documents.

3.3.2.16 Independent Testing Laboratory Report

The consultant shall provide during the design development and the construction document phase a matrix indicating the type, quantity, and quality of tests required by an independent testing laboratory acting as agent of the contractor during construction. The matrix rows shall correlate to technical specification divisions of work or as defined by the Project Manager. The matrix columns shall identify from left to right the following:

A. Specification division
B. Specification division title
C. System or material to be tested
D. Type of test
E. Quantity of tests
F. The quantity of tests is to be identified as actual number of tests, not as a percentage of the work.

This information shall also be incorporated in the consultant cost estimate. Refer to Chapter 30- Construction Cost Estimates.

3.3.2.17 Contract Data Submittal Report

This document is not part of the bid documents issued for bid. The consultant shall prepare a CDSR report for each construction and/or procurement contract document package prepared. The CDSR shall be provided initially at the preliminary design phase or 60% construction document submittal and with subsequent document submittals up to and including the IFC. The CDSR shall identify each submittal and acceptance required, including, but not limited to, required test reports, submittals for the design-build contracts, and analyses by the contractors during the duration of the work from construction notice-to-proceed to Final Completion. The report format shall include the following in columns from left to right:

A. Contract specification section number
B. Paragraph number
C. Submittal description
D. Related sections
E. Number of samples
F. Format of contractor's submittal

3.3.2.18 Cut Sheets

Provide the specifications with cut sheets of all specified items and alternates at the end of each section. Annotate at the top right of each cut sheet the paragraph in the specification section where the cut sheet is applicable. The cut sheets shall be current as supplied to the consultant during the design phase. It is the consultant’s responsibility and liability that the items specified (up and until the date of advertisement) are available on the market. Specifications containing specific manufacturer products are not acceptable.

3.3.2.19 Soils Report

The soils report shall be reviewed and commented upon in writing by the consultant and all subconsultants. The final design analysis shall include a written review by the Soils consultant. This review shall contain geotechnical recommendations applicable to the project.

3.3.2.20 Property Loss Prevention

FM Global has developed Loss Prevention Data Sheets that are guidelines to help reduce the change of property loss due to fire, weather conditions, and failure of electrical or mechanical equipment. The consultant shall review the current Loss Prevention Property Loss Prevention Data Sheets for applicability to the project. The design analysis shall compile all data sheets and specific criteria that are applicable to the project. If necessary, the consultant, in conjunction with the assistance of DEN, develops a dialog with appropriate FM Global

representatives to review the design for adherence to applicable guidelines. The consultant shall produce a detailed breakdown outlining the financial impacts of compliance with the FM Global loss prevention guidelines verses an adherence to the applicable code requirements.

3.3.2.21 DEN Environmental Review

Working in conjunction with the DEN Environmental Services Section, the consultant is responsible to ensure that design of the project is done in compliance with all applicable federal, state, local, and DEN environmental regulations. The Environmental Services Section shall assist the consultant with design reviews to determine compliance. Following the development of project scope, the project manager or consultant shall complete the Environmental Project Review Form (ES-01). Based on this information, Environmental Services will complete the Environmental Checklist for Facility Development and Redevelopment (ES-02) to identify environmental considerations and permitting requirements.

3.3.2.22 Leadership in Energy and Environmental Design (LEED)

The consultant shall review the current LEED rating system and develop design strategies for maximizing the project's energy efficiency. Following the LEED rating system, the consultant and DEN shall determine which level of LEED Green Building Certification is achievable for the project. Following this decision, the consultant shall tailor the design documents to achieve this certification. The LEED rating system document can be obtained at the following website:

U.S. Green Building Council Website

3.3.2.23 Executive Order 123 Compliance

Consultant shall review the latest version of the Executive Order and identify all portions that affect project and design.

3.3.2.24 Quality Control Checklist

Consultant shall include and complete the Quality Control Checklist provided in 33.1.2 Quality Control Checklist in the DAR.

3.3.3 Calculations

This section of the DAR shall be divided by design discipline. Separate volumes of the DARs may be provided depending on the amount of documentation. This section shall contain copies of all design calculations from which design decisions were made.

3.3.3.1 Load Capacity Identification

Identify load capacity requirements for all systems. This shall include the following:

A. Loads of the systems designed for the project.
B. Demand or contributory loads of the project systems.
C. Provide engineering load requirements, design criteria involved with design work, and assumptions made to determine sizes, capacities, etc., of systems.
D. Identify each page with the project title and location.
E. Present calculations in clear and legible form incorporating a tabulation showing all design loads and conditions, formulas, and references.
F. Explain assumptions and conclusions shall be explained.

G. Ensure cross-referencing is clear.

When automated data processing is used, indicate the type of software used for the design analysis and include description of design methods, including assumptions, theories, and technical formulas employed. This description shall be sufficient to verify the validity of methods, assumptions, theories, and formulas, but shall not require source code documentation or otherwise compromise proprietary programs.

3.3.3.2 Calculation Submittals

Submit calculations and designs performed on computers with:

A. Complete input schematic diagrams provided and clearly labeled.
B. Complete input data file clearly labeled and defined.
C. Complete output data file clearly labeled and defined.
D. Provide a CD or DVD of the original computerized input and output data in Microsoft Office format or another electronic format approved by the Project Manager.

If a standard design or other design is being site adapted and a design analysis exists, the analysis for the new project shall include appropriate material from the existing analysis modified to incorporate site adaptations and other essential requirements.

3.3.4 Design Calculations

3.3.4.1 Database

Identify available architectural and engineering data that will be used to design the projects. This shall include a description of all major building systems, including, but not limited to, mechanical, electrical, communications, structural, foundations, plumbing, life safety, FIDS/BIDS, public address, fire protection, security, fire alarm, fiber optics, materials handling, signage, and any other required building systems.

3.3.4.2 General

The following is the guideline for the minimum requirements in developing calculations. Variations due to Special Conditions may be necessary and will be addressed by DEN when the consultant submits the quality control program for acceptance. The procedure provides a definitive method of preparing, checking, reviewing, controlling, and retaining engineering calculations. The consultant shall have a Quality Control Program in place. All disciplines shall be included in the calculations portion of the DAR.

3.3.4.3 Scope

The accepted procedures shall be used by the consultant for calculations prepared for project use. This procedure applies to calculations that establish design systems, dimensions, or other major parameters used for engineering design output documents prepared by the consultant. This procedure also applies to checking documents to conform to the DEN BIM standards per the DFI DSM. The calculations shall include but not be limited to:

A. Infrastructure support systems: geometry, loads, and schedules.
B. Roads
C. Traffic patterns and volumes, emergency access, traffic controls, and signaling.
D. Utilities
E. Electrical power, gas, communications, sanitary, storm water, and gray water, storm water flow, snow removal and storage, ground water quality, and environmental controls.
F. Civil systems
G. Landscaping area, irrigation loads and controls.
    a. Erosion controls.
H. Building systems

I. Occupancy and area calculations

   a. Structural load requirements by code
   b. Hazard area diagrams and calculations
   c. Code analysis

   Plan drawings indicating new and existing occupancy types, occupancy numbers, exiting directions and load tabulations, egress widths and ratings of separations

   NOTE: This document shall be submitted to code agencies as a supplement to drawings.
   a. Soils and structural support analysis
   b. Structural systems analysis including vibration control
   c. Mechanical systems analysis including noise and vibration analysis
   d. Electrical systems analysis including cathodic protection of utilities, heat gains, and harmonics
   e. Plumbing systems analysis
   f. Fire protection systems analysis
   g. Communications systems analysis
   h. Horizontal and vertical people movers
   i. Material conveyance systems

3.3.5 Instructions

Each calculation shall include a list of the basic criteria. These include design assumptions, applicable codes, standards, and references. Major equation sources shall also be listed as well as computer program names and sources used. The source of formula, equation, input data, or assumption and derivation of all uncommon equations should be shown when they are introduced into the calculation.

A. Design assumptions shall be stated so that they may be understood by the checker. Assumptions will be required in the event it becomes necessary to revise calculations or to make them available to outside parties.

B. Established design criteria and previously developed and accepted design methods and solutions should be used as guidelines and identified as the source. The applicability of existing solutions to new problems will be determined before such design methods or solutions are adopted.

C. Calculations shall be orderly and complete with enough sketches and notes so that the work can be understood. Diagrams indicating data (such as loads, flows, voltages, and dimensions) shall be included along with adequate details not considered standard.

D. A flow sample flowchart depicting the preparation and checking of calculations shall be submitted to DEN prior to the start of calculations.

E. The calculations for each project shall be numbered with respect to the project number system as defined by DEN.

F. Calculations shall be made on standard 8-1/2" x 11" calculation sheets. The heading of each sheet in the set of calculations shall be completely filled in with the date, designer's name or initials, checker's name or initials, project name, calculations, sheet number, job number, and subject of calculation.

G. When calculations are based upon preliminary data for early implementation of the work, such calculations shall be subjected to the complete review procedure and the responsible engineer/architect shall assure a final calculation check is made as soon as final data are available. Calculations that are the basis for establishing design criteria, dimensions, or other major parameters shall be checked and submitted to the responsible design professional for review and acceptance in accordance with this procedure.

H. The calculations involving computer printouts shall have an accompanying calculation package containing the appropriate information as outlined above. Computer printouts should be cross-referenced to their corresponding calculation package and printouts shall be labeled and filed in the same manner as the hand calculations.

I. Project originated computer programs shall have a flow diagram, sample calculation, and complete description of the program. In cases where a sample calculation is not practical, other acceptable verification shall be used.

J. The calculation package for a standard computer program output shall consist of a completed cover sheet and a complete outline of the problem, including sketches, if applicable. The user's manual is the prime source of information.

K. When calculations are based upon preliminary data for early implementation of the work, such calculations shall be subjected to the complete review procedure, and the responsible Engineer/Architect shall assure a final calculation check is made as soon as final input data are available

3.3.6 Consultant Quality Control of Calculations

The consultant shall have in place a quality control program that includes checking of calculations by independent parties or parties other than the individuals/computers performing the calculations. The responsible designer shall review all design calculations prepared by their group for technical adequacy and conformance with design requirements. Preliminary calculations shall be reviewed and initialed by the responsible designer and shall be clearly marked PRELIMINARY. Final calculations submitted shall carry the stamp, seal, and signature of the respective consultant. All design calculations shall be checked by a design professional who has a level of design qualifications at least sufficient to originate the calculation. The checker shall not be the originator of the calculations.

After verifying the basis of a calculation, the checker has the option of performing a mathematical check of verifying the calculation by an alternate means. Approximation methods may be adequate for checking. The checker shall be responsible for the following activities:

A. Checking calculations against the design drawing to verify whether they conform to specified configurations, dimensions, and materials.

B. Checking calculations for assumptions, analytical methods, mathematical accuracy, completeness, compliance with design criteria, and the adequacy of design.

C. Initial and date each page of the original calculations after they are completely checked, and all necessary corrections and additions have been made, or attach initialed alternate calculations, if used.

D. Sign-off on cover sheet. A Colorado licensed engineer shall seal calculations.

The checker shall assure that the following actions are taken for checking computer calculations:

A. Check the calculation package accompanying the computer printout checked in accordance with these procedures.

B. For project originated computer programs, check the computer listing for assumptions, program theory, compliance with the flow diagram, and overall correctness.

C. For standard computer programs, check to assure applicability of the program and assumptions made.

D. Regardless of the computer program used, check all input data for correctness, as well as the application of output data.

E. Provide checker sign-off on cover sheet. A Colorado licensed engineer shall seal calculations.

F. Calculations performed by staff personnel, specialist groups, suppliers, and service agencies shall be reviewed and subject to acceptance by DEN. The consultant is liable for the constructability and the function of the system designed.

3.3.6.1 Revisions to Calculations

A. For revisions to calculations, including superseding calculations, the same checking procedures shall be used for the revised calculations as for the original calculations.

B. All parts of the complete calculation, which are dependent on the revision, shall be checked and the complete original calculation shall be reviewed to determine which parts are dependent. It is not necessary

to recheck parts that are independent of the revision. Results of calculation revisions shall be made known to others who may be affected.

C. In making revisions, including handling superseded calculations, records shall always be maintained of the original calculations, and they shall be identified as being superseded by being crossed-out and marked SUPERSEDED.

D. New calculation sheets shall be prepared for all such superseding calculations. Exceptions may be made to preparing new sheets where the change is minor in nature and where the designer authorizes a cross out by initialing the change. In this case, it shall nevertheless be subject to all other revision procedures, and the change shall be identified with a revision number on the calculation cover sheet.

E. The originals of the design calculations for each discipline and specialty group shall be kept in a calculation binder that is part of the DAR in each discipline's files that serve as the master project calculation file for reference. Calculations shall be separated into groups: preliminary, final, and superseded. These shall be identified by discipline or specialty group and shall include an index in each one. Pertinent consultant and supplier calculations, designs, data, and all checks performed shall be kept with the appropriate technical file.

F. Calculations and computer printouts shall not be removed from their binder except when they are revised or reproduced. When calculation binders are removed from files, an **OUT** card shall be inserted in its place indicating what calculations were removed, when, and by whom.

3.4 Appendices

The appendices shall include cost estimates, outline specifications, data reports, product data, conference minutes, and pertinent correspondence relative to the design and referenced in other sections. Each appendix shall be provided with a title page and table of contents (index). Pages shall be numbered consecutively for each appendix and identified in the table of contents. Cross-referencing shall be clear. Assumptions and conclusions shall be explained.

3.5 FAA

For projects requiring FAA review, the consultant shall adhere to the following outline when addressing requirements in Requirements of the Final Design Report.

3.5.1 Design Analysis

A. Airport Layout Considerations:
   a. Airport Layout Plan (ALP) and Master Plan Conference
   b. FAA AGIS Requirements for AIP/PFC Projects
   c. FAA AC150/5300-16-1 7-18 for Spatial Data Submittal to FAA
   d. Dimensional Standards, FAR Part 77 Clearances

B. Soils and Grading:
   a. Soil Profile and Test Results (Utilize Unified Soil Classification System)
   b. Internal Drainage and Frost Conditions
   c. Field and/or Laboratory CBR Test Results
   d. Cut and Fill, Borrow Considerations, Waste
   e. Special Compaction Requirements
   f. Expansive Soil Problems
   g. Drainage
   h. Rainfall and Runoff Data
   i. Capacity and Structure Design
   j. Ponding, Erosion Control, Extraordinary Features

C. Pavements:
   a. Design Loading Basis- Critical Aircraft or Fleet of Aircraft

b. Existing Pavements
c. Material Types and Sources, Joint Design
d. Alternate Construction
e. Cost Comparison
f. Advantages/Disadvantages of Each
g. Recycling of Existing Material
h. Consideration of Fly ash in PCC Pavements
i. Modifications to Standard FAA Specifications
j. Seal Coat Justification
k. Pavement Design Form FAA 5100-1

D. Lighting and Navaids:

a. Existing Cable and Equipment Conditions Including Circuit Loads and Resistance to Ground Readings
b. Power Supply Sources
c. Counterpoise and Grounding
d. New Equipment, Equipment Housing, New Circuit Loads, Electrical Designs
e. Precision Approach Path Indicators (PAPI) Location and Threshold Crossing Height Calculations

3.5.2 Cost Estimates

A. Quantities, Unit Costs, and Labor
B. Special Considerations (Competition, Labor, and Material Availability)

3.5.3 Project Schedule

A. Time Constraints, Liquidated Damages
B. Critical Completion Dates
C. Recommended Schedule

End of Chapter

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Chapter 4 - Schematic Design Phase

4.0 Schematic Design Phase

Based upon information and data in the accepted design analysis programming submittal (if available), which will be reviewed periodically by DEN, and/or the project SOW, the consultant shall perform field investigations and other design services and prepare the schematic design.

4.1 Engineering Surveys and Soils Investigations

4.1.1 Site Survey

The consultant shall perform on-site surveys to establish accurate dimensioned location information and to establish existing and proposed facilities. Surveys shall be performed in accordance with DEN survey standards.

4.1.2 Soils Investigations

The consultant shall conduct engineering surveys and soils investigations, which are required to complete the design of the projects.

4.2 Design and Construction Alternatives

Prepare written descriptions, analyses, and evaluations of alternative concepts and/or design/construction methods. Include consultant's recommendations of the alternatives.

4.2.1 Cost Estimates

Provide cost estimates consistent with requirements as detailed in Chapter 30- Construction Cost Estimates.

4.3 Schematic Design Documents

4.3.1 Schematic Design Drawings

The consultant shall prepare drawings, which are in sufficient detail to illustrate design concepts, systems concepts, interfaces, scale, and relationships. The drawings shall identify all project components, systems, circulation, and access, including, but not limited to, site plans, aircraft parking plans, interior elevations, sections, floor plans that include access locations and passenger circulation patterns, mechanical/electrical design concepts, process flow diagrams, schematic space and general arrangement plans, building systems, emergency exiting plans, and building elevations and sections with overall dimensions. Drawings shall illustrate alternate solutions and preferred options.

4.3.2 Minimum Requirements

At a minimum, the schematic design documents shall define the following:

A. Organization’s functional relationships that effect facility planning.
B. Building and site circulation.
C. Facility massing and scale.
D. Conceptual appearance.
E. Project environmental context.
F. Basic exterior and interior finish material and product concepts.
G. Conceptual structural, mechanical, and electrical systems.
H. Circulation/conveying systems, if applicable.

4.3.3 Initial Schematic Design Submittal

The initial submittal should be limited to small-scale block diagrams illustrating basic functional groupings with horizontal and vertical circulation to confirm these fundamental design concepts. If there are repetitive modules, e.g., hotel guestrooms or prototype offices, include a larger-scale ½" per 1' study of the module.

Drawing scales should be small, e.g., the site plan should be at same scale as the survey and single line block diagrams and building sections should be at a 1/32" or 1/16" per 1' scale.

The initial schematic design submittal should include:

A. Site Plans

   Indicate orientation, site use, demolition, structure's placement, facilities development, circulation and parking, utility systems also showing with existing utilities, landscape and hardscape concepts, and forms.

B. Block Diagrams (Floor Plans)

   One for each proposed level; group repetitive levels.

C. Sections

   At least two perpendicular to each other at the same scale as the block diagrams to establish vertical control.

D. Exterior Elevations

   Block outs to illustrate massing and context.

E. Image Sketches

F. Sketches of the site and its overall development.

4.3.4 Final Schematic Design Submittal

The final schematic design submittal shall establish the conceptual design of the project illustrating the scale and relationship of the project components. This submittal further develops the initial previous submittals.

The final schematic design submittal should include:

A. Site plans shall indicate vehicle circulation for normal and emergency traffic and shall indicate accessible routes.

B. Floor plans shall indicate accessible routes. Provide a plan for each proposed level; repetitive levels may be grouped. Establish horizontal control.

C. Exit plans shall use the same scale as the floor plans.

D. Floor plans of typical repetitive components: At ¼" per 1' scale with their interior elevation studies, (as appropriate) at the same scale.

E. Building sections shall include at least two perpendicular to each other at the same scale as the floor plans. Establish vertical control.

F. Exterior elevations shall use the same scale as the floor plans.

G. Structural framing plans shall use the same scale as the architectural floor plans showing primary vertical and horizontal structure.

H. HVAC plans shall use the same scale as the architectural floor plans showing proposed distribution for primary vertical and horizontal HVAC systems, including shafts and schematic arrangement of primary equipment.

I. Plumbing plans shall use the same scale as architectural floor plans showing primary plumbing risers, chases, fire service risers, roof drains, and overflows with storm water leaders, and proposed primary horizontal distribution, including location and schematic arrangement of primary equipment.

J. Electrical plans shall use the same scale as the architectural floor plans showing vertical and horizontal electrical primary and stand-by power and communication distribution, including locations and schematic arrangement of primary equipment, switchboards, and panel boards.

4.3.5 Basis of Design

The consultant shall summarize the basis of design in the DAR, which outlines the project opportunities and constraints. The summary shall also describe all applicable zoning regulations and building codes that affect the project. The summary shall outline all record of major design decisions.

The summary basis of design should be formatted as follows:

A. Introduction

A brief description of the project scope and purpose, data sources, and contents.

B. Part 1 – Goals

The architect's understanding of the owner's project objectives stated in terms of function, form, quantity, quality, economy, and time.

C. Part 2 – Facts

Identify pertinent data, laws, ordinances, regulations, and jurisdictional agency requirements that influence or control the design, permitting, or construction processes. Include site analysis, a summary of planning, zoning, building, mechanical and electrical codes, standards, and environmental and archaeological requirements.

D. Part 3 – Concepts

Criteria for implementing or achieving design goals expressed in terms of theme, image amenities, configurations, and operations (e.g., general site planning, functional organization, design, site use and development, movement systems, and the facility's structural, mechanical, and electrical systems.)

E. Part 4 – Needs

Space and functional program requirements, including a reconciliation of programmed and designed spaces at an appendix, schedule requirements, and budget requirements.

F. Part 5 – Problem statement

Summary statements identifying unique and essential project design and construction criteria.

G. Part 6 – Appendix

Copies of conference reports, owner's directives, relevant correspondence, figures, and graphical data referenced in the text, functional diagrams, space program reconciliation, reconciliation of programmed and designed spaces, reduced submittal drawings, and schedules.

In the preliminary project description, describe major site, architectural, structural, mechanical, plumbing, fire protection, and electrical systems with proposed construction products and materials; include off-site improvements, if applicable.

Prepare a project material product binder based on the design decisions reflected by the schematics, arranged initially into each of the divisions of the DEN Technical Specifications. File all product and material data in the binder as they are selected for the project use.

4.3.6 Design Analysis

The consultant shall submit a DAR as defined in Chapter 3- Design Analysis Report.

4.4 Study Models and Perspectives

Study models and perspectives shall be provided if identified in the approved project or task scope. The consultant shall prepare rough, to-scale models, and/or interior and exterior perspective renderings or isometric views of areas of each project or portions of the project where DEN and consultant agree that the relationship of building components is difficult to study and to evaluate two-dimensionally.

4.5 Submittal Requirements

The consultant shall comply with for submittal requirements.

End of Chapter

Chapter 5 - Design Development

5.0 Design Development

Based upon the accepted schematic design documents reviewed and accepted by DEN, the consultant shall prepare design development documents that establish and describe the size, scope, character, material composition, systems, sequence of operation/control, and other features of each project by means of plans, sections and elevations, typical construction details, three dimensional sketches, study models, and equipment layouts, including specifications that identify major materials and systems and establish in general their quality levels. These documents shall include DAR for the design development phase, technical specifications, and construction/procurement contract documents.

The consultant shall meet with DEN before the consultant proceeds with design development and review the submittal requirements that apply to each project. These documents, which are described in more detail below, shall be submitted to DEN for review and acceptance in accordance with the information in Chapter 32- Submittals.

5.1 Design Development Drawings/BIM Models

Design development drawings/BIM models shall be developed in sufficient detail to define the location, character, material composition, scope, and size of each project; to identify potential problem areas associated with completing each project; and to describe proposed solutions to the problems. These drawings/models shall provide overall dimensions, code required dimensions and clearances, spot elevations and dimensions of existing and adjacent elements, and shall conform to the DEN DSMs. A select sampling to be selected by DEN of each discipline from the final design development drawings for each project must be submitted in Revit and/or AutoCAD Civil 3D format. Refer to the DFI DSM.

5.1.1 Plans

Building plans, enlarged partial plans, building sections, enlarged wall sections, exterior and interior details, reflected ceiling plans, elevations, aircraft parking plan, site plan, study perspectives, and study models (non-returnable) showing all building spaces, and relationships. The drawings shall fully illustrate all constructed areas, space planning and component sizes, scope, systems, interfaces, spaces, functions, general materials, and finishes. The consultant shall prepare a set of presentation drawings and material/color sample finish boards of all interior and exterior materials and shall submit them to DEN. The presentation boards are property of DEN and shall not be returned to the consultant. The sample boards shall, illustrate as closely as possible, the material in similar ratios, as they would appear to each other, in the project.

In addition to the structural, mechanical, and electrical components, the submittal should also include the same level of information for civil, landscape/hardscape. Using the approved schematic design documents as a basis for continuing project development, design development decisions, and their documentation would include:

A. All site improvements with building footprints by design discipline, e.g., civil, landscape/waterscape/irrigation, site utilities, and electrical.
B. Subdivision of all interior spaces with built-in fixtures and equipment, room names and numbers, wall and partition types, ceiling heights, and all openings, i.e., door, window, and louver.
C. Architectural finishes, including preliminary room finish and color schedule (applied colors may be incomplete).
D. Interior and exterior opening schedules, i.e., door, window, window wall storefront, all-glass, interior glazed partitions, and louvers with material and finishes.
E. Toilet accessories and their locations (an item-by-item schedule by location) with subschedules (typical plans showing locations and elevations showing mounting heights).
F. Toilet partition types and supports.
G. Casework and countertop locations, profiles, configurations, and materials.
H. Architectural woodwork locations, profiles, and materials.

I. Glass-fiber reinforced concrete and glass fiber reinforced gypsum locations and profiles.
J. Building specialties with their locations/configurations, associated equipment/appliances, and furnishings.
K. Exterior horizontal and vertical closure and roofing systems.
L. Exterior horizontal and vertical waterproofing.
M. Foundation drainage and its connection to site drainage systems.
N. Foundation, excavation, and backfill criteria.
O. Horizontal and vertical circulation, including trash or linen chutes, their fire ratings, and their ancillary and equipment spaces.
P. Fire-resistive assemblies and their locations.
Q. Sound-rated assemblies, including operable partitions, and their locations.
R. Horizontal and vertical structural systems, including sizes and fire-resistive requirements.
S. Plumbing fixtures, including trim, and plumbing risers.
T. HVAC systems, including their locations, sizes and locations of intakes and discharges, and sizes and locations of individual equipment.
U. Electrical fixtures, including trim and allowance fixtures.
V. Electrical power systems, including transformers, switch gear, UPS equipment, emergency or stand-by generators, and primary distribution, such as panel board locations.
W. Cable TV, security, communications, fire alarm, smoke control, and sound system, including terminal and equipment locations.
X. Symbolic identification of what will not be provided under the construction contract, i.e., what will be owner furnished but contractor installed and what will be owner furnished and owner installed, such as, not-in-contract.
Y. All drawing sheets, regardless of discipline, should have the same orientation. Architectural, structural, mechanical, and electrical floor plans should be drawn at the same scale.
Z. Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to the DFI DSM.
    a. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

Minimum design development submittal items shall include the following:

A. Drawings should be organized for subsequent use as contract document drawings. Include title sheets with zoning, building, fire, life safety, plumbing, mechanical and electrical code summaries, and calculations; area and location maps; and a drawing index.
B. Architectural drawings should include abbreviations, symbols, legends, room material code index, and general notes.
C. Architectural site plan with cross-reference notes to work documented by other disciplines.
D. Key floor plans
E. Exit plans with exit load calculations
F. Accessible route plans
G. Floor plans with room names, room numbers, room material codes (if used), wall and partition type indications, ceiling heights, openings (i.e., door, window, and louver locations with symbols), plumbing fixture locations, casework, collateral equipment, building specialties, shafts, chases, suspended slab openings, and depressed slab locations.
H. Reflected ceiling plans with light fixture locations and ceiling materials; coffers, vaults, domes, and other special construction; and operable partitions.
I. Roof plans showing all equipment locations, penetrations, slopes, and drainage.
J. Interior elevations

K. Building sections
L. Exterior elevations
M. Exterior wall sections
N. Vertical circulation, including elevator hoistways, escalators, stairs, and chutes.
O. Preliminary opening schedules (e.g., door, window, and louver) and all-glass, glazed partition schedules, with sizes, types, construction, finishes, hardware, frame types, and fire ratings.
P. Wall and partition schedules.
Q. Preliminary architectural finish and color schedules-applied finish colors may be omitted at this phase. (If an interior designer is involved, ensure that the architectural room finish schedule differentiates between architecturally selected finishes and interior designer selected finishes; indicate where interior designer finishes are documented.)
R. Conventional and accessible toilet accessory schedules with fixture-related mounting locations and heights.

5.1.2 Civil and Infrastructure

Grading, drainage, paving, fencing, and erosion control plans including existing contours, final contours, horizontal and vertical clearances, storm sewer and water lines, drainage structures, and details of special structures.

Civil drawings (if part of the consultant's services or if coordinated by the consultant) should include:

A. Site development plan (horizontal control)
B. Site grading plan (vertical control)
C. Pavements, parking, and roadways plan
D. Storm water Management Plan (SWMP)
E. Site utilities plan, including above and below ground utilities, points of connection to off-site services, buildings, and facilities. Show existing utilities at halftone-separate sheets by system if the project involves expansion of existing facilities or new construction on an already developed site.
F. Landscape/hardscape/waterscape drawings (if part of the consultant’s services or if coordinated by the consultant) should include site landscape and related plans, including planting, lighting, landscape, hardscape, waterscapes, pump rooms, and related features; street or site furniture; and recreation elements and their supporting facilities.

5.1.3 Structural Drawings

Structural drawings including, but not limited to foundation plan, caisson plan, excavation details, nominal sizes, types and cross-sections of structural members and systems, critical structural clearances, interfaces, modifications to the base building structural systems, and details necessary to define the structural system.

Structural drawings should include:

A. General notes (do not duplicate information in specifications and vice-versa)
B. Floor plans showing structural foundation systems and sub-slab construction, horizontal and vertical framing systems showing slab (or equivalent) edges, suspended slab openings, depressed slab locations, lateral load cross bracing, and typical construction details; Final structural design criteria; foundation design criteria; preliminary sizing of major structural components; critical coordination clearances; outline specifications or materials list.

5.1.4 Systems Drawings

Systems drawings which define mechanical and electrical systems, including, but not limited to, HVAC, plumbing, fire protection, fire alarm, life safety, security, power, fiber optics, communications, gate facilities distribution, fueling, lighting, automated materials handling, grounding, lightning protection systems and other special systems

which are appropriate for the projects. Refer to the following chapters for systems specific discipline submittal requirements:

- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems

5.1.5 Alternatives

Analyses of alternative building utilities, building automated materials handling systems, and special systems. The analyses shall include comparisons of construction and lifecycle costs, and operational and maintenance advantages and disadvantages of the systems.

5.1.6 Security

Provide plans, operational procedures, and installation details for a complete security system.

5.1.7 Signage and Graphics

Plans, sections, schedules, elevations, and detail drawings of building public signage and graphics including, but not limited to, tenant requested changes to base building signage/graphics locations and selective demolition plans.

Signage and graphics (if a part of the consultant's services or to be coordinated by the consultant) should include floor plans and elevations of signage and graphics showing their size, fastenings, and atypical and typical mounting details, illumination/electrical power requirements, etc.

5.1.8 Interface Drawings

Plans which show system and facility interfaces with related and adjacent projects and which identify the boundaries or contract limits for the consultant's SOW and the work performed by other consultants and design-build contractors, who are designing portions of DEN that are adjacent to, interface with, or which would be affected by the consultant's SOW.

Interior drawings (if part of the consultant's services or if coordinated by the consultant) should include:

A. Floor plans showing floor finishes and patterns and furniture, fixture, and equipment layouts, including special interior features (e.g., flight information display system kiosk, baggage information display system kiosk, electronic ticketing kiosk, built-in and free-standing items, such as automated teller machines, internet kiosk, public art pieces.)
B. Interior elevations with finish materials.
C. Interior window treatments.
D. Interior finish information as required to complete architectural design development documentation.
E. Interior decorative lighting, fixture locations, and selection (unless allowance items).

5.1.9 Standard Drawings

Consultant shall include standard drawings, including, but not limited to, those furnished by DEN, DEN's consultant, the tenant, or the tenant's consultants.

5.1.10 Demolition

Demolition documents identifying the extent of demolition required prior to, or in conjunction with, the start of construction. Demolition documents shall include all systems demolition or systems to be capped off and abandoned. Demolition safety plan as required by the Project Manager.

5.1.11 Envelope

The design and location of complete and functional enclosure of all building spaces.

5.1.12 Art Program

Plans for incorporating DEN's Art Program into the project. In preparing these plans, the consultant shall adhere to the requirements of DEN's Art Program, which meets the requirements of Executive Order No. 92, for incorporation of the artist's works that are consistent with DSMs for each project. Consideration must be given to lighting, structural systems, power, fire protection systems, finishes, and security. The consultant shall periodically review its design for each project with DEN's Art Program Manager. Currently, the Art department is preparing a master plan. Contact the DEN Project Manager for details.

5.2 Preliminary Technical Specifications

The consultant shall prepare a complete set of Technical Specifications for the project in a format accepted by DEN. An outline of the Division 01- General Requirements Technical Specifications will be furnished by DEN and shall be reviewed and commented on by the consultant. Comments shall be submitted to DEN in written form.

The consultant shall comply with Chapter 11- Specification Requirements.

5.3 Design Development Design Analysis Report

The consultant shall comply with Chapter 3- Design Analysis Report.

5.4 Submittal Requirements

The consultant shall comply with Chapter 32- Submittals.

End of Chapter

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Chapter 6 - Contract Documents

6.0 Contract Documents

6.0.1 Intent

The intent of the contract documents is to include all items necessary for the proper execution and completion of the construction work. Prior to beginning the contract documents phase, the consultant shall completely familiarize all team members with the most current version of the Standard Specifications for Construction, General Contract Conditions (GCC), 2011 edition published by DEN and County of Denver, 2011. This document shall become part of the construction contract and the document identifies responsibility of the contractor, DEN, and the consultant. The work (GCC 121 Work and 1801 contractor's Warranties, Guarantees and Correction of Work) provided by the contractor shall be ultimately governed by this document. The individual documents comprising the contract documents are all essential parts of the contract and a requirement occurring in one is binding as though occurring in all. They are complementary and indicate the construction and completion of the work. Anything mentioned in the technical specifications and not shown on the contract drawings or shown on the contract drawings and not mentioned in the technical specifications, shall be of like effect as if shown or mentioned in both.

6.0.2 Referenced Standards

Material and workmanship specified by the number, symbol, or title of a referenced standard shall comply with the latest edition or revision and amendments and supplements thereto in effect on the date the bid is received except where a particular issue or edition of a publication is indicated. In case of a conflict between the technical specifications and the referenced standard, the more stringent shall govern.

6.0.3 Precedence of Contract Documents

6.0.3.1 Special Conditions

Special Conditions shall be given precedence over General Conditions. Special conditions are authored by Airport Legal Services with input from DEN and the consultant. Special conditions typically address the following:

A. Schedule of work and sequence (milestones)
B. Liquidated damages for each milestone and overall project
C. Special security requirements
D. Others

6.0.3.2 General Contract Conditions

These conditions are established by DEN. The consultant shall obtain a copy of GCC 2011 from DEN's website:

Denver Government Website

GCCs shall be given precedence over DEN standard technical specifications except that if, and to the extent that, the DEN standard technical specifications provide for a higher standard or for more stringent requirements than the General Conditions do, the DEN standard technical specifications shall be given precedence in such respects.

6.0.3.3 DEN Standard Technical Specifications

DEN Standard technical specifications shall be given precedence over contract drawings. This condition dictates that the consultant not repeat in the drawings, annotations in the specifications. This condition also does NOT relieve the consultant from completely and accurately coordinating dimensional and product profiles/illustration

on the drawings. If alternate products are specified, the larger of the acceptable products shall be illustrated on the drawings.

6.0.3.4 Larger Scale Drawings

Large-scale drawings shall be given precedence over smaller scale drawings, for example: 1" =1' is larger scale than 1"=40' and 1"=1' is larger scale than 1/8"=1'. This requirement in no way relieves the consultant from the liability of accurate coordination of dimensions between small and large-scale drawings.

6.0.3.5 Conflict or Inconsistency

In the event of conflict or inconsistency between provisions of the technical specifications, the more stringent shall be given precedence over the less stringent. This requirement in no way relieves the consultant from the liability of coordinating all aspects of the specifications, including Division 01 - General Requirements.

6.0.4 Scope of Work

The contract documents contain the SOW for the contractor.

Not all the following will necessarily be included in every project. Actual scope of work contract documents will be based on project requirements. If DEN PM determines that project has different requirements for SOW contract documents, DEN PM will set up a meeting with DEN stakeholders and consultant to determine which SOW contract documents are required for the contractor prior to the submittal of 100% contract documents by the consultant.

6.0.4.1 Part I – Scope of Work Contract Documents

The following documents are prepared by the City, except as noted:

A. Advertisement of Notice of Invitation for Bids
B. Instructions to Bidders
C. Addenda Paperwork (If Any)
D. Bid Forms: Bid Letter
E. Contractor's Insurance Bid Document
F. Bid Data Forms
G. Schedule of Prices and Quantities- (Consultant shall assist in preparation)
H. Notice to Apparent Low Bidder
I. Contract W/Exhibits
J. Performance Bond
K. Payment Bond
L. Notice to Proceed
M. Form of Final Receipt
N. Construction Contract General Conditions (Separate volume)
O. Special Conditions (Consultant may advise in preparation)
P. Equal Employment Opportunity Provisions

6.0.4.2 Part II: Technical Specifications

The following technical documents are also included in the SOW, subject to contractual requirements:

A. Division 01, DEN Standard Technical Specifications

   Prepared by City and consultant

B. Divisions 02 – 14, 21 – 23, 26 – 28, and 31 – 33, DEN Standard Technical Specifications

   Prepared by consultant, as required

C. Schedules

   Prepared by consultant

D. Contract drawings

   Prepared by consultant)

E. Accepted shop drawings, approved change directives, and change orders

6.0.4.3 Geotechnical Study

The Geotechnical study is issued at the time of bid and is for information only

6.1 Trademarks, Copyrights and Patented Devices, Materials, and Processes

Refer to the Department of Aviation/Department of Public Works, Standard Specifications for Construction, General Contract Conditions, 2011 (GCC 2011).

6.1.1 Notification by Consultant

If the contract documents require the contractor to use any design, device, material, or process covered by letters, patents, copyrights, trademarks, or artists, the consultant shall provide written notification to DEN of any requirement for such use and shall procure suitable written acceptance with the patentee or patent owner, copyright owner, or trademark owner, which agreement shall provide that there will be no future or continuing royalties or payments by the contractor or by DEN. For example, the consultant may not publish as part of the bid documents, copies of designs, shop drawings or materials by contractors, designers, or suppliers without written authorization from that contractor, designer, or supplier.

6.1.2 Disclosure

If the contract documents require use of a particular design, device, material, or process, the contract documents shall disclose the existence of any letters, patents, copyrights, or trademarks covering it.

6.1.3 Liability

The contractor need not indemnify against the negligence of DEN, its officers or employees, or against claims for infringement of letters, patents, copyrights, or trademarks required by the contract but neither disclosed in the contract documents nor apparent by virtue of common knowledge in the construction industry.

6.2 Contract Documents, Technical Specifications, and Technical Reports

6.2.1 Construction Documents

Based upon design development documents that have been reviewed and accepted by DEN, the consultant shall prepare complete construction documents and shall provide the following:

A. Agency and utilities applications and permits
B. Final DARs
C. CDSR report
D. Geotechnical study

6.3 Submittal Requirements

The consultant shall comply with Chapter 32- Submittals.

6.4 System Compatibility

As project systems are refined and operational requirements are defined that require interface between the project and DEN systems. The consultant shall specify system controls that are compatible with existing DEN control systems, including, but not limited to: electrical, lighting controls, mechanical controls, fire protection and detection, surveillance, and security. This system compatibility shall include, but not be limited to any and all upgrades to existing systems to handle the increased existing control system responsibilities created by the addition of the systems installed with the project or task. The consultant shall identify all necessary upgrades to existing systems and provide the necessary documentation to accomplish those upgrades within the construction contract documents. The consultant shall identify the requirements for equipment and software compatibility and specify project equipment and software that will facilitate that interface.

End of Chapter

Chapter 7 - Bid and Proposal Evaluation

7.0 Bid and Proposal Evaluation

7.0.1 Advertisement

The project shall be advertised for bid for three (3) consecutive business days in newspapers and journals. The advertisement is prepared by DEN BMS based on materials provided by DEN. Complete sets of bid documents shall be available for distribution on the first day of advertisement.

7.0.2 Distribution of Documents

The consultant shall be responsible for preparing the bid or Request for Proposal (RFP) documents in electronic format for distribution to bidders and in accordance with instructions from DEN. All documents are posted on the DEN website by BMS free of charge. See link below:

DEN Business and Community

7.0.3 Approval

Following City review and approval of the final (100%) construction document phase submittal, and with written notification from DEN's Project Manager, the consultant shall complete the contract documents and prepare them for distribution to prospective bidders.

7.1 Interpretation of Bid Documents

7.1.1 Interpretation Requests

During the bid period, bidders may request, in writing, clarification or interpretation of any apparent inconsistencies between different provisions of the contract documents or any other point in the bid documents, which the bidder believes requires a decision or interpretation by DEN. All questions are submitted to contract procurement (see link below), no later than ten (10) calendar days before bid opening unless otherwise specified. Questions and answers are posted to the DEN contract website. The consultant shall respond to such information or interpretation requests to DEN within 24 hours of receipt of the request from the bidder, regardless of timeframe of the submittal.

contract.procurement@flydenver.com

7.1.2 Control of Information

The consultant shall not discuss the content of the construction documents with proposers or potential bidders. All requests for interpretations shall be forwarded to the consultant and DEN in writing. All changes to the construction documents shall be issued as addenda. The consultant shall prepare — in a timely manner to cause no delay — written answers to questions and addenda descriptions in the format as defined by DEN.

7.2 Substitutions

7.2.1 Materials and Substitutions

The following is the typical language directed to the contractor during the bid phase:

It is often convenient and practical to specify materials and equipment to be incorporated into the work by a proprietary name or by the name of its manufacturer. When so specified and further qualified by the phrases or equal or equivalent, it shall be understood that such specification is not intended to limit the material and equipment selection process. Rather, the specification is intended to indicate a standard of quality and capability, which will be accepted. However, all bidders desiring to use materials other than the specified material must obtain the written acceptance of DEN. All such requests for acceptance of equal or equivalent material must be made in writing and, except as hereinafter provided, be submitted to the consultant with a copy sent to DEN. Consultant shall coordinate with the DEN Project Manager the number of days required for Materials and Substitution Requests prior to the date and time set for opening of bids so that all such acceptances will be included in addenda to ensure full and complete disclosure to all potential bidders of all accepted equal or equivalent materials. All requests for acceptance of equal or equivalent material shall contain adequate technical data to clearly demonstrate equivalency. Incomplete submittals will not be reviewed. Requests must be submitted on the attached form titled **Request for 'or equal' Acceptance** following this page. Requests containing inadequate or incomplete information will not be considered.

An awarded contractor may elect to use an **OR EQUAL** if published in addenda.

7.2.2 Substitution Form

The contract documents contain directions and forms for the Proposers to use in submitting substitutions. The contractor is required to forward to DEN and the consultant their requests for substitutions. The consultant shall in a timely manner advise DEN in writing on the acceptability of substitutions of materials, software, equipment, or construction methods suggested by prospective bidders prior to bid or proposal opening, including the consultant's detailed written reasons for recommending or denying substitutions. Addenda accepted by DEN shall be prepared and issued by the consultant regarding these items.

7.2.3 Acceptance

Acceptance of an **OR EQUAL** by the consultant constitutes that the consultant has warranted the following:

- The use of the **OR EQUAL** fulfills the specification requirements contained in the contract documents, and
- The installation of the **OR EQUA**L will not affect the spatial and functional requirements for the work or the scheduling of work performed by DEN or other contractors

7.3 Addenda

The consultant shall prepare at no additional cost any addenda to the contract or RFP documents in electronic format required by DEN during the bidding and RFP process. DEN shall post all addenda on the DEN contract website.

7.3.1 Preparation

Information about any interpretation, clarification, or substitution made by DEN and/or the consultant shall be assembled as addenda by the consultant in the following manner:

7.3.1.1 Written Description of the Change

This description is part of the Forward of the Addenda and is typically not a contract document. Each item that requires change or correction is listed in the order that it appears in the bid documents, and a general description of the change is provided referencing drawing or page number and the change that is made. The description is a vehicle to aid the proposers by providing the general understanding of the change. The actual change appears as modifications to the bid documents as re-issued drawings or specifications.

A. Description of Specification Change

A written summary of each change sighting the specification section, issue number, page number, and paragraph and sub-paragraph number. The following is an example: 1. Reference Specification Section

092113 Plaster Assemblies, Issue for Bid, Page 2, Paragraph 1.07A as follows: Delete **Deliver all materials to Tulsa Oklahoma** and Replace with the following: **Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer of supplier.**

B. Description of Drawing Change

Each description is a written summary of each change citing the contract document sheet number, issue number, detail or drawing number, and a general specific description of the change.

7.3.1.2 Bid Document Changes

A. Specifications

The consultant shall prepare a complete specification section noting the addenda number and date in the footer.

B. Drawings

The consultant shall revise the entire drawing and bubble the area affected by the change described in item (A) above, numbering the bubble with the correlative addenda number. The title block of the drawing shall have the correlative addenda number entered.

7.3.2 Addenda Numbering

Addenda shall be numbered consecutively beginning with the number 1 as assigned by DEN.

7.3.3 Addenda Cost and Schedule Impacts

The consultant shall prepare a matrix identifying all cost and schedule impacts of each addenda item. The consultant shall immediately notify DEN of any item that will affect the advertised contractor Period of Performance or established budget for the project.

7.4 Addenda Submittal and Review

7.4.1 Electronic Documents

The consultant shall include one set of electronic documents of addenda items.

7.4.2 Review

DEN will review the addenda and may add items to the addenda regarding administrative items.

7.4.3 Approval

The Chief Executive Officer (CEO) or approved designee shall approve in writing, addenda prior to issue of addenda.

7.4.4 Distribution of Addenda

The consultant shall, after receiving written acceptance of the addenda materials, shall produce an electronic copy of the addenda to DEN. DEN shall post all addenda on the DEN contract website.

7.5 Pre-Bid/ Proposal Meeting and Site Visits

7.5.1 Consultant Attendance

The consultant shall be represented at pre-bid and pre-proposal meetings and site visits to respond to inquiries and requests for interpretations by prospective bidders and proposers unless directed otherwise by DEN. The consultant shall also prepare written responses to questions and shall forward these responses to DEN for review and acceptance. Answers to questions that do not change the contractor's SOW will not be issued as addenda. The

questions will be issued as a simple *Question and Answer* summary and shall be posted on the DEN contract website by DEN.

7.5.2 Contractor Site Visit

The Instructions to Bidders may include the requirement or opportunity for contractors to visit the site. At required contractor site visits prior to bid opening, the consultant shall be represented at the site visits. The consultant shall record questions for further reference. All contractor questions shall be submitted in writing consistent with Construction contract requirements.

7.6 Opening of Bids

7.6.1 Bid Opening

Where required by the contract and directed by the DEN PM, the consultant shall be present at bid openings unless directed otherwise by DEN. The consultant shall receive one copy of each proposal for consultant review of Bids and recommendation of the Apparent Low Bidder. The consultant shall not duplicate in any form the Bid documents and shall return the Bid documents to DEN on completion of the consultant review.

For FAA funded projects, the consultant shall follow all FAA guidelines.

7.6.2 Consideration of Bids

After the bids are opened and read and any discrepancies have been reviewed, bids will be compared based on the total contract bid amount written on the bid letter and any unit prices or task proposals that are part of the bid pricing. If a discrepancy exists between a price or amount written in words and the price or amount written in figures, the price or amount written in words shall govern, except that in the case where a price or amount shown in figures has been crossed out and replaced with a new, legible, initialed figure, the initialed figure shall govern.

7.6.3 Basis of Selecting the Apparent Low Bidder

Selection will be based on the lowest, responsive bid by a qualified bidder whose bid complies with all the requirements prescribed herein. This selection shall be subject to the acceptance of such resulting contract in accordance with the Charter and ordinances of DEN.

7.7 Bid and Proposal Evaluation

7.7.1 Consultant Review

The consultant shall assist DEN and the County in reviewing, checking, and evaluating bids and proposals, preparing bid tabulations, reviewing system performance capability to meet design criteria, and making written recommendations to DEN for the award of contract during the five (5) business days following a bid or proposal opening.

7.7.2 Consultant Cost Estimate vs. Low Responsive Bid

If the low responsive bid or proposal received from a responsible qualified bidder or proposer is more than +/- 15% of the established construction budget for the SOW in the bid or RFP documents, the consultant shall, if DEN requests, either modify the contract documents and specifications in a manner acceptable to DEN, to bring the contract amount for the work within individual contract package construction budget or reissue the bid or proposal package at the expense of the consultant. The ways in which DEN may accomplish this reduction/addition in the contract amount includes, but is not limited to, reissuing the project contract package, or requesting additional proposals after the design changes have been incorporated in the RFP or contract documents. If the project is reissued for bid or proposal, this paragraph will continue to be applicable until a low responsive bid or proposal is received which is within the established construction budget for the SOW included in the bidding or proposal documents.

7.8 Notice to Apparent Low Bidder - Execution of Contract

7.8.1 Notice to Apparent Low Bidder

The Notice to Apparent Low Bidder (NTALB) will typically be provided in written format by DEN on the form included in the bid documents within ninety (90) calendar days from the date of opening of bids.

7.8.2 Conformed Documents (Incorporation of Addenda)

As directed by DEN, the consultant shall incorporate in the contract documents the addenda. Only changes made in formally issued addenda may be incorporated into the documents.

All conformed documents must be stamped and signed by the Engineer of Record.

7.8.2.1 Specifications

Cover sheet and footers of all specifications shall be changed to **Issue for Construction – (Bid opening Date)**.

7.8.2.2 Drawings

The most current drawings shall be revised, removing the bubbles and title block changes. The issue block on the drawings shall be changed to **00 Issue for Construction – (Bid Opening Date)**

7.8.3 Delivery

The consultant shall deliver conformed construction documents in electronic format to the Project Manager before execution of the contract.

7.8.4 Consultant Certification

The consultant shall perform a review of the Issued for construction documents to verify the completeness of the technical specifications and drawings. the consultant shall issue a certification that states that issued for construction documents have been reviewed for completeness and that all information contained in the issue for bidding construction documents and all pre-bid addenda have been incorporated into the issued for construction documents.

7.8.5 Second Party Signature

The Apparent Low Bidder shall execute the contract and return it to DEN along with the required bonds and insurance forms within five (5) calendar days after its receipt of the notice. When the executed contract and the required bonds and insurance certificates are received, acceptance for DEN to contract with the Apparent Low Bidder shall be sought in accordance with the Charter of DEN. Such notice shall not create any rights in the Apparent Low Bidder to any contract with DEN.

7.8.6 Award of Construction Contract

7.8.6.1 Contract Values less than $5,000,000

The contract may be awarded only after approval and signature by the following: City Attorney, City Auditor, City Clerk and Recorder, Mayor. The duration required for these signatures and approvals is typically between two weeks and six weeks.

7.8.6.2 Contract Values greater than $5,000,000

The contract may be awarded only after approval by City Council. The process of review and approval by City Council is typically between three and eight weeks. After City Council approval, the contract description is advertised for a period of three days by DEN Clerk and Recorder. Subject to no exceptions taken during the

advertisement period, the contract is filed as an Ordinance. The contract is then processed for signatures as identified in the paragraph above. This process typically takes an additional seven weeks.

7.8.7 Construction Notice to Proceed

NTP is the initiation of the construction administration phase of work. The NTP shall be issued to the contractor by DEN on the date selected by DEN. The consultant shall be advised of the NTP date.

End of Chapter

Chapter 8 - Construction and Administration

8.0 Construction and Administration

8.0.1 Notice to Proceed

The construction phase begins with the issue of the NTP to the contractor. The consultant shall provide at a minimum the following services during construction administration:

A. Attend construction meetings in accordance with City's instructions.
B. Visit project site at appropriate intervals; complete observation reports.
C. Review and process submittals; adhere to standard procedures established by DEN regarding stamping and filing submittals.
D. Interpret contract documents.
E. Review and evaluate discrepancies in contract documents.
F. Review and evaluate change orders.
G. Assist City in testing observation and final acceptance review.

8.1 Inconsistencies in Documents

8.1.1 Notification

If the consultant, while it performs construction administration services discovers any inconsistencies improper cross-references, omissions or ambiguities in the accepted Issued for construction documents, change directives or change orders in the construction documents it shall promptly notify DEN in writing. If DEN agrees that errors or omissions in those documents exist and must be corrected, the consultant shall make the required revisions to the documents at no cost to DEN.

8.2 Construction and Procurement Meetings

8.2.1 Pre-construction Conference

The consultant shall attend the meeting set by DEN. The pre-construction conference is a general review with the contractor of all the contract requirements.

8.2.2 Pre-work Meetings

The quality control requirements of the contract will typically require the contractor to set up pre-work meetings on each phase of work and sometimes on each trade prior to initiation of work for that phase or trade. The consultant shall attend the meetings as directed by DEN and shall be the expert representing each contract requirement for the general work and/or the specification/drawing documents related to the trade. The consultant's team shall be fully competent and completely familiar with the contractor's SOW.

8.2.3 Weekly Meetings

The consultant shall attend weekly construction and procurement meetings and such other construction meetings, at the request of DEN.

8.2.4 Written Communications with the Contractor

The consultant shall not, without written acceptance from DEN, communicate directly with the contractor. Refer to GCC 2011. Any communications with the contractor shall be transmitted by DEN.

8.2.5 Consultant Authority

The consultant does not have the authority to modify the terms and conditions of the construction contract. That authority rests solely with DEN.

8.3 Construction Observation

8.3.1 Site Visits

The consultant shall conduct the site visits with DEN or a designated representative and, prior to leaving the site, will verbally discuss with DEN or an authorized representative any observed defects, deficiencies and other problems and possible solutions to those problems. Unless required by contract, the consultant shall not be required to make exhaustive or continuous site visits to check quality or progress of the work. Such activities shall be conducted in accordance with any additional instructions from DEN to observe activities associated with the construction of the project. During these visits the consultant shall review the quality of the work, answer questions regarding the project design and investigate the circumstances surrounding any defects or deficiencies in the work and any other failure of the work to comply with the contract documents observed and/or reported by the consultant's personnel or the construction inspectors retained by DEN. The consultant shall also monitor any critical construction activities identified in the contract documents for the projects or requested by DEN.

8.3.2 Fabrication and Assembly

The consultant shall visit the project sites and other sites in the Denver metropolitan area where manufacturing, assembly, fabrication, or similar activities are occurring (1) at intervals appropriate to the progress of construction/manufacturing (weekly or more frequently to the project site if necessary or if requested by DEN), and (2) during critical construction and manufacturing processes. If the consultant’s visitation to out of region project sites (Denver Metropolitan area of 5 adjacent counties) is required, the consultant shall arrange for such visitations at the direction of DEN.

8.4 Contractor/Manufacturer Inspection and Acceptance Reviews

8.4.1 Preliminary and Completion Observations

At the request of the Project Manager, the consultant shall participate in observations to establish the completion status of each project including the following observations: initial observation, completion observation, pre-final observation, and final observation. Participate in other observations and testing/start-up as required by DEN, which include completion observations of phases of the work and observations of mockups and equipment startups. The consultant shall prepare and submit written reports to DEN on the results of the observations within 24 hours.

8.4.2 Punch Lists

The consultant shall assist DEN in the preparation of punch lists and subsequent walk-through verification that the contractor has completed the work identified on the punch list in an acceptable manner.

8.4.3 Final Inspection and Certifications

The consultant shall participate with DEN in the preparation of any final inspection certificates and documents required to close out affected contracts and to facilitate final payment by DEN. The consultant shall coordinate with all government agencies including but not limited to the Denver Development Services (DDS) and Denver Fire Department (DFD) and provide the needed information to these departments to assure the issuance of all permits and certificates of occupancy.

8.4.4 Warranties

The consultant shall review any written warranties and guaranties required by the contract documents for each project submitted to DEN prior to DEN's acceptance of final payment.

8.5 Observation Reports

8.5.1 Reports

The consultant shall prepare and submit, within twenty-four (24) hours after a site visit, a written observation report to DEN that describes the extent of the visit and summarizes the consultant's observations, recommendations, and answers given to questions raised by DEN or City representatives. This report shall include:

A. A description of all defects in materials incorporated in the work or stored-on-site materials, furnishings, equipment, workmanship, or any other failure by the contractor or its Subcontractors of any tier to perform their work in full compliance with the contract documents for the projects that it observes during its visits to the projects and/or manufacturing sites.

B. Consultant recommendations for correcting such observed defects and non-conforming work. The consultant shall immediately notify DEN both verbally and in writing of any such defects and/or non-conforming work that it observes which have potential to delay a project if they are not addressed immediately. This notice shall contain the consultant's recommendations for correcting such defects, non-conforming work, and/or failures.

8.5.2 Protection

The consultant shall endeavor to protect DEN against defects and deficiencies in the work performed by contractors on the projects, including any failure of the work to conform to contract drawings and specifications. The consultant does not assume to have control over, have charge of and is not responsible for any of the contractors' or manufacturers' construction means, methods, techniques, sequences, procedures or safety precautions and programs in connection with the construction of the projects or for the failure of any of the contractors to perform their work in accordance with the contract documents.

8.6 Review of Contractor/Procurement Submittals

8.6.1 Submittal Review Process

The contractor shall submit all documents described in the contract documents and any other written communications to DEN unless otherwise specified in the contract documents. The consultant shall not review submittals submitted directly by the contractor to the consultant unless directed in writing by DEN.

A. DEN will electronically transmit copies of submittals to the consultant. The consultant shall review and return submittals to DEN within seven (7) business days unless notified in writing by DEN.

B. The consultant shall prepare and keep current, a log of submittals indicating status of submittals, date received, submittal action, date submitted to subconsultants, and date returned to DEN. The submittal log shall be available at each construction meeting for review. The format of the log shall be as directed by DEN.

8.6.2 Consultant Review of Submittals

A. The consultant shall review and accept contractor submittals required by the construction contract documents for all the projects for conformance with the design concept of the project and the contract documents. These submittals include those listed in the CDSR or requested/transmitted to the consultant by DEN, and all submittals shall be submitted in accordance with instructions received from DEN for conformance with the construction contract documents with such reasonable promptness to cause no delay in the progress of the work.

B. All reviews and acceptances shall be completed, and the submittal returned to the Project Manager within seven (7) business days after the consultant receives them, unless DEN has established a shorter review period for particular submittals in writing. The returned submittal shall include the consultant's comments and any corrections or revisions, which are required to obtain its acceptance. Comments shall be on the

submittal and may not be provided on separate correspondence. Annotations of submittals shall be made electronically.

C. The consultant shall not use shop drawings or contractor submittals as a vehicle for making changes to the contractor's scope, correction of design errors and omissions. Completion of the design in the Shop Drawing Process is not acceptable. The design shall be complete at time of Bid advertisement. In the event the consultant, during its review identifies deficiencies in contract documents, the consultant shall immediately notify DEN and review the issues for further direction.

8.6.3 Consultant Review Stamp

The consultant and all lower tier subconsultants shall use a review stamp format consistent with the Construction Contract Documents Part I in the language of the review and the marking of the status.

The consultant shall mark, sign, and date the review; the consultant and subconsultant review stamp shall have the following marks:

8.6.3.1 Accepted

Accepted (ACC) is an acceptance and means that the illustration and description appears to conform to the respective requirements of the contract documents.

8.6.3.2 Accepted as Noted

Accepted as Noted (AAN) is an acceptance and means that the illustration and description appear to conform to the respective requirements of the contract documents after changes in recognition of the reviewer's comments. Submittals so marked need not be resubmitted.

8.6.3.3 Revise and Resubmit

Revise and resubmit (R&R) means that the submittal is unacceptable and shall be revised and resubmitted.

8.6.3.4 Rejected

Rejected (REJ) means that the submittal is not acceptable and that a new submittal in accordance with the contract documents shall be made.

8.6.3.5 For Information Only

For information only (FIO) means DEN receives the item but no review was made. This mark is for use in resubmitting items that were previously accepted as noted and the contractor has incorporated the notes and wants DEN's staff to have the same material that the contractor's field staff is using.

The consultant's review is limited to the above categories. No other submittal review categories shall be noted on the contractor submittals without the written permission of the Project Manager.

Review of a separate item will not constitute review of an assembly in which the item functions. DEN will withhold acceptance of submittals, which depend on other submittals not yet submitted. Review and acceptance will not relieve contractor from their responsibility for accuracy of submittals, for conformity of submittal document to requirements of contract drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the contract in accordance with the contract drawings and specifications.

8.6.4 Review

The consultant shall review contractor and/or City reports of Deficiencies and Non-Conformance Reports (NCRs) forwarded to the consultant by DEN. The purpose of these written requests is to correct deficiencies in the work.

8.7 Interpretation of Contract Documents

8.7.1 Consultant Review and Response

The consultant shall, in a timely manner provide, when requested by DEN, interpretations of the contract documents for the projects. Such interpretations shall be expressed in supplementary drawings or sketches in Revit/Civil 3-D format, specifications, and instructions that the consultant or DEN may determine are necessary to provide affected contractors with sufficient direction to continue their work. All supplementary documents shall be distributed to DEN in accordance with DEN's instructions. The consultant shall respond in writing to any questions or comments by DEN concerning the contract documents for the projects and possible variations in those documents, which would be accepted in the field to help maintain project progress and project quality.

8.7.2 Request for Information

The contractor shall submit any Requests for Information (RFI) or clarification of drawings and specifications to DEN. DEN will forward the RFI to the consultant. The consultant shall provide written responses to contractor Requests for Information. The response time to the RFI shall be no greater than five (5) business days from receipt of RFI but in no case shall the RFI response time by the consultant cause delay to the contractor's work. DEN will forward the consultants response to the contractor. Refer to GCC 2011.

8.7.3 Consultant Timely Notification

The consultant shall notify DEN in writing in a timely manner to cause no delay to the project whether the information that clarifies or answers the RFI is a change in the work scope of the contractor. The answer to an RFI is NOT a vehicle or substitution for completion of the contract documents as required in Chapter 6- Contract Documents. If the answer to an RFI constitutes a change in scope, the consultant, when directed by DEN, shall prepare the Change Request and any necessary drawings, cost estimates and specifications that are associated with it.

8.7.4 Time Extensions or Changes in Construction Contract Amount

Responses to requests for information shall neither authorize nor constitute time extensions or changes in contract Amount. Should the contractor believe that the response to requests for information requires a change in contract Time and/or contract Amount, it must submit a contractor Change Request (CCR) to DEN in accordance with GCC 2011.

8.8 Changes in the Construction Work - Administrative Vehicles

8.8.1 Issue of Changes to the Work

DEN may, without notification to any contract surety, require the contractor to perform additive or deductive changes without invalidating the contract or the surety bond. All changes shall be accomplished by either a written Change Order. Refer to GCC 2011.

8.8.2 Contractor Performance of Changes

The contractor shall promptly perform changes in the work, which are described in Change Orders and Change Directives in accordance with applicable provisions of the contract documents, unless otherwise provided in the Change Order or Change Directive.

8.8.3 Change Notice

DEN will issue a Change Notice informing the contractor of a planned change in the work and its scope and requesting the contractor's detailed price proposal. The contractor shall submit a priced proposal for performing the proposed change in the work. Change notices are typically not schedule sensitive items. The Change Notice may be accompanied by a Change Request document.

8.8.4 Change Order

A Change Order is a written instrument signed by the Manager of Aviation, other designated parties, and the contractor, which contains their agreement upon all the following matters:

A. Changes, additions, or deletions to the work.
B. The amount or method of the adjustment in the contract amount, if any. Refer to GCC 2011.
C. The extent of the adjustment in the contract time or period of performance. Refer to GCC 2011

NOTE: No change of contract Time or contract Amount, or any other change to the contract shall be binding until the contract is modified by fully executed Change Order.

8.8.4.1 Change Order Execution

When DEN and contractor reach agreements on the adjustments to the contract amount and/or contract time, if any, such agreements shall be promptly recorded in an executed change order.

8.8.5 Contractor Change Request

The contractor shall give DEN prompt written notice of such matters in a letter or notice denominated **Contractor Change Request** and request a Change Order if the contractor: Refer to GCC 2011.

A. Receives any written instructions, directives or interpretations of contract documents, or determinations from DEN or,
B. Identifies design errors/omissions or any other errors/omissions in the contract documents or,
C. Encounters a differing site condition or,
D. Is delayed in the progress of the work or,
E. Becomes aware of any other matter or circumstance that it believes would require a change in contract time or contract amount.

All CCRs shall be dated, numbered sequentially, and shall describe the action or event that may require the issuance of a change order. The contractor shall also provide descriptions of possible contractor actions or solutions to minimize the cost of the CCR and, provide an estimate of the adjustment in the contract time and contract amount, which it believes, is appropriate.

8.9 Changes in the Work - Consultant Requirements

When requested by DEN, the consultant shall assist DEN in a timely manner to review, evaluate, prepare, and process all change notices, change directives and change orders described in DEN's construction contract documents and all change requests prepared by others in the following manner:

8.9.1 Change Request

A change request is a set of documents (specifications, drawings, and other documents) that describe a desired change to a project. The change request may be issued to the contractor as an attachment to a change notice, a change directive, or a change order. When directed by DEN, the consultant shall prepare a change request including but not limited to the following:

A. Cost estimate consistent with standard cost estimate format.
B. Evaluation of schedule impact stated in days of duration and specifying contractor activities impacted
C. Document preparation.

   The consultant shall prepare specifications and construction drawings to depict the change proposed. Prepare appropriate revisions to the contract drawings and specifications for the projects required by the change and provide the number of copies of these documents as required in the consultant's IFC submittal requirements. The consultant shall, during the construction administration phase of each project,

incorporate all accepted change directives and change orders into the Revit/Civil 3D model as they are issued. The consultant shall continually update all Revit/Civil 3D models for each project during the construction phase in such a manner that at the completion of the construction phase of each project, all accepted changes should have been incorporated into the contract drawings and specifications. The consultant shall place in the title block and/or footer of the document indication of the change request number and the date. Revisions shall be *bubbled* in black ink and noted with the change request number. Subject to issue of a change directive or change order, the subsequent change would have the CR 01 bubbles and annotations removed from the documents. The annotation in the title block or footers will remain the duration of the construction contract until the time of record document or project record development by the consultant. Change Requests shall be numbered sequentially. The first change request number issued on the 12th of March 2019 would be labeled CR 01 12 MAR19.

D. The consultant shall include with any submittal of a change request a certification that the documents comply with all applicable codes and regulatory agency requirements.

8.9.2 Review and Negotiation of Changes

Assist DEN in the review and negotiation of costs and durations submitted by the contractor, which are associated with changes and recommend acceptance or rejection of such costs and durations.

8.9.3 Design Alternatives

The consultant shall prepare and develop alternate designs and documentation when requested by DEN to help maintain each project schedule and budget.

8.9.4 Code Agency Submittal

The consultant shall assure that change requests developed by the consultant comply with code agency requirements before issue of the change to the contractor. The consultant shall provide all code agencies stamped copies of the request that have been issued the contractor as a change directive or a change order. One stamped copy shall also be forwarded to DEN.

8.9.5 Change Analysis

Provide to DEN, when requested, the consultant's evaluation of whether the SOW described in a third-party submittal of a change is complete, what impact the change may have on other portions of the contractor's work and on construction work by other contractors, the impact of the change on schedules and an estimate of the cost of the proposed change in the work.

8.9.6 Written Recommendations

Provide written recommendations to DEN on the desirability of the proposed change.

8.10 Contractor Substitutions

Refer to GCC 2011. The consultant shall in a timely manner review, evaluate and make recommendations on all contractor requests for the use of or equals and substitutions. If the consultant does not recommend acceptance of a substitution or an or equal, it shall provide specific and detailed reasons for its denial in writing.

8.10.1 Substitution Requirements

The contractor may ask for substitution of specified material or equipment with equal or equivalent items only under the following circumstances:

A. The contractor provides evidence to DEN which in DEN's opinion, establishes that an item of specified material is not available or,
B. The contractor provides evidence to DEN which, in DEN's sole opinion, establishes that the specified item will have an unreasonable delivery time due to no fault of the contractor or,
C. If the Special Conditions allow the use of or equal.

If any of these circumstances occur, contractor shall request acceptance for a substitution at least 30 days before the material or equipment must be ordered. All requests shall be in writing as part of a submittal. The request shall describe all features of the requested substitution including any tie-in with other elements of the construction including utilities and controls along with the substitute materials or equipment's size and capacity. The request must be submitted on the form provided by DEN and shall list all differences from the product described in the technical specifications, include the price of the specified item and the requested substitution, and describe any advantages or disadvantages of the proposed substitution. If the *or equal* material or equipment costs less than that specified, the contractor shall so state in its submittal and if DEN accepts the proposed substitution it may issue a change order to reduce the contract amount by the amount of the direct cost savings to the contractor. Refer to GCC 2011. If the *or equal* material or equipment is accepted for the reasons described in GCC 2011, DEN may issue a change order to increase the contract Amount by the direct cost increase to the contractor.

8.11 Miscellaneous Services

The following paragraphs detail Miscellaneous Services that the consultant agrees to perform whenever they are requested by DEN.

8.11.1 Written Opinions

The consultant shall provide a written opinion on whether any failures by a contractor or manufacturer to perform in accordance with the contract documents are of sufficient magnitude to constitute a basis for terminating the contract.

8.11.2 Contractor Claims

The consultant shall in a timely manner provide assistance in the review and analysis of customer change requests and contractor claims for changes in contract price and contract time. This assistance shall include providing DEN with a written analysis of whether and to what extent a construction change request or claim has any basis, and if not, providing the reasons why the construction change request or claim should be denied. The consultant, when requested by DEN, shall make its personnel available to serve as witnesses for DEN in administrative or legal proceedings, which involve or relate to the design or construction of the projects.

8.11.3 Certifications

The consultant shall provide a consultant's certificate which may be required by an applicable Airport bond ordinance or other City ordinance, by any government agency providing funds for the projects or any other local, state or federal agency with jurisdiction over the projects, so long as it contains terms and conditions which the consultant has a reasonable basis for certifying based on its expertise and experience on the projects.

8.11.4 Product Records

The consultant shall provide product and equipment record document information in electronic format approved by DEN that can be entered into the DEN Revit/Civil 3D models.

8.11.5 Additional Services

Provide other assistance and advice requested by DEN, which is reasonably related to the work it is required to perform during the construction phase. This assistance shall include, but shall not be limited to, assisting contractors' coordination for work with interfacing contractors and preparing design modifications required by DEN to maintain the progress of the work, design intent, and quality of work.

8.12 Change Order/Directive Tracking

At the time of signing each project change order/directive, each pay item of a change order, or each change directive shall be categorized as one of the following:

A. Betterment Change Order/Directive

A Betterment Change Order/Directive is a change order or change directive authorizing or directing changes in the work that is not essential for the completion of the project in accordance with the construction documents approved by DEN but is desired by DEN to achieve either a better operating facility or more expeditious or economical construction process.

B. Required Change Order/Directive

A Required Change Order/Directive is a change order or change directive authorizing and directing change in the work that is:

a. Necessary to complete the project as set forth in the construction documents,
b. Made essential by the passage, adoption or promulgation of laws, statues, ordinances or regulations or an interpretation or application thereof intervening after DEN shall have approved the construction documents and before the work shall have been completed and,
c. Under circumstances where the intervening passage, adoption, or promulgation of such laws, statutes, ordinances or regulations or the intervening interpretation or application thereof were unforeseen, unforeseeable, and unknown by the consultant at the time of DEN's approval of the construction documents

8.12.1 Errors and Omissions Change Order/Directive

An Errors and Omissions Change Order/Directive is a change order or change directive authorizing and directing change in the work arising out of an error, omission, ambiguity, defect or deficiency in the services performed under the SOW by the consultant or their subconsultants including, without limitation, the preparation of the contract documents and corrections of which is necessary in order to complete the project as it would have been designed if such error, omission, ambiguity, defect, or deficiency had not occurred.

8.12.2 Submittal

The consultant shall prepare and submit to DEN monthly, a summary of all change orders and change directives. The summary shall:

A. Categorize each change order and change directive
B. Explain the cause of each change order and change directive

End of Chapter

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Chapter 9 - Record Documents

9.0 Record Documents

All documents shall be dated with the date of project Final Completion and shall be noted as Project Record in the title block or footer. Cover sheets of specifications and drawings shall be titled Project Record. The consultant is responsible for creating a final reconciled Revit/Civil 3D model. Refer to the DFI DSM.

9.0.1 Record Drawings

Incorporate in Revit/Civil 3D format all changes in the projects and any deviations between the drawings and the work performed, no matter how insignificant, including all clarifications made during construction based on marked-up prints, change directives, change orders, request for information, drawings, and other data furnished to the consultant by DEN. Refer to the DFI DSM. The consultant shall maintain on an ongoing basis from contractor NTP to construction contract Final Completion the record drawing information based upon information provided by DEN. Annotations in the title block shall be removed and Project Record and date of final construction contract completion shall be entered in the title block.

9.0.2 Specifications

Incorporate all changes in e-SPECS format in the projects and any deviations between the specifications and the work actually performed, no matter how insignificant, including all clarifications made during construction based on marked-up specifications, change directives, change orders, RFI, cut sheets, submittals, other data furnished to the consultant by DEN. The consultant shall maintain record specification information based upon information provided by DEN.

9.0.3 Final Design Analysis Report (Conformed)

Provide update and any modifications to the final DAR required due to changes made during construction of the project. Submit PDF files in accordance with Chapter 32- Submittals.

9.0.4 Certification

Include a certification on the cover sheet of drawings and specifications stating that to the best of the consultant's knowledge and belief, the consultant certifies that all construction shown in these record drawings has been completed in substantial conformance with the contract documents, and that all changes from the contract documents as bid have been noted to the best of its knowledge and belief. The consultant shall include its full business address, phone numbers, and a statement of disclaimers where appropriate.

9.0.5 Submittal

Refer to Chapter 32- Submittals.

End of Chapter

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Chapter 10 - Design Contract Closeout/Task Closeout

10.0 Design Contract Closeout/Task Closeout

Work specified in this chapter includes procedures required prior to acceptance of the consultant's work.

10.0.1 Document Inspection

The consultant shall inspect records of all submittals completed to assure that all deliverables required by the contract have been completed. Inspection shall include inspection of each submittal to assure that each submittal is complete and in compliance with the consultant contract including the DEN DSMs.

10.0.2 Final Review

The consultant shall meet with DEN to review the status of work completed prior to submittal for project or task closeout. When the consultant considers that the work is complete, they shall submit written certification that:

A. Work has been completed in compliance with the contract and all submittals have been received by DEN.
B. Work has been completed in accordance with the assigned project or task.
C. Review of all contractor submittals is complete and third-party inspections required by code agencies have been completed, submitted, and accepted.
D. If the project or task required installation or construction, the record documents have been submitted and accepted by DEN.
E. All damaged or destroyed real, personal, public, or private property has been repaired or replaced.
F. All personnel badges and vehicle permits have been returned (contract closeout only).

10.0.3 City Review

DEN and authorized staff will inspect to verify status of completion with reasonable promptness after receipt of such certifications. If DEN finds incomplete or defective work:

A. DEN, at DEN's sole discretion, will either terminate the inspection or prepare a list and notify the consultant in writing, listing incomplete or defective work.
B. The consultant shall take immediate steps to remedy stated deficiencies and send second written certification to DEN that work is complete.
C. DEN will then re-inspect work.

10.0.4 Final Adjustment of Accounts

The consultant shall submit a final statement of accounting to DEN.

A. Statement shall reflect all adjustments to the design contract amount:
    a. The original contract or task amount
    b. Additions and deductions resulting from
        • Previous amendments and/or allowances
        • Final quantities for unit price items.
        • Along with this statement shall be detail backup for the quantities.
        • Deductions for incomplete work and/or damaged property
        • Other adjustments
    c. Total contract amount, as adjusted
    d. Previous payments
    e. Sum remaining due

10.0.5 Retainage Release

The consultant shall submit a request for retention release after receipt of final payment. The request shall include all original hard copy lien releases with wet signatures have been received by DEN.

End of Chapter

Chapter 11 - Specification Requirements

11.0 Specification Requirements

11.0.1 Consultant Requirements

The consultant shall provide complete specifications for all projects and/or tasks. Specifications include tables and schedules arranged as noted in this Chapter.

11.0.2 Compliance

The Specifications are part of the contract documents and shall comply with requirements of Chapter 6- Contract Documents.

11.0.3 Location

Specifications are to be in Part II of the Construction contract. Part II of the Specifications shall include all general requirements, product data sheets (if required), finish/room schedules, door schedules, equipment schedules, hardware schedules, fixture schedules, other appropriate schedules and the Technical Specifications and criteria required to construct or prepare design/build proposals to construct the projects. Part II of the Specifications shall be prepared by the consultant based upon the consultant's previously accepted preliminary technical specifications. Division 01- General Requirements technical specifications shall be prepared jointly by DEN and the consultant.

11.0.4 Consultant Preparation

The consultant shall be responsible for preparation of the Technical Specifications listed in Table 11-1: Part II Specificationss. Division 01 - General Requirements are available from DEN in draft stage.

Table 11-1: Part II Specifications

Section	Title
011100	Summary of Work**
011400	Work Sequence and Constraints**
011420	Security Requirements & Sensitive Security Information (SSI)*
011430	Vehicle and Equipment Permitting**
011810	Utilities Interface**
012300	Alternates**
012510	Substitutions*
012910	Schedule of Values*
013100	Project Management and Coordination**
013119	Project Meetings*
013210	Schedule*
013223.11	Construction Layout and As-Built Surveys**
013223.15	Survey Information**
013223.15	Quantity Survey**

Table 11-1: Part II Specifications (Continued)

Section	Title
013233	Photographic Documentation**
013300	Submittal Procedures*
013325	Shop and Working Drawings, Product Data and Samples*
013510	Construction Safety*
013516	Alteration Project Procedures
013520	Construction Safety-Airside
014100	Regulatory Requirements***
014210	Referenced Material**
014220	Abbreviations and Symbols***
014225	Reference Standards**
014230	Definitions and Conventions**
014320	DEN Quality Assurance for FAA Funded Projects*
014510	Contractor Quality Control**
014520	Contractor Quality Control Program–FAA
014525	Material Testing Agency**
014545	Special Inspection Agency and Owner Testing Agencies**
015050	Mobilization*
015210	Temporary Facilities*
015215	Field Offices**
015525	Traffic Control**
015719	Temporary Environmental Controls**
015810	Temporary Signs**
016000	Product Requirements
016610	Storage and Protection**
017330	Cutting and Patching**
017419	Construction Waste Management and Disposal**
017420	Cleaning**
017515	System Startup, Testing and Training**
017720	Contract Closeout*
017825	Operation and Maintenance Data**
017835	Warranties and Bonds*

Table 11-1: Part II Specifications (Continued)

Section	Title
017840	Contract Record Documents*
017900	Demonstration and Training**
018113.13	Sustainable Design Requirements– LEED for New Construction and Major Renovations***
018113.16	Sustainable Design Requirements– LEED for Commercial Interiors***
018113.19	Sustainable Design Requirements– LEED for Core and Shell Development***
019113	General Commissioning Requirements**

**Provided by DEN*
***Shared responsibility of DEN and Design Consultant*
****Provided by Consultant*

Divisions 02 – 14, 21 – 23, 26 – 28, and 31 – 33	The consultant shall prepare Divisions 02 – 14, 21 – 23, 26 – 28, and 31 – 33 specifications, construction drawings, schedules, allowances, and bid forms in compliance with DEN Technical Requirements.

Notes:

- *The formatting requirements apply to the DEN Standard Technical Specifications, which follow the Construction Specifications Institute (CSI) Masterformat layout.*
- *If the project requires CDOT and/or FAA specifications in addition to the DEN Standard Technical Specifications, the consultant must work with the DEN Project Manager to properly format at the CDOT and/or FAA specifications.*

11.0.5 DEN Technical Requirements

The DEN technical requirements provide DEN-specific requirements that must be included in nonstandard specifications for all DEN projects. For each specification division, an itemized list of DEN-specific technical specification requirements is provided, which may include general requirements, product requirements, and execution requirements. The designer shall incorporate these requirements into their project specification content as appropriate for the project scope. Requirements are provided in an outline format, similar to construction specifications, for ease of incorporation. Content may be copied directly, with article/paragraph numbering and structure modifications as needed to ensure a cohesive specification document. Care must be taken to avoid introducing conflicting information.

DEN Technical Requirements are provided in different DSMs according to the discipline with which they are most closely related. Refer to Table 11-2: DEN Technical Requirements Location List for a listing of where the DEN Technical Requirements can be found.

Note: DEN technical requirements are intended to be used as an aid to development of a project specification and ***are not intended to represent a complete specification as presented.***

Table 11-2: DEN Technical Requirements Location List

Division No.	Division Title	Requirements Found In
02	Existing Conditions	Architecture DSM, Chapter 5
03	Concrete	Civil DSM, Chapter 8
04	Masonry	Structural DSM, Chapter 6
05	Metals	Architecture DSM, Chapter 5
06	Wood, Plastics, and Composites	Architecture DSM, Chapter 5
07	Thermal and Moisture Protection	Architecture DSM, Chapter 5
08	Openings	Architecture DSM, Chapter 5
09	Finishes	Architecture DSM, Chapter 5
10	Specialties	Architecture DSM, Chapter 5
11	Equipment	Architecture DSM, Chapter 5
12	Furnishings	Architecture DSM, Chapter 5
13	Special Construction	Architecture DSM, Chapter 5
14	Conveying Equipment	Architecture DSM, Chapter 5
21	Fire Suppression	Life Safety DSM, Chapter 12
22	Plumbing	Mechanical DSM, Chapter 12
23	Heating, Ventilating, and Air-Conditioning (HVAC)	Mechanical DSM, Chapter 12
26	Electrical	Electrical DSM, Chapter 9
27	Communications	Communication & Electronic Systems DSM, Chapter 14
28	Electronic Safety and Security	Communication & Electronic Systems DSM, Chapter 14
31	Earthwork	Civil DSM, Chapter 8
32	Exterior Improvements	Civil DSM, Chapter 8
33	Utilities	Civil DSM, Chapter 8

11.0.6 Coversheet, Index and Certification Page

All specifications shall contain a standard coversheet. The standard coversheet is available as a template file from DEN. All specifications shall contain an Index and Certification page between the coversheet and first page of the Table of Contents. The certification page shall be used to document the number of pages per Division. A space shall be provided below the Index for Professional Seals per Division or group of Divisions.

11.1 Format

11.1.1 Style

Use *The Associated Press Stylebook* (available in most bookstores) as a companion writing style guide. It alphabetically lists preferred spelling, standard abbreviations, and numbering styles.

11.1.2 Construction Specification Institute Divisions

The formatting requirements apply to the DEN standard and nonstandard technical specifications, which follow the Construction Specifications Institute (CSI) MasterFormat layout. If the project requires CDOT and/or FAA specifications in addition to the DEN standard technical specifications, the consultant must work with the Project Manager to properly format the CDOT and/or FAA specifications.

The general CSI division breakdown of divisions 01 – 14, 21 – 23, 26 – 28, and 31 – 33 will be followed. The general CSI section format will be followed as the basis for the content and arrangement of the specification sections. Appropriate articles will be utilized to expand on these headings.

- Part 1 General
- Part 2 Products
- Part 3 Execution

The following Part 4 and Part 5 shall be included:

- Part 4 Measurement for Payment
- Part 5 Method of Payment

NOTE: Method of payment for each specification section may vary, depending on the inclusion or exclusion of unit pricing, owner allowances, sequencing, etc.

11.2 Standard Text Elements

11.2.1 General

A Microsoft Word template for creating specifications with all DEN styles outlined in this chapter is available from the DEN Project Manager upon request.

11.2.2 Margins

A. Top and bottom margin, 0.5 inches, 0.0 Gutter, 0.5 inches Header and Footer margins
B. Left and Right Margins are each 1.0-inch

11.2.3 Typeface and Line Spacing

Print text in 10 pt. Arial normal type with 10 pt. Bold Section Titles in uppercase, Line spacing is single space unless specified otherwise.

11.2.4 Tab Set

Text formatting will be done by tab spaces. The standard tab is one tab equals 0.5 inches unless otherwise specified.

11.2.5 Header

At the top of each text page is a six-line, flush right and flush left header. Border them on top and bottom. Set three returns below the bottom border. Set margins at standard 1" left and right. Typeface shall be 8 pt. uppercase Arial.

Table 11-3: Technical Specification Header Layout

Line #	Alignment	Description
Line 1	Flush left	TECHNICAL SPECIFICATIONS
	Flush right	DENVER INTERNATIONAL AIRPORT
Line 2	Flush left	Enter Division number and name
	Flush right	DEN STANDARD TECHNICAL SPECIFICATIONS - 2017
Line 3	1 Space from Left:	Enter CSI Section Number
	Flush right	Enter Construction Contract Number (as provided by City
Line 4	Flush left	Enter Section Name

11.2.6 Footer

At the bottom of each text page is a six-line flush right and flush left header and Section/Page Number Centered. Border them on top. Set three returns above the border. Set margins at standard 1" left and right. All typefaces in the footer shall be 8 pt. lowercase Arial bold.

Table 11-4: Technical Specifications Footer Layout

Line #	Alignment	Description
Line 1	Flush Left:	ISSUED FOR: _____. During the Design Phases and before Issue for Bid, Indicate the Phase such as **Issue for DD Review: 13 March 2019.** At IFC, enter Issue for Construction and the date of the bid opening. At record drawing phase, enter **Project Record** and the date of Final Completion of the Construction or Installation
Line 4	Centered	Enter consultant's Name
Line 4	Flush Right:	Enter Revision Number. At Issue for Bid and IFC, the number shall be 000. Thereafter, any changes will be sequential in number.
Line 5	Flush Left	Enter Date of Baseline Specification
Line 5	Centered:	Enter Section Number. Microsoft Word will automatically update the page number

11.3 Table of Contents Page and Paragraph Numbering System

11.3.1 Location

Table of Contents shall be at the beginning of each manual and volume and will be designated Table of Contents in the left header and in the footer (TOC). TOC title shall be immediately below the header and centered.

11.3.2 Line Spacing

All line spacing shall be Single space.

11.3.3 Line Numbering

Line numbering is not used at DEN. Upon request of the Project Manager, line numbering shall be incorporated into the specifications. The individual pages for the technical shall use automatic line numbering function of the word processing program. In the case of one side or two-sided printing of the specification document, the line numbering must be shown on the right margin.

11.3.4 Page Numbers

Number the pages in each section beginning with a section number, followed by a hyphen (-), and then the page number. Repeat for each section.

11.3.5 Section Title

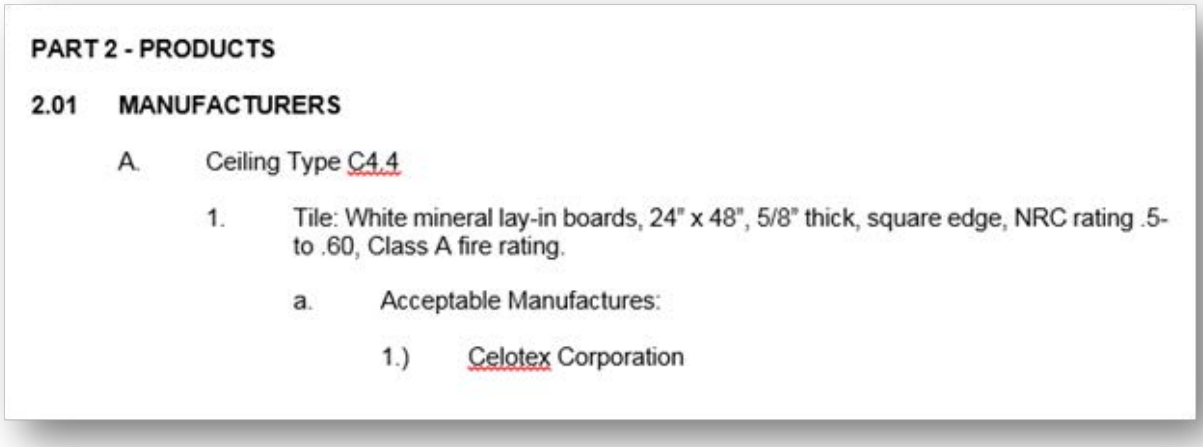
10 pt. Arial Bold centered at the top of the page. No returns prior to title entry are required in that the header carries three returns to allow visual spacing in the print out. Section titles correspond to the CSI Master Format. Division and number are flush left, followed by a hyphen and division title. If the technical specifications are provided by CDOT or the FAA, the numbering/naming must follow the current CDOT/FAA specifications, as appropriate.

11.4 Text Pages

Text pages follow many of the same rules as the Table of Contents page. The exceptions are detailed in the following section.

11.4.1 Exceptions

Technical Specification General Format displays the general format utilizing hanging indents.



PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ceiling Type C4.4

1. Tile: White mineral lay-in boards, 24" x 48", 5/8" thick, square edge, NRC rating .5- to .60, Class A fire rating.

a. Acceptable Manufactures:

1.) Celotex Corporation

Figure 11-1: Technical Specification General Format

11.5 Table and Figure Indexes

11.5.1 Location

These indexes appear immediately after the Table of Contents and are designated List of Figures and List of Tables under the volume number and title in the page header. In the text, figures and tables are located as closely as possible to the narrative they illustrate.

11.5.2 Title

Like the Table of Contents, the titles for these indexes are located 1/2" below the header and centered between the margins. In each case, the title is in 10 pt. uppercase bold.

11.5.3 Format

A. Divide each index into division. Place division numbers flush left, tab once and begin title.
B. Identify each table or figure by section, part or division and number in series.
C. Table or figure number should be flush with section title.
D. Indent one tab (1/4") and begin graphic title.
E. Print section numbers and title in 10 pt. uppercase bold.
F. Print chart or figure number and title in 10 pt. uppercase normal.
G. Include section numeral along with page number and place flush left.

11.6 Tables and Charts

11.6.1 Location

Tables and charts are located as closely as possible to the narrative they illustrate. The tables and charts may be incorporated into the text in Microsoft Word format. Note that tables and charts used in the specifications must be submitted in magnetic media. Full-page charts or tables immediately follow the page they illustrate. They may be either horizontal or vertical. Always allow 1 inch along the binding edge to assure legibility after reproduction and 3-hole punch.

11.6.2 Numbering

Table and chart numbering are by section, part or CSI division and table number (i.e., Division 2, Section 024119, part 8, table number 3 would become Table 024119.8.3) Print in 10 pt., uppercase/lowercase bold.

11.6.3 Titles

Titles are centered above the table or charts and printed in 10 pt. uppercase bold.

11.6.4 Typeface

Print section title 10 pt. uppercase bold. Print abbreviations in 10 pt., uppercase, bold and descriptions in 10 pt. uppercase/lowercase, normal.

11.7 Nomenclature

11.7.1 Terminology

Terminology used in all documents shall be in accordance with the terms established in the DEN standard technical specifications, be generally accepted throughout the industry, and must be consistent throughout the documents.

11.7.2 Abbreviations

Abbreviations shall be avoided unless listed and fully explained in Division 01- General Requirements or within the specification section in which the abbreviation occurs.

11.7.3 Generic Terms

Generic terms shall be used throughout the documents, except that the names of manufacturers, trade names, and model numbers may be specified as described in 11.9 Detail Specifications.

11.8 Bidding Requirements

Division 0 of the specifications will include the Advertisement for Bids, Bidding Requirements, Instruction to Bidders, Proposal and Bond Forms, contract Forms, General Conditions, Special Conditions, and other such documents, which DEN requires to complete this Division of Specification. Division 0, Bid Forms, and Special Conditions will be prepared by DEN with input from the consultant, in accordance with the guidelines and instructions furnished by DEN.

11.9 Detail Specifications

11.9.1 General Requirements

This portion of the specifications will describe specific project requirements and quality of materials, processes, and workmanship. The detail specifications will include the following items, when applicable:

A. Names of manufacturers- minimum of three (3)
B. Trade names and model numbers of products
C. Type, grade, and quality of materials
D. Alloy of metals
E. Type and grade of finishes
F. Physical properties
G. Required performance, tests, and submittal
H. Methods of fabrication
I. Methods of installation
J. Tolerances
K. Warranties

11.9.2 DEN Standard Technical Specifications

DEN provides and maintains a standard set of DEN specific boilerplate specifications for Division 01 as well as a small number of key sections in Divisions 02-33. Refer to Table 11-1: Part II Specifications and Table 11-5: DEN Standard Specifications: Divisions 02-33 for a listing of all available DEN standard specifications. DEN does not maintain a comprehensive set of specifications. These Division 01 specifications are to be used on all projects in the Terminal, Concourses, and adjoining areas. Division 02-33 DEN standard specifications shall be selected for use on all projects where the applicable product, system, or process described by the section is included in the project. The consultant shall obtain the most current DEN standard technical specifications from the Project Manager at the start of each project. **IN NO CASE, SHALL DEN STANDARD TECHNICAL SPECIFICATIONS BE RE-USED ON PROJECTS.**

Before preparing red-lined specifications, Consultants shall obtain the most recent copy of DEN boilerplate specification Table of Contents (TOC). The Consultant shall strike-through any unneeded specification sections from the TOC and submit the red-lined TOC to the DEN PM to request the specifications needed for the project. The Consultant shall include the red-lined TOC in all future red-line specification submittals.

Table 11-5: DEN Standard Specifications: Divisions 02-33

Section	Title
087100	Door Hardware
129300	Site Furnishings

Table 11-5: DEN Standard Specifications: Divisions 02-33 (Continued)

Section	Title
147300	Over the Wing Passenger Loading Bridges
147310	Apron Drive Passenger Loading Bridges
147320	Radial Drive Passenger Loading Bridges
221226	Potable Water Cabinets
230130.51	HVAC Air-Distribution System Cleaning
230596	HVAC Smoke Control Testing
230993	Sequence of Operations for HVAC Controls
236600	Preconditioned Air Hydronic Air Handling Units – Aviation
236611	Preconditioned Air DX Air Handling Units – Aviation
236614	Preconditioned Air Ductwork and Accessories – Aviation
236616	Preconditioned Air Electric Control Systems – Aviation
236619	Preconditioned Air Sequence of Operation - Aviation
238126	Split-System Air Conditioners
263544	Aircraft Ground Power Units
265650	Exterior Lighting – Airside
272100	Local Area Networks (LANs)
272101	Public Wireless LAN (WiFi)
273200	Telephone System
274111	Video Surveillance and Environmental Monitoring System (VSEMS)
274133	Master Antenna Television System
274219	Multi-User Flight Information Display System (MUFIDS)
274220	Common Use Passenger Processing Systems (CUPPS)
275123	Emergency Communications System
275313	DEN Standards for Time Synchronization
275319	Public Safety Distributed Antenna System (DAS)
281300	Access Control
282300	Video Surveillance
283300	Compressed Gases
283801	Emergency Fuel Shutoff System (EFSO)

If a DEN standard technical specification does not exist, the consultant shall develop a technical specification based on MasterSpec or other industry standard technical specification content source. Project specifications must

include all DEN technical requirements identified in discipline DSMs as referenced in Table 11-2: DEN Technical Requirements Location List.

Consultant-supplied MasterSpec sections shall be based on content no older than 2 years old.

Include a specification source matrix in each design submittal which lists all sections included in the project, along with their source (DEN boilerplate, MasterSpec, manufacturer's guide specification, etc) and revision date. The specification source matrix is available upon request via the DEN Project Manager. Nonstandard technical specifications shall be submitted to the DEN Project Manager as part of the standard contract document reviews. Any sections added to the project following the 60% design submittal shall be submitted for an independent internal review and acceptance by DEN SMEs and Stakeholders, separate from the standard contract document reviews.

11.9.3 DEN Technical Requirements

The DEN technical requirements can be found in discipline DSMs as outlined in Table 11-2: DEN Technical Requirements Location Listt.

11.9.4 Products and Materials

Specific products or materials required by these DEN standard technical specifications shall be specified on each project to maintain design continuity, engineering efficiency, and ease of maintenance. The *required* products or materials must be confirmed in writing by DEN. DEN standard technical specifications shall be used for all projects. The consultant shall obtain a set of the most current DEN standard technical specifications from the Project Manager at the start of each project. **IN NO CASE, SHALL DEN STANDARD TECHNICAL SPECIFICATIONS BE RE-USED ON PROJECTS.**

11.9.5 Specifying and Reviewing Products and Material Submittals

All products, materials, process, etc., which the consultant deems necessary to specify within the project specification, to identify contractor requirements for quality of materials, procedures and processes, and workmanship must require a contractor submittal that must be reviewed by the consultant in accordance with the requirements of Chapter 8- Construction and Administration. At no time, shall any contractor submittals not undergo a consultant review for compliance with the project specifications. Using the DEN standard technical specification formats and protocols for preparation of the project specification, should the consultant believe that a contractor submittal for a product, material, or workmanship issue not require a submittal, written approval from DEN must be obtained; to delete any requirement for the deletion of a submittal requirement of the specifications or the consultant not reviewing the contractor submittal for compliance to the specification requirements. If a specification does not exist, the consultant may develop specifications based on MasterSpec or other industry standard specification. Specifications used in this manner shall be submitted separately from the contract documents for a separate review.

11.9.6 Redundancy

Care must be taken to assure that information contained in any section is not redundant, in conflict or at variance with the General Conditions, Special Conditions, Detail Specifications, or Drawings.

11.9.7 Reference

Each section of the Detail Specifications must list a cross-reference to related work specified in other sections of the detail specifications, to define the limits of the work described in each section.

11.9.8 Industry Codes and Standards

Industry codes and standards may be referenced in the detail specifications to require compliance with these codes and standards. Such references shall not be used to supersede the design indicated on the project drawings, or to take the place of a complete design.

11.9.9 Design Standards

The specifications shall not contain any reference to compliance with the DSMs by name. The DSMs are to be used as a guide to the design of a project and not as a contract document for construction. The DEN technical requirements outlined in 11.0.5 DEN Technical Requirements must be incorporated in consultant specifications and cannot be referenced.

11.9.10 FAA Requirements

The consultant shall produce a report, which details the specific FAA requirements for contractor activities during construction on operating airports. This report shall contain copies of the rules, regulations, and advisory circulars that specify contractor activities while constructing the project. Following the review and acceptance of the report, the consultant shall prepare or modify a contract document section, which specifically details contractor requirements for compliance with the FAA rules and regulations.

11.9.11 Redline DEN Standard Technical Specifications

All DEN standard technical specifications are required to be submitted in redline format at all intermediate submittals of the contract documents (DD, 30%, 60%, 90%, 100%, etc.). DEN standard technical specifications shall be edited in Microsoft Word with the track changes tool enabled (striking out deleted items and adding comment bubbles or bold text of new items). The intent of this step is to identify quickly to DEN Review Staff DEN standard technical specification items that are being removed and non-standard items that are being added to the specification. This requirement shall not be waived for any project.

11.9.12 Submittal Register

During the process of preparing the technical specifications, the Consultant shall also prepare and keep a register of submittals to be delivered by the construction Contractor according to the technical specifications. Prior to the commencement of design, the DEN PM shall provide the Consultant with an outline for this submittal register. The Consultant shall submit the completed submittal register to DEN with the 100% Contract Documents.

11.9.13 Overstock Materials

DEN has found Overstock Materials are more expensive to store than ordering as needed. Also, shelf life has been an issue. There some items that are more long lead which we may require. During the process of preparing the technical specifications, the Consultant shall also prepare and keep a table of overstock materials to be delivered by the construction Contractor according to the technical specifications. Prior to the commencement of construction, the DEN Project Manager shall provide the Consultant with confirmation of this table of overstock materials table with amounts. The Consultant shall submit the coordinated overstock materials list with amounts to DEN with the 100% Contract Documents.

End of Chapter

Chapter 12 - General Drawing Requirements

12.0 General Drawing Requirements

As of 2011, all projects shall be done using Autodesk Revit and/or Civil 3D. Refer to the DFI DSM for detailed procedures and requirements.

12.1 Intelligibility and Legibility

Drawings shall be intelligible and legible and shall not require additional auxiliary files to be submitted for review. Consultants should use good judgement about what is legible. For example, on drawing sheets containing text, such as mechanical sequences of operations, consultants shall break text down into columns to facilitate easier comprehension, where doing so makes sense. DEN reviewers shall not need additional Word files containing the same language to facilitate the review process.

12.2 Legacy Projects

In some instances, Autodesk Revit and Civil 3D may not be required. If you have any questions regarding the use of Autodesk Revit and Civil 3D, please contact the Project Manager.

End of Chapter

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Chapter 13 - Phasing and Staging Drawings

13.0 Phasing and Staging Drawings

13.0.1 Airport Layout Plan

DEN will provide Revit/Civil 3D models for consultant use in modifying the Airport Layout Plan (ALP) key plan.

13.0.2 Site Access

The consultant shall indicate routes the contractor Personnel and the contractor Delivery shall be required to take to access the worksite. Included shall be indications of vehicle gates that access the restricted area if the work activity is in the restricted area.

13.0.3 Haul Routes

Indicate haul routes for truck movements such as earth fill supply or removal, including borrow, stockpile and waste locations. Indicate security gate numbers.

Indicate haul routes for truck and equipment movements including hauling to staging, storage, and construction sites. Indicate which roads and security gates all drivers must take to access these sites.

13.0.4 Trailer Site and Employee Parking

Include in the Key Plan the referenced location for the contractor's trailer, employee parking. The plan for these areas shall be presented in larger scale drawings as part of the drawing set.

13.1 Staging Plan - Vertical Elements and Lighting Restrictions

13.1.1 General

Provide large-scale staging plans indicating grade level elevations and allowable height above existing grade that equipment may extend. Include also photometric studies of anticipated site lighting required during contractor execution of the work. This document shall be submitted to DEN Planning and DEN Operations to assure conformance with FAA and DEN Operational requirements. Refer to Chapter 28- Planning Study for further information.

13.2 Staging Plan - General

13.2.1 Utility Access

The consultant shall provide documentation of the source of Utilities during construction including quality and capacity of the following: communications, fire protection water, electrical power, potable water, and storage areas.

13.2.2 Environmental Controls

Provide documentation locating and defining erosion control, storm water control, temporary drainage, security, spoils areas, and locations of de-watering control areas.

13.2.3 Temporary Facilities

Provide documentation locating and defining employee parking, delivery, pedestrian and construction barriers, contractor storage and laydown areas, security requirements, winter protection, signage, trailers, lighting, fencing, and other requirements as directed by DEN. The consultant shall provide guidelines for temporary structure orientation and appearance.

13.2.4 Temporary Traffic Control

Vehicle and pedestrian rerouting, including required temporary signage, signals, etc. Temporary Pavement markings shall be shown at 1"=100' or at a scale as directed by DEN.

13.2.5 Preliminary Plans

Preliminary traffic control modification plans for construction of the project shall be included in the schematic design submittal. The consultant will consult with the Project Manager and other DEN Operations personnel in developing the staging and phasing plan.

13.2.6 Hazard Locations

Provide setback of work and constraints

13.3 Sequencing Plans

13.3.1 General

The consultant shall provide construction-sequencing plans where construction sequences must be controlled to assure proper safety and operations at DEN. Include sequencing of pedestrian or vehicular routing, signage, staging areas, etc.

13.3.2 Traffic Control

Preliminary traffic control modification plans for construction of the project shall be included in the schematic design submittal. The consultant will consult with DEN's personnel and other DEN operations personnel in developing this plan.

13.3.3 Operating Facility

DEN is an operating air and ground transportation facility. All parties participating in the continuing development of this facility understand that construction will cause disruptions in the normal operations of the facility. However, normal or modified operations must continue at all times. The consultant shall identify the sequencing and staging implications of constructing the project under the constraints required for maintaining DEN operations. The consultant shall prepare construction drawings and specifications to describe DEN operational constraints, which will affect the construction of the project.

13.3.4 Analysis

The consultant shall analyze and quantify the effects of construction sequencing, staging, and constructability on construction cost and schedule and incorporate these effects into its construction estimate and construction schedule. The construction contract Documents shall communicate the construction sequencing, staging requirements and DEN operational constraints that are necessary for the contractor to understand, prepare the bid and construct the project.

13.4 Demolition and Site Preparations

13.4.1 General

Drawings shall be prepared which indicate altered, discontinued, and removed work where extensive removal and/or demolition operations are required. Demolition drawings shall indicate but not be limited to the following pertinent information.

13.4.2 Civil Drawings

Provide at a minimum the following information:

A. Location and size of existing utilities or other elements.
B. Other information to indicate the extent of known conditions and materials and the extent to which these are to be maintained, modified, or removed.
C. Location, size and type of existing vegetation and extent to which existing vegetation is to be removed, pruned, or protected, and maintained.
D. Location and extent of topsoil on-site or in stockpile, indications of directions for retention, stripping, stockpiling, or spreading of topsoil.
E. Symbols that are used for the demolition work shall be the same as those used on the drawings for new construction.

13.4.3 Structural and Architectural

Demolition drawings shall be prepared which indicate altered, discontinued, and removed work where extensive removal and/or demolition operations are required. Demolition drawings shall indicate but not be limited to the following pertinent information:

A. Location and size of structural members.
B. Methods of closing openings.
C. Other information to indicate the extent of known materials and conditions to be removed.
D. Symbols that are used for the demolition work shall be the same as those used on the drawings for new construction.
E. Allowable loads on existing structures, constraints.
F. Locations allowed for dust or protection barriers, including type of barriers. Include drawings and constraints of barrier construction where protection of existing work is required.
G. Maximum crane height for use during construction is identified.

13.4.4 Systems Drawings

A. Fire zone interruption
B. Paging interruption
C. IMPACC system tie in
D. Baggage system interruption
E. Cutoff of HVAC and impact on other systems
F. Temporary heating inside occupied areas
G. Freeze protection
H. Ice, snow, and wind considerations
I. Emergency features- emergency shut-off locations
J. Emergency lighting and exiting requirements
K. Electrical lockout procedures
L. Lighting and Power systems interruptions
M. Plumbing system interruptions
N. Fueling system interruptions
O. Deicing system interruptions
P. All interruptions to movement or operational activities

End of Chapter

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Chapter 14 - Civil Drawings

14.0 Civil Drawings

14.0.1 General

Unless otherwise specified in this chapter, the Civil Engineering project drawings shall be completed in Autodesk Civil 3D. The drawings shall indicate complete design.

14.0.2 Design Requirement Categories

A. General Civil Notes
B. General Contract Layout Plan
C. Abbreviations and Symbols
D. Contract Quantities Schedules
E. Soil Boring Logs
F. Typical Cross-sections
G. Runway, Taxiway, and Roadway Alignments
H. Alignment Data
I. Site Grading Plans
J. Drainage Plans and Details
K. Utilities Profiles
L. Paving Plans and Details
M. Marking Plans and Details
N. Electrical and Lighting Plans and Details
O. Signing Plans and Details
P. Cross-Sections

14.0.3 Bridge Drawings

A. Bridge Plan and Elevation
B. Foundation Plans and Details
C. Structural Plans and Details
D. Drainage/Utilities Plans and Details
E. Marking Plans and Details
F. Lighting/Electrical Plans and Details

NOTE: The actual packages may split these into separate units.

14.0.4 Sequence

Construction documents are divided into specific groups per National CAD Standards (NCS). The group number shall always remain the same no matter how large the project. Refer to the DFI DSM.

Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets V2 01, B2 01, C2 01, and L2 01 shall all show work in the same area.

14.1 Runway, Taxiway, and Roadway Alignment

14.1.1 Scale

The upper half of the sheet shall be a plan of appropriate scale. The following scales shall be used unless acceptance to do otherwise is given by DEN:

A. Runway, taxiway, apron: Horizontal geometry shall be shown at 1"-100', Pavement markings shall be shown at 1"=100', Paving, grading and drainage plans shown at 1"=40', Profile scales shall vary to suit the level of detail to be shown Maximum horizontal scale 1"=200', Maximum vertical exaggeration shall be 20:1 Minimum vertical exaggeration shall be 4:1.

B. Roadways: Scales shall vary to suit the level of detail to be shown For roadways with complex geometry and dense utilities, a plan scale of 1"=10' shall be used Plans of medium complexity shall use 1"=20' Plans of low complexity shall use 1"=40' Unpaved roads with no utilities or very simple utilities and which have very little detail to be shown may use scales of 1"=50' or 1"=100'.

C. Profiles shall be shown at the same horizontal scale as the plan views except that the horizontal scale need not exceed 1"=20' (1"=10' shall not be used). A vertical scale: 1"=5' shall be used.

It is assumed that those roads with plan scales of 1"=50' up to 1"=100' shall not require profiles. If profiles are required, they shall be drawn with a horizontal scale of 1"=50'.

14.1.2 Stationing

Stationing shall be indicated in relation to the scale as shown in the following table.

Table 14-1: Stationing Scale

Scale	Station At
1" = 50'	Each 100 ft
1" = 100' or greater	Each 500 ft.

The station shall be identified by a tick mark 1/8" long. The numerals shall be 3/32" high. Station equalities shall be shown as a 1/8" open square. The equation shall be shown on a fine line drawn perpendicular to the stationed line.

14.1.3 Legend

Refer to DEN DSMs legend families provided with site models.

14.1.4 Roadways

Where perimeter roads, access roads, etc., are to be constructed, they shall be solid lines defining the edges of the proposed alignment. Where applicable, the centerline of roads or structures shall be shown.

14.1.5 Utilities

When a set of plans is to be prepared, the plan and profile sheets shall show utilities that effect the runways, taxiways, roadways, or structures. Underground Utilities: Underground utility layouts shall be shown on the appropriate paving, grading or drainage plans. Profiles shall be shown at the same scales as the plan sheets. Vertical profiles shall be 1"=5'.

14.1.6 Match Lines

Each sheet shall bear match lines at each end, drawn perpendicular to the alignment, preferably at a full station. The lines shall be made up of a long dash 3/4" long and short dashes 1/8" long; the pattern repeats. The match lines shall be labeled, **MATCH LINE-STA #+00** in letters and numbers approximately 3/16" high.

14.1.7 Profile Grid

The horizontal scale shall be the same scale as the plan. The horizontal/vertical scale ratio shall be a maximum of 1/10 or a minimum of 1/5, as appropriate. Elevations shall be indicated at 10 ft. intervals. Stations shall be shown along bottom of profile grid at 4" spacing. Numbers shall be approximately 3/16" high.

14.1.8 Runway and Roadway Profiles

The profile shall be shown by a single solid line. The top edge of this line defines the grade line profile of the runway or roadway. Significant points designating changes in grade shall be shown by an open circle of 1/8" diameter. These points shall be identified by a fine vertical line drawn to the circle showing the station and pertinent abbreviation.

Profile tangent intersections shall be identified by open triangles 1/8" on a side. A fine vertical line shall be drawn to the triangle and the station, abbreviation (PIVC), and the elevation shall be shown. Reference CADD Symbols in the DFI DSM.

A. Ground Line

   The profile of the existing ground along the centerline of the runway, road, etc., shall be shown by a freehand style broken line and shall be labeled EXISTING GROUND.

B. Utilities

   Where they cross the runways, taxiways, or roadways, utility lines shown in plan shall also be shown in profile.

14.1.9 Profile Match Line

Match lines shall be designated as in section above describing Match lines. In addition, the elevation of the profile grade shall be shown.

14.1.10 Alignment Data

These sheets shall be arranged in tabular form showing all horizontal points. The tables shall be arranged by runway, taxiway, etc., and read from the top to the bottom of the page. Table headings are as follows:

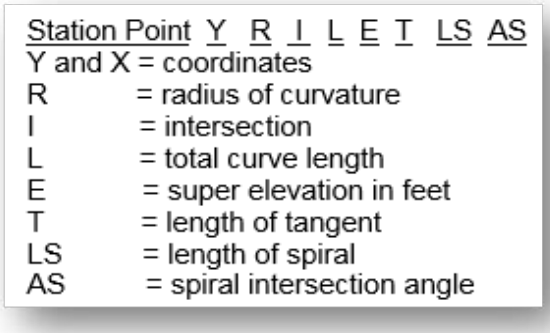

Figure 14-1: Alignment Data

14.1.11 Roadway and Runway Sections

14.1.11.1 Nomenclature

Runway sections, including earthwork sections, shall be referred to as cross-sections.

14.1.11.2 Identifying Symbols and Titles

Road and runway sections shall be indicated on the plan by a section symbol and shall be identified by station below the section detail.

14.1.11.3 Orientation

Cross-sections shall be taken looking ahead on line. When more than one cross-section is drawn on one sheet, they shall be oriented so that the section station increases from the bottom to the top of the sheet.

14.1.11.4 Typical Cross-Sections

Typical cross-sections shall be shown at appropriate points along the runway or roadway. They shall include the runway or roadway, shoulders, and other miscellaneous typical details.

14.1.11.5 Special Cross-Sections

Special cross-sections shall be provided in areas where they will be useful in clarifying construction details.

14.1.12 Typical Details

Typical details may eventually become DEN standards. They shall include runway, taxiway, apron, roadway, and miscellaneous civil details.

14.1.13 Drainage

Drainage layout sheet shall include detailed layout information for all utilities. These depictions shall be plan and profile sheets with horizontal scale (1" = 50'). Sheets shall be referenced by number to the layout index.

14.1.14 Utility Lines

The location shall be shown by lines and identifiers as described in the DFI DSM.

14.1.15 Drainage Details

These details may include typical and special details and may become DEN standards.

End of Chapter

Chapter 15 - Landscape Drawings

15.0 Landscape Drawings

15.0.1 Contents

The drawings shall present all information relative to the size, form, location, and arrangement of the landscape components and systems of the project. The drawings shall indicate complete design. Prior written acceptance is required of any design-build components. The following shall be included on the landscape architectural drawings, when applicable to the specific project:

A. Location of materials, assemblies, products, and accessories.
B. Size, thickness, and significant dimensions of all landscape elements.
C. Separation details of adjacent dissimilar materials.
D. Soil boring or test pit logs including locations.
E. Irrigation drawings shall present all necessary information to show location and/or routing of all landscape irrigation system components. Drawings shall indicate at a minimum the following items as applicable to the specific area irrigation system:
    a. Spray and rotor heads
    b. Non-pressure (lateral) piping
    c. Drip tubing
    d. Electric control valves
    e. Air relief valves
    f. Quick coupling valves
    g. Isolation gate valves
    h. Pressure regulating valves
    i. Pressure (mainline) piping
    j. Effluent distribution piping
    k. Backflow preventer
    l. Master valves
    m. Water meters
    n. Point of connection and service line
    o. Field controllers
    p. Chemical/fertilizer injection assemblies
    q. Sleeving
F. Separate drawings shall be prepared indicating power source wiring diagrams, controllers, point of connection, and service lines.

15.1 Sequence

15.1.1 Numbering

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets V2 01, B2 01, C2 01, and L2 01 shall all show work in the same area.

15.2 Plans

15.2.1 Landscape Plans

Plan view drawings shall present the following minimum information:

A. North direction arrow located in accordance with drawing format requirements.
B. Floor elevation of adjacent structures using survey datum elevations and reference elevations if applicable.
C. Cross reference symbols or notations to sections, elevations, detailed plans, details, or other related information continued in the drawings so these drawing elements can be readily located.
D. Extent and location of all proposed materials, patterns, and finishes for all landscape elements shall be clearly indicated.
E. Topographic Drawings indicating existing conditions – contours, existing utilities, and drainage.
F. Topographic Drawings indicating contours and drainage of proposed plan.
G. Topographic Drawings indicating Construction Staging, contractor access, and environmental control requirements during construction.

15.2.2 Irrigation Plans

Irrigation plans shall present the following minimum information.

A. Location and size of all system components including controllers.
B. Routing and sizing of all piping.
C. Description of requirements for points of connection.
D. Description of requirements for field controller installation including electrical source and controller size.
E. Separate plans indicating power, controllers, and signaling/control wiring Plans shall be dimensioned All locations of all buried devices shall be fully dimensioned.

15.2.3 Irrigation Schedule

Schedule shall be structured in columns showing from left to right, the component or piping symbol, manufacturer, model number, description of item, and appropriate detail numbers.

A. Model number, manufacturer, and nozzle size for all spray and rotor heads.
B. Class of schedule and material type for all piping.
C. Manufacturer and model number of all system components.

15.2.4 Key Symbols

A. Electric control valves shall be labeled with hexagon symbol indicating valve size, controller, station number, and designed flow rate in gallons per minute.
B. Pressure setting of all regulating valves.
C. Location of all evergreen trees located within irrigated turf area.
D. Specific irrigation notes as required to clearly communicate design and installation intent.
E. Location and description of existing components, piping or conditions.
F. Construction notes describing any special irrigation conditions.
G. Designed static water pressure.
H. Drip emitter schedule for specific size and type of plant material.

15.2.5 Sections

Sections and elevations shall be provided to indicate the correct vertical relationships, size, and location of the landscape components.

15.2.6 Details

Construction details shall be provided which illustrate the intent of installation of all landscape components and systems including irrigation systems and components. Details shall clearly identify all required assembly parts, sizes,

and dimensions. Details shall be numbered and appropriately keyed with overall landscape and irrigation plans, detailed plans and schedules.

15.2.7 Continuation

Drawings shall indicate, where applicable, any continuation from one drawing to another, and where plans and system layouts are continued on another drawing. The location of the drawing on which the continuation appears shall be noted at the point of break in the plans.

15.2.8 Demolition and Site Preparation

Drawings shall be prepared which clearly indicate altered, discontinued, and removed work where extensive removal and/or demolition operations are required. Demolition drawings shall indicate, but not be limited to, the following pertinent information:

A. Location and size of existing utilities or other elements.
B. Other information to clearly indicate the extent of known conditions and materials and the extent to which these are to be maintained, modified, or removed.
C. Location, size and type of existing vegetation and extent to which existing vegetation is to be removed, pruned or protected, and maintained.
D. Location and extent of topsoil on-site or in stockpile, indications of directions for retention, stripping, stockpiling, or spreading of topsoil.
E. Symbols that are used for the demolition work shall be the same as those used on the drawings for new construction.

End of Chapter

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Chapter 16 - Architectural Drawings

16.0 Architectural Drawings

16.0.1 Contents

The drawings shall present all information relative to the size, form, location, and arrangement of the project components. The drawings shall indicate complete design. Prior written acceptance from DEN is required for any design-build component. The following items shall be included on the architectural drawings, when applicable to the specific project:

A. Location of materials, assemblies, products, and accessories.
B. Size, thickness, and significant dimensions of all building elements.
C. Gauges, except for prefabricated and assembled units.
D. Diagrams of specially fabricated connections.
E. Relationships of adjacent dissimilar materials.
F. Soil boring or test pit logs including locations.

16.0.2 Design Requirements

Refer to Architectural DSM for detailed requirements of architectural design, details, and specifications.

16.0.3 Sequence

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

16.1 Plans

16.1.1 Floor Plans

Plan view drawings shall present the following minimum information:

A. North direction arrow located in accordance to drawing requirements and at top of drawing where feasible.
B. Floor elevation- The floor elevation shall be keyed to DEN NAVD-88 Datum in at least one location on each floor plan. The elevation shall be clearly defined as finish floor or elevation of structural floor.
C. Identify and indicate the correct horizontal relationship, size, and location of all component. Avoid repeating dimensions that are to be found on large-scale drawings.
D. Cross-reference symbols or notations to sections, elevations, insert plans, larger scale plans, diagrams, and other drawing details so these drawing elements can be readily located.

16.1.2 Reflected Ceiling Plans

Reflected ceiling plan drawings shall clearly delineate all systems including but not limited to materials, soffits, ceilings, partitions, exterior walls, columns, lighting, sprinklers, monitoring devices, diffusers, grilles, registers, signage, and furring elements. The reflected ceiling plans shall carry the same minimum information as itemized above.

16.1.3 Large Scale Plans

Where large-scale plans are presented, critical dimensions for code compliance shall be identified. Enlarged plans are required at each gate and shall accurately depict all equipment (PCA, GPU, PWC, etc.) with required access clearances and the relationship to aircraft and airline ground support equipment (GSE).

Sections shall be included when loading bridges serve multiple sizes of aircraft to ensure loading sill height does not negatively affect gate equipment.

16.1.4 Precedence

There is no precedence; plan drawings of the same areas that are presented at different scales shall not deviate.

16.1.5 Roof Plans

Provide roof plans that indicate all components of other disciplines including, but not limited to lightning protection, mechanical, electrical, plumbing, access systems and communications systems. Indicate traffic pads from all access points to and around roof mounted equipment or areas requiring maintenance and access. Show storm water flow directions, crickets, flashings, and materials.

All roof penetrations shall conform with roof manufacturer's requirements and shall not void roof warranties.

16.2 Sections

16.2.1 Precedence

There is no precedence; section drawings of the same areas that are presented at different scales shall not deviate.

16.2.2 Sections

Sections shall be provided to define completely the character of construction elements. Above or below grade elevations shall be keyed to the DEN NAVD-88 Datum. Notes such as similar to shall not be acceptable. consultant shall provide design of each type of detail.

16.3 Elevations

16.3.1 Exterior Elevations

Exterior elevations shall be provided for all exterior planes of new or modified construction, and shall include all other systems including, but not limited to civil, mechanical, electrical, plumbing, fire protection, lighting, communications, lightning protection, fences, and access systems. Indicate the correct vertical relationships, size, and location of the components.

16.3.2 Interior Elevations

Interior elevations shall be provided for all interior planes of new or modified construction and shall include all other systems installed in or on the surfaces.

16.3.3 Material Definition

Different materials shall be delineated to define separation of materials.

16.4 Demolition Drawings

16.4.1 General

Demolition drawings shall be prepared which clearly indicate altered, discontinued, and removed work where extensive removal and/or demolition operations are required. Demolition drawings shall indicate, but not be limited to, the following pertinent information:

A. Location and size of structural members.
B. Methods of closing openings.
C. Other information to clearly indicate the extent of known materials and conditions to be removed.
D. Symbols that are used for the demolition work shall be the same as those used on the drawings for new construction.
E. Complete design and detailing of systems interruptions and protection of adjacent or affected systems and operations from damage due to interruptions and/or construction activities.

16.5 Composite Drawings

The consultant shall coordinate and prepare composite drawings showing all disciplines on one drawing. Each discipline shall be identified by a specific color. One set of plots shall be submitted to DEN as indicated in Chapter 32- Submittals indicating ceiling cavity spaces and utility/structural drawings. The consultant shall ensure that the project systems are completely coordinated and that no designed interference exists. This includes conduit routings, drain lines, sprinkler systems, etc.

16.5.1 Egress Plans

The consultant shall provide floor plans indicating safety egress from the facilities that shall include blocks of occupancy types, calculated quantity of occupants, and calculated egress widths. This shall include block diagrams indicating the egress schemes.

End of Chapter

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Chapter 17 - Structural Drawings

17.0 Structural Drawings

17.0.1 Definition

A structural drawing delineates the various portions of the overall structural system. All construction materials shall be defined with dimensions, sizes, and locations in the structure. The drawings shall indicate complete design. Prior written acceptance from DEN is required for any design-build component. Structural drawings shall be coordinated with other disciplines and shall include penetrations and other accommodations required.

17.0.2 Sequence

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

17.1 Foundation Plans

Foundation plans show location, size, and type of foundations, which support the building. Plan views locate supported columns, grade beams, basement walls (if any), location, and size of piles, equipment pedestals, and any other items, which are part of the foundation. Cross sections and details shall be provided to show dimensions and shapes of all concrete items not completely defined in plan. Show number and location of foundation elements along with type, size, and length. Show reinforcing bars, anchor bolts and other embedded items, joints, and penetrations. Define material properties for concrete, reinforcing steel and all other parts of foundations. Indicate on foundation plans all required penetrations and references for any modifications to reinforcing or structure required for penetrations.

17.2 Floor Plans

17.2.1 Structural Steel Framing

Show framing for each floor level, and elevations (top of steel) for all members. Locate all beams with respect to column lines and give sizes. Locate all support points for equipment, posts, hangars, stairs, etc. Sections referring to structural steel details shall be required.

Define by notes all grades of steel used, types and sizes of connections (with details as required) and refer to all standard drawings, charts, tables, notes, etc., for information required to construct a safe and complete floor system.

17.2.2 Floor Plans

Show all plan dimensions of floor. Define outer limits, location, and size of openings, elevations for all areas, floor types (concrete, grating, floor plate, etc.) and thickness, equipment supports, and any other items to be incorporated in the floor construction. Cut sections and indicate details shown on same or other sheets to show edge details, equipment pedestals, reinforcement, anchor bolts, and miscellaneous embedments.

Define reinforcement grades and sizes, bar grating or floor plate sizes, and details; locate all floor construction joints, reinforcement lap/splices as required. Define and locate all penetrations. Define steel decking wherever used as concrete form or otherwise shall be defined. Define material properties required for all concrete, steel, floor topping, or other materials used.

17.2.3 Roof Plans

Define all plan dimensions and openings as for floors. Define top of steel elevations, sizes, and locations of all beams, purlins, and joists. Define roof type (concrete, steel deck, etc.) Provide framing as required around openings. Define loading requirements for steel deck roofs, such as live load, wind uplift, and attachment to framing for diaphragm action. Define roof slope and locate drains. Locate support points for all roof-mounted equipment such as HVAC equipment, tanks, etc.

All roof penetrations shall conform with roof manufacturer's requirements and shall not void roof warranties.

17.3 Elevations and Wall Sections

17.3.1 General

Show all columns, beams, bracing on column lines. Size all columns and bracing. Define connections or show loads for connections to be designed by contractor. Give size for all struts and beams not shown on floor plans. Show framing at doors, windows, etc. Provide details for any non-standard connections.

On exterior walls, show girt system. Show sizes, spacing, and locate sag rods. Detail special girts, parapet construction, framing around openings, etc. Types and sizes of siding shall be coordinated with architectural drawings.

17.4 Standard Drawings, Schedules, Tables, and Details

17.4.1 Drawings

In lieu of detailing repeated identical items on all views where they occur, detail on standard drawings and refer to them by letter or number designations. The drawings include, but are not limited to, the following:

17.4.1.1 General Notes and Details

Include references to pertinent codes and standards. Give design criteria and loads as required. Show standard details for treatment of concrete edges, joints, penetrations, and anchor bolts. Detail standard handrails and ladders and their anchorage to structure.

17.4.1.2 Column Schedules

Show location and size of columns used. Detail splices and base plates, showing shear bars, anchor bolts, grout, and any other required features.

17.4.1.3 Bracing Connections

Show typical details for diagonal bracing. List all combinations of vertical, horizontal, and diagonal connections between braces, beams and columns and reference by letter or number designations to plans and elevations.

17.4.1.4 Standard Beam and Joist End Connections

Detail typical connections, showing required tolerances, edge distances, pitch, gage, etc. Show manner of designating connections on plans. If standard connections are used for given beam sizes, list.

17.4.1.5 Non-standard Connections

Detail as required except where shown on plan or elevation drawings.

17.4.1.6 Stair Details

Show plan and elevations for all stairs, with riser and tread dimensions. Show reinforcing for concrete stairs. For steel stairs, show all member sizes, connections, bracing and supports.

17.4.1.7 Girt Details

Show all girt bracket types, sag rods, and joints between girt sections and all connections. Detail special built-up girt sections.

17.4.1.8 Miscellaneous Details

Show details for all welded girders, trusses, built-up members, and assemblies used. Show all necessary views of crane girders, crane columns, and brackets and attachment to building, crane stops, clearance requirements, and dimensions relative to building column lines and elevations. Provide details for fabrication of floor plates, floor bracing, and all other miscellaneous items to be installed by the contractor.

End of Chapter

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Chapter 18 - Mechanical Drawings

18.0 Mechanical Drawings

18.0.1 Definitions

A mechanical drawing delineates equipment, materials, components, ductwork, piping, and accessories to convey liquids, and gases for the construction of mechanical systems. Mechanical systems include HVAC, plumbing, fire protection, building automation and any process system requirements. The drawings shall indicate complete design. Prior written acceptance is required for any design-build component.

18.0.2 General Requirements

These drawings establish the requirements for construction of the facility design, including pertinent services, equipment, and other features required for the performance of the mechanical equipment. These drawings shall incorporate dimensions, symbols, reference to codes, conventions, schedules, diagrams, etc., in describing the size and routing of pipes, material to be used, equipment criteria, duct sizes and shapes, amount of flow and the temperature of material in pipes and ducts, valve types and location, floor and wall penetrations, tank construction, equipment, piping insulation, and other facets of mechanical design as are required.

Provide a legend sheet indicating all symbols, line types, and abbreviations used in the contract drawings. Legend shall be project specific. General legends encompassing symbols and abbreviations not part of the work are prohibited.

18.0.3 Design Requirements

Refer to Mechanical DSM for detailed requirements of mechanical design, details, and specifications.

18.1 Sequence

18.1.1 Numbering

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

18.1.2 Demolition

Demolition drawings of mechanical systems shall call out all ductwork, insulation, piping, and associated controls to be removed. Controls shall be called out to be removed in the programming of that system. Abandoned-in-place equipment, piping, and ductwork is not allowed unless authorization is obtained in writing from the Project Manager.

18.2 Flow Diagrams

18.2.1 Schematic Illustrations

Flow diagrams are schematic illustrations of piping or duct circuits including equipment, components, and instruments involved in the mechanical system. The purpose of flow diagrams shall be to define a mechanical system with respect to flow directions, component sizes, control functions, operational and flow balances.

18.2.2 Key Drawings

Flow diagrams are key drawings, which form a basis for detail design drawings, maintenance, operator training, and construction. Because of the definitive nature of flow diagrams, they shall be developed prior to the

commencement of construction document phase piping drawings or any detail design drawings, which may be affected by the flow diagrams.

18.2.3 Flow Diagrams

Flow diagrams shall be required to illustrate the following:

A. HVAC airflow of all HVAC systems and relative pressurization of spaces
B. Chilled water piping systems
C. Cooling tower water and/or condenser water systems
D. Process systems; chemical feed systems
E. Heating water piping systems
F. PCA Glycol piping system
G. Automation; temperature controls, process controls, life safety controls, etc. Diagram shall depict all components in control of equipment and interface with DEN EMCS systems.

Existing flow diagrams shall be modified to show new work and modifications to any equipment represented in the diagram. The need for additional flow diagrams shall be determined on a project-by-project basis by the Design Engineer, the DEN Mechanical Engineer, and the DEN Project Manager. The need for additional flow diagrams shall be based on the complexity of piping in the mechanical system. Flow diagrams shall define all contributory loads and demand loads of existing systems or systems to be provided by others.

18.3 Flow and Control Diagram Requirements

18.3.1 General Requirements

All piping, ductwork, and equipment shall be represented on flow diagrams in schematic form. Accurate depiction of physical relationships is essential for clarity, e.g., a pressure vessel with nozzles located on top, bottom, and sides should appear on the flow diagram with nozzles shown in approximately the same relationship. Piping specialties and special features shall bear a reasonable resemblance to the actual items or installations.

Flow and controls may be shown on a single diagram. For complex or very large control and flow diagrams, they may be requested to be separate by the DEN Mechanical Engineer.

18.3.2 Flow Direction

A flow direction arrow shall appear at each line junction or change of direction to illustrate the flow direction.

18.3.3 Limits of Construction

Purchased equipment packages, which are pre-assembled or pre-piped, shall be so designated with a dashed line to outline the limits of the vendor-supplied portion.

18.3.4 Instruments and Controls

Instrument Society of America (ISA) symbols shall be used to represent instruments and control loops. Instruments shall be identified by a tag number inside a circular balloon, in accordance with ISA standards. Tag numbers shall be permanently affixed to each instrument. Typical industry Process and Instrumentation Diagram (P&ID) standard level of detail is preferred.

Flow diagram shall completely identify all devices, mechanisms of control (i.e., pneumatic, electric) and interface points. Level of detail documents can be provided upon request through the DEN Mechanical Engineer.

18.3.5 Set Points

Set points for relief valves, limit switches, control valves, dampers, and operating temperatures shall be indicated. Normal and failure positions shall be called out for control valves and dampers (fail open, fail closed, normal open,

normal closed, etc.). Other instrument set points or operating control points shall be called out as appropriate to aid design and construction.

18.3.6 Logic/Control

For complex systems and/or those systems controlled by Direct Digital Control (DDC), or those connecting to the DEN EMCS, a written logic description shall be added to the flow diagrams or included in the project technical provisions of the Specifications.

A. Instrument Society of America (ISA) symbols shall be used to represent control devices, instruments, and control loops.
B. All components shall be identified by a tag number inside a circular balloon, in accordance with ISA standards. Tag numbers shall be permanently affixed to each instrument.

18.3.7 Operating Controls

Consideration shall be given to all anticipated operating conditions, including start-up and shutdown. Flow diagrams shall show bypasses, start-up lines, shutdown lines, and any valves, controls, etc., required for any anticipated operating condition.

18.3.8 Identification Tags

Facilities management identification tag numbers and basic design parameters shall be shown on the flow diagrams. The Engineer shall obtain equipment tag numbering from the DEN Project Manager.

18.3.9 Existing System Tie-in

When new mechanical systems are to be connected to existing systems or systems being designed by others, each tie-in shall be identified on the drawings by a hexagon symbol bearing a unique tie-in number. The designer shall include a list of tie-ins on the drawings as required for a project. The tie-in schedule shall note the tie-in number, piping, ductwork, or other service, and the extent of interruption required to affect each tie-in. This schedule shall be used to help coordinate construction with normal operations to minimize unscheduled down time.

18.3.10 Symbols

Symbols used on flow diagrams for valves, instruments, and accessories shall conform to standards established by the legend.

18.3.11 Gravity Drainage

When a specific service requires positive gravity drainage, arrows and notes on the flow diagram shall illustrate the slope required. Plans shall indicate starting and ending invert elevations.

18.3.12 Space Pressurization Diagrams

Space pressurization diagrams are required to show how air is intended to move throughout the facility and required pressurization aspects of many space types (i.e., restrooms under negative pressure). Diagrams shall be in block form and depict as clearly and simply as possible all HVAC & Life Safety systems. Diagrams shall show:

A. All equipment (AHU, EF, VAV, FCU, etc.) serving each space/area with appropriate unit tags.
B. Total airflow rates of pressurized systems in each space (each diffuser is not required unless a VAV serves many individual spaces).
C. Paths of transfer air in each space with anticipated airflow rate.
D. Path of return air in each space with anticipated airflow rate.
E. Path of smoke control and airflows in each space.
F. Room names of each space.

G. Single- or double-line presentation of ductwork system flow.

18.4 Drawings for Mechanical Systems

18.4.1 General

Piping drawings shall delineate the components required to convey the fluids. Drawings shall be completely coordinated with other disciplines and existing systems to ensure no conflicts occur in the documents. Drawings shall include but not be limited to such items as the supply and distribution of potable water, sanitary water and waste, storm waste, chilled water, systems for fire protection, drainage, fuel supply to boilers and heating water. Piping drawings shall delineate the material, system, size, and routing of pipe, hose and tubing, the associated vessels and equipment, and other facets of mechanical design by incorporating dimensions, symbols, codes, conventions, schedules, and diagrams.

18.4.2 Flow Diagrams

When flow diagrams are required, they shall be completed prior to commencement of detail piping drawings.

18.4.3 Enlarged Plans

When adequate detail cannot be shown on arrangement plans, enlarged plans shall be provided.

Enlarged plans are required at each gate and shall accurately depict all equipment (PCA, GPU, PWC, etc.) with required access clearances, movement requirements, and the relationship to aircraft and airlines ground support equipment (GSE).

Sections shall be included when loading bridges serve multiple sizes of aircraft to ensure loading sill height does not negatively affect gate equipment. Sections shall show minimum clearances to ground for loading bridge mounted equipment.

18.4.4 Drawing Delineation

The following rules shall be followed in the delineation of ductwork and piping drawings.

Exposed pipe shall be shown as a single thick line, and hidden or buried pipe shall be shown as a thick dashed (hidden) line; however, to delineate clearances and special conditions, 6" and larger pipe shall be shown using a double line, drawn to scale shown, the actual pipe dimensions, and pipe centerline

When new and existing piping, ductwork and/or equipment are shown on the same drawing, existing pipe, ductwork, and equipment shall be shown using a light or shaded lineweight. New equipment shall be drawn with heavier lineweights than main piping. Hidden lines shall be reserved for hidden equipment, ductwork, or piping below and not used to represent existing systems.

All ductwork shown on plans hall be shown using a double line, drawn to scale shown, the actual duct dimensions, and round duct centerline. Single line representation shall only be used for flexible ductwork to diffusers/grilles

Pipe shall be identified as to size, service code (fluid in pipe), and flow direction. Flow direction shall be clearly identified with arrows indicating the direction of flow on the centerline of the pipe.

Valve stems, hand wheels, etc., even though shown symbolically, shall be drawn to scale where a clearance problem may exist or where removal or operation may be critical

The scale used for Mechanical drawings shall be as follows:

A. General site routing plans – 1/10" to 1/20" = 1'-0"
B. Piping plans (including double line piping) – 1/8" to 1/4" = 1'-0"
C. Enlarged plans, sections and details – 1/4" to 3/4" = 1'-0"

Pipe and ductwork mains and branches shall be dimensionally located from the facilities structure, such as column lines, walls, ceiling, equipment, supports, etc., or from recognized benchmarks; as required or justified by complexity or space constraints.

Pipes and ductwork shown in elevation or section shall have their centerline or bottom of pipe/duct elevations given above or below grade or floor elevation to a reference datum plane. All pipe/duct elevations shall be identified on the drawings and coordinated with other items vertically.

When draining of horizontal piping is required or drip stations are called for, the slope in lines shall be called out by an arrow placed adjacent to the applicable line.

The slope shall be indicated in fraction of an inch per foot or the elevation given at both ends of the slope. Invert elevations shall be given at the start point of the first bend, and obstruction clearance, at tie-ins to existing piping and/or when the continuation of the piping is covered by another discipline.

When more than one system or service is delineated on the drawing, line designations shall be used.

When pipe or tubing runs are grouped close together, the line designations shall be called out.

Guides, anchors, and expansion compensators shall be located and described.

Show all dampers (balancing, control, fire, smoke, etc.) and location of maintenance access.

All new and existing diffusers, registers, and grilles shall be called out with a minimum face size or neck size, design airflow, specification type, and maximum pressure drop or maximum throw at 100 fpm. Presentation shall be identified with a single callout. Figure 18-1: Air Distribution Device Identification shows the correct callout identification method.

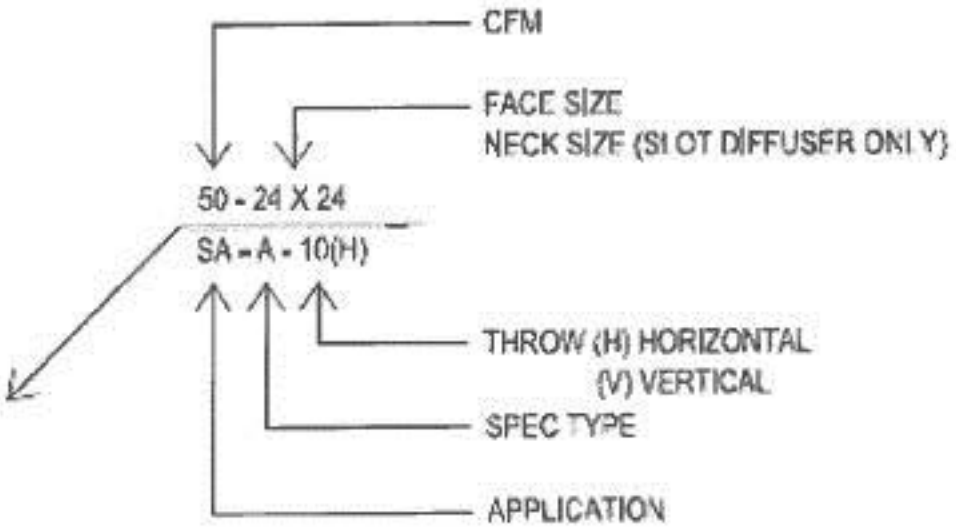

Figure 18-1: Air Distribution Device Identification

Ductwork sizing shall be called out W x H. No symbols for measurement units are required. All dimensions shall be in inches.

A. Correct: 24 x 36
B. Incorrect: 24"/36"

Round ductwork shall be identified in inches followed by the diameter symbol. No symbols for measurement units are required, i.e., 24.

Ductwork and piping callouts shall be labeled in the direction of fluid flow and indicate equipment service. Figure 18-2: Exhaust Air Callout Diagram is labeled incorrectly. It should read 34x16 from AHU-CX above:

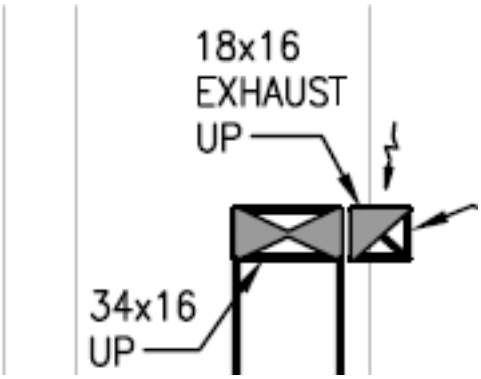

Figure 18-2: Exhaust Air Callout Diagram

The piping abbreviations shown in Figure 18-3: Mechanical Piping Abbreviations and Line Typess from the DEN Revit Template are to be used for drawing consistency. Designers shall use the line type designation illustrated when single line drawings are used.

MECHANICAL

PIPING

GRAPHIC	DESCRIPTION
LPS	LOW PRESSURE STEAM
MPS	MEDIUM PRESSURE STEAM
HPS	HIGH PRESSURE STEAM
HPC	HIGH PRESSURE CONDENSATE
MPC	MEDIUM PRESSURE CONDENSATE
LPC	LOW PRESSURE CONDENSATE
BBD	BOILER BLOWDOWN
PC	PUMPED CONDENSATE
MU	MAKEUP WATER
ATV	ATMOSPHERIC VENT
FOD	FUEL OIL DISCHARGE
FOG	FUEL OIL GAUGE
FOS	FUEL OIL SUCTION
FOR	FUEL OIL RETURN
FOV	FUEL OIL TANK VENT
HWS	LOW TEMP HOT WATER SUPPLY
HWR	LOW TEMP HOT WATER RETURN
MTWS	MEDIUM TEMP HOT WATER SUPPLY
MTWR	MEDIUM TEMP HOT WATER RETURN
HTWS	HIGH TEMP HOT WATER SUPPLY
HTWR	HIGH TEMP HOT WATER RETURN
GLHS	GLYCOL SOLUTION HEATED SUPPLY
GLHR	GLYCOL SOLUTION HEATED RETURN
CA	COMPRESSED AIR
VAC	VACUUM (AIR)
VPD	VACUUM PUMP DISCHARGE
(NAME)E	EXISTING PIPING
X-X-X-(NAME)-X-X-X	PIPE TO BE REMOVED

AIR CONDITIONING AND REFRIGERATION

GRAPHIC	DESCRIPTION
RD	REFRIGERANT DISCHARGE
RS	REFRIGERANT SUCTION
RL	REFRIGERANT LIQUID
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
GLCS	GLYCOL SOLUTION CHILLED SUPPLY
GLCR	GLYCOL SOLUTION CHILLED RETURN
GLH/CS	GLYCOL SOLUTION HOT/CHILLED SUPPLY
GLH/CR	GLYCOL SOLUTION HOT/CHILLED RETURN
FILL	FILL LINE
H	HUMIDIFICATION LINE
D	DRAIN
HPWS	HEAT PUMP WATER SUPPLY
HPWR	HEAT PUMP WATER RETURN

Figure 18-3: Mechanical Piping Abbreviations and Line Types

18.4.5 Demolition Drawings

A. Demolition drawings shall completely identify limits of demolition and items to remain for each system.
B. Define the requirements for maintaining system operation in critical operational spaces where HVAC systems cannot be interrupted.
C. Drawings shall identify locations of all existing piping isolation valves and drain points required to perform the scope of work indicated and shall not direct the contractor to locate them in the field. Include additional floor plans if required to indicate the locations of the piping isolation valves. Verify locations of valves and drain points at the project site; do not rely on as-built drawings.
D. Drawings shall be fully coordinated with other life safety systems for removal.

18.4.6 Mechanical Details

A. All roof penetrations shall be fully detailed and conform with roof manufacturer's requirements. Roof penetrations shall not void roof manufacturer's warranty.

18.5 Update of Standard Diagrams

DEN currently maintains standard diagrams for most buildings, which shall be used in any project that modifies these listed systems:

A. HVAC control router location map
B. Heating and chilled water flow diagrams
C. PCA flow diagram for Concourses A and C

These diagrams should be included in the base building Revit model. If not, they are available from the DEN Mechanical Engineer in AutoCAD format. All new flow/location diagrams shall be developed using the existing diagrams in the guidelines.

18.6 Heating, Ventilating, Air Conditioning

18.6.1 General

Heating, ventilating, and air conditioning drawings delineate the components required to supply or move air by natural or mechanical means. Such air may or may not be conditioned (i.e., filtered, tempered, and/or humidified). These drawings shall establish procedures for construction of the facility design, including pertinent services, equipment, and utilities. The delineation for these drawings shall incorporate dimensions, symbols, codes, conventions, schedules, diagrams, etc., in describing the ducts blowers, filters, heating or cooling coils, roof exhausts, grilles, dampers, air conditioning units, pumps, controls, ducts, and equipment. The drawings shall be completely coordinated with all other design disciplines to assure that there are no designed conflicts and that the systems can be installed as delineated.

18.6.2 Combined Drawings

HVAC Systems and piping systems for HVAC systems may be combined on the same set of drawings where practical and prior written acceptance form DEN has been issued.

18.6.3 Drawing Delineation

The following rules shall apply when detailing these drawings:

A. Drawings shall be prepared showing routing of ducts and piping and location of ducts, grilles, and required ventilation, exhaust, and/or air conditioning equipment. The preferred scale for arrangements is 1/4" = 1'-0" (To aid in checking drawings and resolving potential interferences among other components, such as piping, electrical, architectural, etc., the heating, ventilation, and air conditioning drawing shall be prepared to the same scale as these other drawings, where feasible).

B. Duct layouts shall include grille sizes, CFM, splitters, outlet control dampers, elbows, access doors, branches, volume control dampers, louver openings, booster heating equipment, test holes, and other miscellaneous components equipment and controls.

C. When duct sizes are given, the first dimension is the side shown, for example, 20x12. The 20" dimension is the width and the 12" dimension is the depth where the duct is shown in plan.

D. Material for ducts, gage of metal, type and spacing of joints and reinforcements, type and spacing of hangers, angle, or change in size transitions, and cross bracing shall be covered in specifications.

E. Direction of flow shall be indicated by an arrow.

F. In multiple level facilities, piping shall be fully detailed on the level where the work occurs. Piping on the floor level below shall not be shown as hidden line as the only method of presentation.

G. All parts such as coils, fans, dampers, filters, housings, compressors, and miscellaneous items shall be called out on the drawing. A schedule may be employed for this purpose. A schedule lists the type, size, capacity, speed, pressure, type enclosure, fins per inch and rows, and other pertinent components in tabular form. Deviations from the standard schedules shall be approved by the Project Manager prior to use.

H. Clearly define dedicated maintenance access areas for all equipment on plans and details. Presentation shall indicate clear space from area of maintenance of equipment and include a dedicated area directly below to the operational floor. Maintenance areas shall include but not be limited to:

   a. Filter pull areas
   b. Coil pull areas
   c. Dedicated control panel access (24” clear)
   d. Door swings (duct and equipment)
   e. Valve and damper handle/actuator access
   f. Motor service space
   g. Major component removal
   h. Life safety devices
   i. Specialized expansion fittings
   j. P/T ports

I. Automatic control diagrams for ventilation, heating, and air conditioning systems shall show:

   b. All controllers, sensors, thermocouples, valve and damper operators, relays, and accessories necessary to illustrate the functions and sequence of operation of all principal components in the system.
   c. The set point and throttling range of all controllers.
   d. The normally open or closed position of all valves and dampers.
   e. A list or matrix of inputs and outputs.
   f. The sequence of operation of the system through a complete winter-summer cycle, including the off and fire alarm conditions shall be provided in the specifications.

18.7 Mechanical Design Submittal Requirements

18.7.1 General

This section addresses the minimum requirements for the submittal of mechanical discipline construction or RFP documents during the progress of design. Unless otherwise stated in the consultant’s contract or approved task, at a minimum, the consultant shall deliver the following content in the submittal packages to DEN. These requirements are in addition to the requirements detailed in Chapter 32- Submittals of this DSM.

The information and requirements in this section are in addition to the requirements laid out in Chapter 2- Design Phases and Chapter 6- Contract Documents.

The following are the minimum requirements for each submittal phase, and are required in all projects, except for written exemptions from the PM and approval of DEN Mechanical Engineer (defined in the Mechanical DSM). In general, mechanical system designers should focus on large equipment locations and clearances, controls and

sequences of operations, and mechanical diagrams in earlier submittals, and work on smaller details such as branch ductwork, selection of smaller equipment, and mechanical details in later submittal packages.

Table 18-1: Submittal Requirements

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
General Mechanical Notes					
	Boilerplate Notes[A,C]		x	x	
	Project-Specific Notes[A,B,C]				X
Symbols Legend					
	General Symbols[A,C]	X	X		
	Project-Specific Symbols[A,B,C]			x	x
Demolition Phasing Plans					
	General Area of Demolition	x			
	Phasing Plan[D]	x[P]	x[F]	x[F]	x[F]
	Tie-In Points and Schedule	x[P]	x[U]	x[F]	x[F]
Floor Plans					
	General Equipment Layout	x			
	Large Equipment Placement	x[P]	x[U]	x[F]	x[F]
	Small Equipment Placement		x[P]	x[U]	x[F]
	Phasing Plan[D]	x[P]	x[F]	x[F]	x[F]
	Tie-In Points and Schedule	x[P]	x[F]	x[F]	x[F]
	Duct Pressure Classifications		x[U]	x[U]	x[F]
	Transfer/Return/Exhaust Opening Sizing		x	x	x
	Control Device Locations		x[U]	x[U]	x[F]
	Life Safety Airflow Coordination		x[F]	x[F]	x[F]
Equipment Placement					
	Large Equipment Placement	x	x	x	x
	Large Equipment Coordination		x	x	x
	Large Equipment Maintenance Areas		x	x	x

Table 18-1: Submittal Requirements (Continued)

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
	Small Equipment Placement		x	x	x
	Small Equipment Coordination			x	x
	Small Equipment Maintenance Areas			x	x
Ductwork Layouts					
	Single-Line New Medium Pressure Ductwork or Duct Zones	x			
	Double-Line New Medium Pressure Ductwork		x	x	x
	Single-Line New Low Pressure Ductwork		x		
	Double-Line Low Pressure Ductwork			x	x
	Single-Line Existing Piping			x	
	Double-Line Existing Piping				x
	Existing Shut-Off Valve Locations		x	x	x
	Tie-In Points and Schedule	x^{P}	x^{U}	x^{F}	x^{F}
Enlarged Plans					
	Dimensional General Arrangements for Large Equipment	x			
	Enlarged Plans for Mechanically Intensive Areas		x^{P}	x^{U}	x^{F}
	Tie-In Points and Schedule		x^{P}	x^{U}	x^{F}
Section Views					
	Section Views for Mechanically Intensive Areas		x^{P}	x^{U}	x^{F}
	Section Views for Dimensionally Sensitive Areas		x^{P}	x^{U}	x^{F}
	Section Views for Critical Structure Crossings		x^{P}	x^{U}	x^{F}
	Tie-In Points and Schedule	x^{P}	x^{U}	x^{F}	x^{F}

Table 18-1: Submittal Requirements (Continued)

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
Controls and Sequence of Operations					
	Sequences for Large Equipment	x[P]	x[U]	x[F]	x[F]
	Sequences for Small Equipment		x[P]	x[U]	x[F]
	P&ID for Large Equipment		x	x	x
	P&ID for Small Equipment			x	x
	Points Lists for Large Equipment		x[P]	x[F]	x[F]
	Points Lists for Small Equipment			x[P]	x[F]
Mechanical Details					
	General Details[A,B]		x[P]	x[U]	x[F]
	Non-Standard Details[C]	x[P]	x[U]	x[F]	x[F]
Equipment Schedules					
	Equipment Schedules	x[P]	x[U]	x[F]	x[F]

[P]- Preliminary: Preliminary denotes some work has been done, but much of the detail is missing. Consultant shall focus more on difficult work first, such as large equipment placement, maintenance clearances, and sequences of operations. Routing of low-pressure ductwork and mechanical piping are not desired for preliminary work.

[U]- Updated: Updated denotes work has been submitted to DEN before review, and DEN's comments have been taken into account and feedback incorporated into Construction Documents. More detail and revisions may still be required.

[F]- Finalized: Finalized denotes work that needs little if any more updated before being submitted for permits. All DEN comments shall be taken into account and feedback incorporated into Construction Documents.

[A] Use DEN=provided symbols, general notes, and details.

[B] Remove any symbols, notes, and details not used in project for final submittal.

[C] Non-standard symbols, notes, and details, where required by the project, shall be submitted in earlier sets of Construction Documents

[D] Phasing Plans, when required by the project, shall be finished by the 60% submittal.

End of Chapter

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Chapter 19 - Plumbing Drawings

19.0 Plumbing Drawings

19.0.1 Definitions

A plumbing drawing delineates equipment, materials, components, ductwork, piping, and accessories to convey liquids, and gases for the construction of mechanical systems. Mechanical systems include HVAC, plumbing, fire protection, building automation and any process system requirements. The drawings shall indicate complete design. Prior written acceptance is required for any design-build component.

19.0.2 General Requirements

The drawings establish the requirements for construction of the facility design, including pertinent services, equipment, and other features required for the performance of the mechanical equipment. These drawings incorporate dimensions, symbols, reference to codes, conventions, schedules, diagrams, etc., in describing the size and routing of pipes, the kind of material to be used, equipment criteria, duct sizes and shapes, amount of flow and the temperature of material in pipes and ducts, valve types and location, floor and wall penetrations, tank construction, equipment, piping insulation, and other facets of mechanical design as are required. Drawings shall be completely coordinated with other disciplines to ensure there are no conflicts and that the systems can be installed as delineated.

Provide a legend sheet indicating all symbols, line types, and abbreviations used in the contract drawings. Legend shall be project specific. General legends encompassing symbols and abbreviations not part of work are prohibited.

19.0.3 Design Requirements

Refer to Mechanical DSM for detailed requirements of plumbing design, details, and specifications.

19.1 Sequence

19.1.1 Numbering

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

19.1.2 Demolition

Demolition drawings of plumbing systems shall call out all insulation, piping and associated controls to be removed. Controls shall be called out to be removed in the programming of that system. Abandoned-in-place piping is not allowed unless written authorization is obtained in writing from the Project Manager.

19.2 Flow Diagrams

19.2.1 Schematic Illustrations

Flow diagrams are schematic illustrations of piping or duct circuits including equipment, components, and instruments involved in the mechanical system. The purpose of flow diagrams shall be to define a mechanical system with respect to flow directions, component sizes, control functions, operational and flow balances.

19.2.2 Key Drawings

Flow diagrams are key drawings, which form a basis for detailed design drawings, maintenance, operator training, and construction. Due to the definitive nature of flow diagrams, they shall be developed prior to the

commencement of construction document phase piping drawings or any detailed design drawings, which may be affected by the flow diagrams.

19.2.3 Requirements

Flow diagrams shall be required to illustrate the following:

A. Process drain/sewer systems; chemical feed systems.
B. Hot water piping systems
C. Plumbing waste and storm drainage systems: diagrams shall be provided and show calculated fixture unit counts or GPM on all sections and equipment.
D. Plumbing hot and cold-water supply systems: diagrams shall be provided and show calculated fixture unit counts or GPM on all sections and equipment.
E. Automation; temperature controls related to plumbing equipment.
F. Natural gas piping systems. Natural gas piping systems shall include calculations of inches of water and shall note the demand loads of all equipment to be connected to the gas system.
G. Fuel systems

The need for additional flow diagrams shall be determined on a project-by-project basis by the Design Engineer and Project Manager. The need for additional flow diagrams shall be based on the complexity of piping the mechanical system.

19.3 Flow Diagram Requirements

19.3.1 General

Piping and equipment shall be represented on flow diagrams in schematic form. Accurate depiction of physical relationships is essential for clarity (i.e., a pressure vessel with nozzles located on top, bottom, and sides should appear on the flow diagram with nozzles shown in approximately the same relationship). Indicate direction of fluid flow with flow arrows. Piping specialties and special features shall bear a reasonable resemblance to the actual items or installations.

19.3.2 Flow

A flow direction arrow shall appear at each line junction or change of direction to illustrate the flow direction.

19.3.3 Limits of Construction

Purchased equipment packages, which are pre-assembled or pre-piped, shall be so designated with a dashed line to outline the limits of the vendor-supplied portion.

19.3.4 Instruments

Instrument Society of America (ISA) symbols shall be used to represent instruments and control loops. Instruments shall be identified by a tag number inside a circular balloon, in accordance with ISA standards. Tag numbers shall be permanently affixed to each instrument.

19.3.5 Set Points

Set points for relief valves, limit switches, control valves, dampers, and operating temperatures shall be indicated. Failure positions shall be called out for control valves and dampers (fail open, fail closed). Other instrument set points or operating control points shall be called out as appropriate to aid design and construction.

19.3.6 Controls

For complex systems or those systems controlled by Direct Digital Control (DDC), a written logic description shall be added to the flow diagrams or included in the project technical provisions of the Specifications.

19.3.7 Operating Conditions

Consideration shall be given to all anticipated operating conditions, including start-up and shutdown. Flow diagrams shall show bypasses, start-up lines, shutdown lines, and any valves, controls, etc., required for any anticipated operating condition.

19.3.8 Identification Tags

Facilities management identification tag numbers and basic design parameters shall be shown on the flow diagrams in a neat format along the top or bottom of each drawing.

19.3.9 Exiting System Tie-in

When new plumbing systems are to be tied into existing systems or systems being designed by others, each tie-in shall be identified on the drawings by a hexagon symbol. The designer shall include a list of tie-ins on the drawings as required for a project. The tie-in schedule shall note the tie-in number, piping, ductwork, or other service, and the extent of interruption required to affect each tie-in. This schedule shall be used to help coordinate construction with normal operations to minimize unscheduled down time.

19.3.10 Symbols

Symbols used on flow diagrams for valves, instruments, and accessories shall conform to standards established by the legend.

19.3.11 Gravity Drainage

When a specific service requires positive gravity drainage, arrows and notes on the flow diagram shall illustrate the slope required.

19.4 Drawings for Piping

19.4.1 General

Piping drawings shall delineate the components required to convey the fluids. Included shall be such items as the supply and distribution of potable water, sanitary water and waste, storm waste, chilled water, systems for fire protection, drainage, fuel supply to boilers and heating water. Piping drawings, or a set of piping drawings, delineate the kind, size, and routing of pipe, hose and tubing, the associated vessels and equipment, and other facets of mechanical design by incorporating dimensions, symbols, codes, conventions, schedules, and diagrams.

19.4.2 Flow Diagrams

When flow diagrams are required, they shall be completed prior to commencement of detail piping drawings.

19.4.3 Drawing Delineation

The following rules shall be followed in the delineation of piping drawings:

A. Exposed pipe shall be shown as a single thick line, and hidden or buried pipe shall be shown as a thick dashed (hidden) line; however, to delineate clearances and special conditions, 6" and larger pipe shall be shown using a double line, drawn to scale shown, the actual pipe dimensions, and pipe centerline.

B. When new and existing pipe and/or equipment are shown on the same drawing, existing pipe and equipment shall be shown using a lighter or shaded lineweight. New equipment shall be drawn with heavier lineweights than main piping.
C. Pipe shall be identified as to size and service code (fluid in pipe).
D. Valve stems, hand wheels, etc., even though shown symbolically, shall be drawn to scale where a clearance problem may exist or where removal or operation may be critical.
E. The scale used for piping drawings shall be as follows:
    a. General site routing plans – 1/10" to 1/20" = 1'-0"
    b. Piping plans (including double line piping) – 1/8" to 1/4" = 1'-0"
    c. Enlarged Plans, Sections and details – 1/4" to 3/4" = 1'-0"
F. Pipe mains and branches shall be dimensionally located from the facilities structure, such as column lines, walls, ceiling, equipment, supports, etc., or from recognized benchmarks; as required or justified by complexity or space constraints.
G. Pipes shown in elevation or section shall have their centerline or bottom of pipe elevations given above or below grade or floor elevation to a reference datum plane. All pipe elevations shall be identified on the drawings and piping coordinated with other items vertically.
H. Piping callouts shall be labeled in the direction of fluid flow and indicate equipment service. Indicate direction of fluid low with flow arrows.
I. When draining of horizontal lines is required or drip stations are called for, the slope in lines shall be called out by an arrow placed adjacent to the applicable line.
J. The slope shall be indicated in fraction of an inch per foot or the elevation given at both ends of the slope.
K. When more than one system or service is delineated on the drawing, line designations shall be used.
L. When pipe or tubing runs are grouped close together, the line designations shall be called out.
M. Guides, anchors, and expansion compensators shall be located and described.

19.4.4 Plumbing Details

A. All roof penetrations shall be fully detailed and conform with roof manufacturer's requirements. Roof penetrations shall not void roof manufacturer's warranty.

19.5 Plumbing

19.5.1 General

Plumbing drawings delineate the components required to supply domestic hot and cold water to plumbing fixtures and then to remove this water after use through a sanitary drainage and vent system. These drawings shall establish procedures for construction of the plumbing system design, including pertinent utility connections, plumbing fixtures, and piping. The delineation for these drawings shall incorporate dimensions, symbols, codes, conventions, schedules, diagrams, etc., in describing the plumbing system design.

19.5.2 Detailing Requirements

The following rules shall apply when detailing these drawings:

A. Drawings shall be prepared showing routing of domestic cold, hot, and re-circulating hot water piping. Sanitary drainage and vent piping shall also be shown. The preferred scale for arrangements is 1/4" = 1'-0". (To aid in checking drawings and resolving potential interferences among other components, such as ductwork, electrical equipment, etc.) The plumbing drawing shall be prepared to the same scale as the drawings of the other disciplines, where feasible.
B. Plumbing drawings shall include pipe sizes and routing, design fixture unit counts or design flow rates, direction of flow, clean-out locations, plumbing fixture schedule, invert elevations for sanitary drainage

piping, and locations for vent piping roof penetrations. Design fixture unit counts, or design flow rates shall be identified on all main piping between branch connections.

C. In multiple level facilities, piping shall be fully detailed on the level where the work occurs. Piping on the floor level below shall not be shown as hidden line as the only method of presentation.

D. Materials for piping, insulation, and equipment such as water meters, water heaters, water hammer arresters, infrared sensing devices for automatic valve control and plumbing fixtures, shall be covered in the technical specifications.

E. An isometric diagram to five feet outside the buildings shall be provided for the domestic hot and cold-water piping, with re-circulation hot water piping included on the isometric where applicable. Indicate water heater location, valves, and tie-in location for connection to water utility service. Indicate all water meters as necessary.

F. An isometric diagram shall be provided for the sanitary drainage and vent piping to five feet outside the building, with pertinent invert elevations indicated.

G. An isometric diagram shall be provided for the following additional plumbing systems:

   a. Gas piping systems
   b. Storm water systems (primary and secondary)
   c. Grease waste and vent systems
   d. Acid waste and vent systems

H. All plumbing fixtures shall be itemized in schedules on the drawings. The schedule shall list the type of fixture, and connection sizes of hot, cold, sanitary and vent piping. Water heaters may be scheduled in cases where several are required.

I. Automatic (infrared) lavatory valve operators and flush valves shall be coordinated with the electrical engineer/electrical drawings and shown on the plumbing drawings.

J. On existing plumbing systems, detail location of nearest shut-off valve and system drain for all tie-ins. Design shall not direct the contractor to locate them in the field.

K. The following abbreviations in from the DEN Revit Template are to be used for drawing consistency. Use the line type designation illustrated when single line drawings are used.

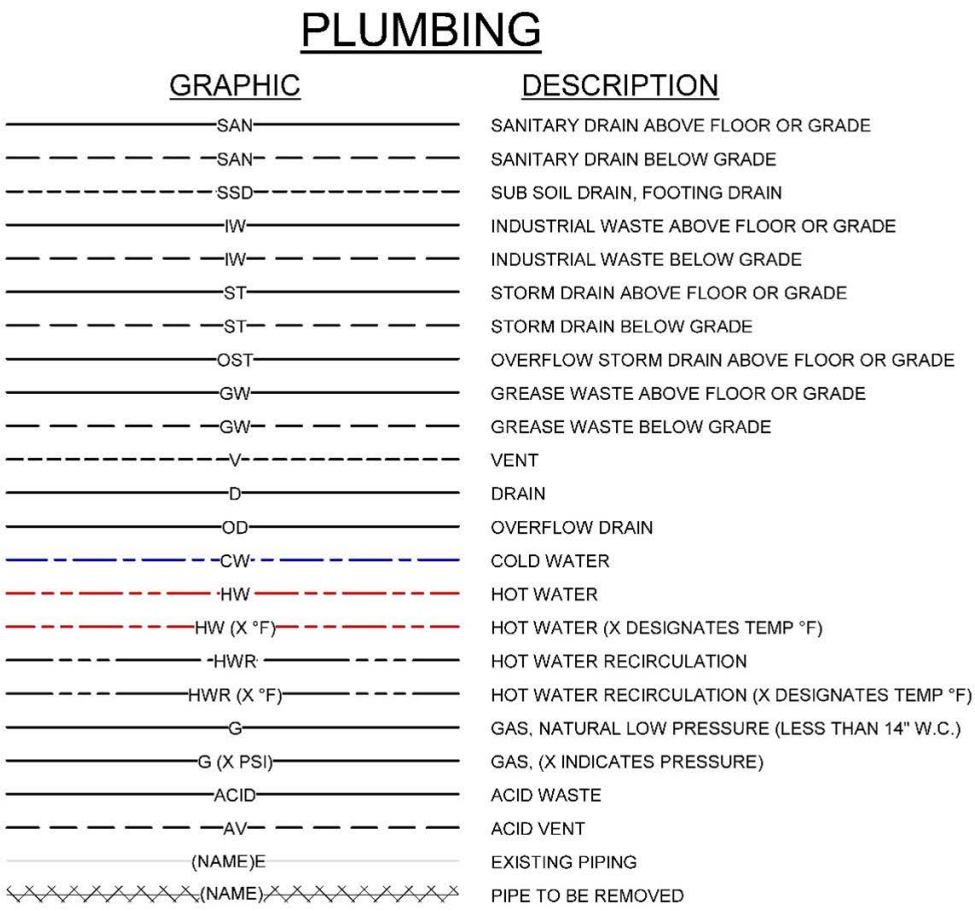

Figure 19-1: Plumbing Piping Abbreviations and Line Types

19.5.3 Demolition Drawings

Demolition drawings shall completely identify limits of demolition and items to remain for each system. Drawings shall identify locations of all existing piping isolation valves and drain points required to perform the scope of work indicated and shall not direct the contractor to locate them in the field. Include additional floor plans if required to indicate the locations of the piping isolation valves. Verify locations of valves and drain points at the project site; do not rely on as-built drawings. Drawings shall be fully coordinated with other life safety systems for removal.

19.5.4 Service Diagrams

On all projects requiring natural gas service, compressed air, or other types of pressured systems, provide as part of the construction documents flow diagrams indicating demand loads. An example may be a flow diagram indicating gas service with regulator size, and inches of water demand calculations for each element or devices to be served by the gas service. Include identification at each device the range of pressures acceptable for start-up, testing, and operation of the device.

19.6 Update of Standard Diagrams

DEN currently maintains standard diagrams for most buildings, which shall be used in any project that modifies these listed systems:

A. Grease trap flow diagram for all Concourses and Terminal

These diagrams should be included in the base building Revit model. If not, they are available from the DEN Mechanical engineer in Auto CAD format. All new flow/location diagrams shall be developed using the existing diagrams as guidelines.

19.7 Plumbing Design Submittal Requirements

19.7.1 General

This section addresses the minimum requirements for submittal of plumbing discipline construction or RFP documents during the progress of design. Unless otherwise stated in the consultant's contract or approved task, at a minimum, the consultant shall deliver the following content in the submittal packages to DEN. These requirements are in addition to the requirements detailed in Chapter 32- Submittals of this DSM.

The information and requirements in this section are in addition to the requirements laid out in Chapter 2- Design Phases and Chapter 6- Contract Documents.

The following are the minimum requirements for each submittal phase, and are required in all projects, except for written exemptions from the PM and approval of DEN Mechanical Engineer (defined in the Mechanical DSM). In general, mechanical system designers should focus on restroom, kitchen, and water entry room layouts and clearances, locations of interceptors, and plumbing diagrams in earlier submittals, and work on smaller details such as branch piping runs, selection of smaller equipment, and plumbing details in later submittal packages.

Table 19-1: Submittals

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
General Mechanical Notes					
	Boilerplate Notes[A,C]		x	x	
	Project-Specific Notes[A,B,C]				X
Symbols Legend					
	General Symbols[A,C]	X	X		
	Project-Specific Symbols[A,B,C]			x	x
Demolition Phasing Plans					
	General Area of Demolition	x			
	Demolition Plans		x[P]	x[U]	x[F]
	Phasing Plan[D]	x[P]	x[F]	x[F]	x[F]
	Tie-In Points and Schedule		x[P]	x[U]	x[F]
Floor Plans					
	General Plumbing Equipment and Fixtures Layout	x			
	Plumbing Equipment and Fixtures Layout		x[P]	x[F]	x[F]

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
	Phasing Plan[D]	x[P]	x[F]	x[F]	x[F]
	Tie-In Points and Schedule	x[P]	x[F]	x[F]	x[F]
	Control Device Locations		x[P]	x[U]	x[F]
Equipment Placement					
	Plumbing Equipment and Fixtures Placement		x	x	x
	Plumbing Equipment and Fixtures Coordination			x	x
	Plumbing Equipment and Fixtures Maintenance Areas			x	x
Plumbing Piping Layouts					
	General Connections for new/modified systems	x			
	Single-Line New Piping		x		
	Double-Line New Piping			x	x
	Single-Line Existing Piping			x	
	Double-Line Existing Piping				x
	Existing Shut-Off Valve Locations		x	x	x
	Tie-In Points and Schedule		x[P]	x[U]	x[F]
Enlarged Plans					
	Dimensional General Arrangements for Plumbing Equipment and Fixtures	x			
	Enlarged Plans for Plumbing Intensive Areas[E]		x[P]	x[U]	x[F]
	Tie-In Points and Schedule		x[P]	x[U]	x[F]
Section Views					
	Section Views for Plumbing Intensive Areas[E]		x[P]	x[U]	x[F]
	Section Views for Dimensionally Sensitive Areas		x[P]	x[U]	x[F]
	Section Views for Critical Structure Crossings		x[P]	x[U]	x[F]

Submission Type	Description	30% Design	60% Design	90% Design	100% Design
	Tie-In Points and Schedule	x[P]	x[U]	x[F]	x[F]
Controls and Sequence of Operations					
	Sequences for Plumbing Equipment		x[P]	x[U]	x[F]
	P&ID for Plumbing Equipment			x	x
	Points Lists for Plumbing Equipment			x[P]	x[F]
Plumbing Diagrams					
	Grease Waste Riser Diagram and Interceptor Location		x[P]	x[U]	x[F]
	Isometric Diagrams for Plumbing Intensive Areas[E.G]		x[P]	x[U]	x[F]
Plumbing Details					
	General Details[A,B]		x[P]	x[U]	x[F]
	Non-Standard Details[C]	x[P]	x[U]	x[F]	x[F]
Plumbing Schedules					
	Plumbing Equipment and Fixture Schedules	x[P]	x[U]	x[F]	x[F]
Specifications					
	Specifications Table of Contents	x[P]	x[U]	x[F]	x[F]
	Red-lined Specifications		x[P]	x[U]	x[F]
	Clean Specifications				x[F]

[P]- Preliminary: Preliminary denotes some work has been done, but much of the detail is missing. Consultant shall focus more on difficult work first, such as large equipment placement, maintenance clearances, and sequences of operations. Routing of low-pressure ductwork and mechanical piping are not desired for preliminary work.

[U]- Updated: Updated denotes work has been submitted to DEN before review, and DEN's comments have been taken into account and feedback incorporated into Construction Documents. More detail and revisions may still be required.

[F]- Finalized: Finalized denotes work that needs little if any more updated before being submitted for permits. All DEN comments shall be taken into account and feedback incorporated into Construction Documents.

[A] Use DEN=provided symbols, general notes, and details.

[B] Remove any symbols, notes, and details not used in project for final submittal.

[C] Non-standard symbols, notes, and details, where required by the project, shall be submitted in earlier sets of Construction Documents

[D] Phasing Plans, when required by the project, shall be finished by the 60% submittal.

[E] *Plumbing-intensive areas are areas with many pieces of plumbing fixtures and/or equipment, such as restroom groups, kitchen groups, water entry rooms. pump stations, etc.*

[G] *Consultant shall use their best judgment to determine where isometric diagrams will best aid the constructibility and maintainability of the project. All plumbing-intensive areas shall have isometric diagrams.*

End of Chapter

Chapter 20 - Fire Protection Drawings

20.0 Fire Protection Drawings

20.0.1 Definitions

A fire protection drawing delineates equipment, materials, components, piping and accessories to convey liquids, and gases for the construction of fire protection systems. The drawings shall indicate complete design. Prior written acceptance from the Project Manager is required for any design-build component. These drawings establish the requirements for construction of the facility design, including pertinent services, equipment, and other features required for the performance of the mechanical equipment. These drawings incorporate dimensions, symbols, reference to codes, conventions, schedules, diagrams, etc., in describing the size and routing of pipes, the kind of material to be used, equipment criteria, duct sizes and shapes, amount of flow and the temperature of material in pipes and ducts, valve types and location, floor and wall penetrations, tank construction, equipment, piping insulation, and other facets of mechanical design as are required. Drawings shall be complete and coordinated with other disciplines to ensure there are not conflicts and that the systems can be installed as delineated.

20.0.2 Design Requirements

Refer to Life Safety DSM for detailed requirements of fire protection design, details, and specifications.

20.1 Sequence

20.1.1 General

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

20.2 Flow Diagrams

20.2.1 Schematic

One-line diagrams are schematic illustrations of piping including equipment, components, and instruments involved in the sprinkler system. The purpose of one-line diagram shall be to define the sprinkler system with respect to flow directions, component sizes, control functions and operational.

20.2.2 Key Drawings

One-line diagrams are key drawings, which form a basis for detail design drawings, maintenance, operator training, and construction. Because of the definitive nature of one-line diagrams, they shall be developed prior to the commencement of construction document phase piping drawings or any detail design drawings, which may be affected by the one-line diagrams.

20.2.3 Requirements

One-line diagrams shall be required to illustrate the following:

A. Standpipe systems and fire risers
B. Sprinkler System
C. Fuel systems
D. Fire Alarm System
E. Emergency Fuel Shutoff System

The need for additional one-line diagrams shall be determined on a project-by-project basis by the Design Engineer and Project Manager. The need for additional one-Line diagrams shall be based on the complexity for piping of the fire protection system.

20.3 Flow Diagram Requirements

One-line diagram requirements shall conform to requirements in this DSM and the guiding NFPA standard.

20.4 Drawings for Piping

20.4.1 General

Fire Protection Drawings shall delineate the components required to convey the fluids. Piping drawings shall delineate the material, size, and routing of pipe, hose and tubing, the associated vessels and equipment, and other facets of mechanical design by incorporating dimensions, symbols, codes, conventions, schedules, and diagrams.

Systems shall never be shown to be supported by slab on grade without flex connections.

Where systems require structural penetration for clearances of other project elements, provide a complete design including required penetration sizes. Completely coordinate with the Structural Engineer all penetrations sizes and locations.

20.4.2 One-line Diagrams

When one-line diagrams are required, they shall be completed prior to commencement of detail piping drawings.

20.4.3 Demolition

Demolition drawings of Fire Protection systems shall call out all piping, and associated controls to be removed. Controls shall be called out to be removed in the programming of that system. Demolition drawings shall include phasing plans identifying how the area and life safety systems will remain operational throughout all phases of the scope of work. Abandoned-in place systems are not allowed unless authorization is obtained in writing from the DEN Project Manager.

20.4.4 Existing System Tie-In

When new fire protection systems are to be tied into existing systems or systems being designed by others, each tie-in shall be identified on the drawings by a hexagon symbol. The designer shall include a list of tie-ins on the drawings as required for a project. The tie-in schedule shall note the tie-in number, piping, or other service, and the extent of interruption required to affect each tie-in. This schedule shall be used to help coordinate construction with normal operations to minimize unscheduled down time.

20.4.5 Delineation

The following rules shall be followed in the delineation of piping drawings:

A. Exposed pipe shall be shown as a single thick line and hidden, or buried pipe shall be shown as a thick dashed (hidden) line; however, to delineate clearances and special conditions, 6" and larger pipe shall be shown using a double line, drawn to scale shown, the actual pipe dimensions.

B. When new and existing pipe and/or equipment are shown on the same drawing, existing pipe and equipment shall be shown using a hidden line. New equipment shall be drawn with lighter lines than main piping.

C. Pipe shall be identified as to size and service code (fluid in pipe).

D. Valve stems, hand wheels, etc., even though shown symbolically, shall be drawn to scale where a clearance problem may exist or where removal or operation may be critical.

E. The scale used for piping drawings shall be as follows:

a. General site routing plans – 1/10" to 1/20" = 1'-0"
b. Piping plans (including double line piping) – 1/8" to 1/4" = 1'-0"
c. Sections and details – 1/4" to 3/4" = 1'-0"

F. Pipe mains and branches shall be dimensionally located from the facilities structure, such as column lines, walls, ceiling, equipment, supports, etc., or from recognized benchmarks; as required or justified by complexity or space constraints.

G. Pipes shown in elevation or section shall have their centerline or bottom of pipe elevations given above or below grade or floor elevation to a reference datum plane. All pipe elevations shall be identified on the drawings and piping coordinated with other items vertically.

H. When draining of horizontal lines is required or drip stations are called for, the slope in lines shall be called out by an arrow placed adjacent to the applicable line.

I. The slope shall be indicated in fraction of an inch per foot or the elevation given at both ends of the slope.

J. When more than one system or service is delineated on the drawing, line designations shall be used.

K. When pipe or tubing runs are grouped close together, the line designations shall be called out.

L. Guides, anchors, and expansion compensators shall be located and described.

20.4.6 Detailing

The following rules shall apply when detailing these drawings:

A. Drawings shall be prepared showing routing of fire protection piping. The preferred scale for arrangements is 1/4" = 1'-0".

B. To aid in checking drawings and resolving potential interferences among other components, such as ductwork, electrical equipment, etc. The fire protection drawings shall be prepared to the same scale as the drawings of the other disciplines.

C. Fire protection drawings shall include pipe sizes and routing, direction of flow, test connection points, riser diagrams showing valves and alarms, fire extinguisher and hose locations.

D. Materials for piping, valves, sprinkler heads, alarm devices, and fire department connections shall be covered in the technical specifications.

E. Identify space hazard classification for all fire sprinkler systems.

F. Density and remote square footage requirements shall also be indicated.

G. Designs modifying existing Fire Sprinkler Systems shall clearly indicate location of the existing zone control valves, locations of system drains, locations of all existing devices and all existing fire protection zones.

H. All roof penetrations shall be fully detailed and conform with roof manufacture's requirements. Roof penetrations shall not void roof manufacturer's warranty.

20.5 Update of Standard Diagrams

DEN currently maintains standard diagrams for most buildings, which shall be used in any project that modifies these listed systems:

A. Fire Protection Riser diagram for all Concourses

B. Fire Protection Zone diagram for all Concourses, AOB, Terminal, HTC/PTC

C. Smoke Control Zone diagram for all Concourses, AOB, Terminal, HTC/PTC

These diagrams should be included in the base building Revit Model. If not, they available through the DEN Life Safety Engineer in AutoCAD format. All new flow/location diagrams shall be developed using the existing diagrams as guidelines.

20.6 Life Safety Design Submittal Requirements

20.6.1 Sprinkler Systems

20.6.1.1 A/E 30% Drawings

The A/E 30% drawing should contain the design density of the areas identified by room or area, as well as the required Architectural drawing backgrounds.

20.6.1.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 20.6.1.1 A/E 30% Drawings and the following information::

A. The identification of the Fire Zone.
B. The new layout area or the new zone that is created for the remodeled area.
C. The locations of the sprinkler locations for the NFPA 13 required layout.

20.6.1.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 20.6.1.1 A/E 30% Drawings, 20.6.1.2 A/E 60% Drawings and the following information:

A. The identification of the sprinklers in the locations they are presented with details to the type, pendant, upright or sidewall.
B. A note from the EoR that they are confident that the calculations for the area are adequate for supply.

20.6.2 Fire Alarm Systems

20.6.2.1 A/E 30% Drawings

The A/E 30% drawing should indicate if any detection will be required, as well as the required Architectural drawing backgrounds.

20.6.2.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 20.6.2.1 A/E 30% Drawings and the following information:

A. Initial placements of the detection.
B. Fire alarm notification.
C. Emergency communication devices.
D. If there are any other life safety system, they need to be identified, as well as their future locations.
E. Preliminary sequence of operations.
F. Identification of the Fire/Smoke Zone the equipment is part of.

20.6.2.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 20.6.2.1 A/E 30% Drawings , 20.6.2.2 A/E 60% Drawings, and the following information:

A. Final locations of all detection, fire alarm notification and emergency communication devices. Fire Alarm Terminal Cabinets included.
B. Final tap settings of strobes.
C. If there are any other life safety systems, they shall indicate any monitoring or controlling of those devices.
D. The Sequence of Operation is the responsibility of the Engineer of Record.

20.6.3 Emergency Communication System

20.6.3.1 A/E 30% Drawings

The A/E 30% drawing should indicate if any intelligibility will be required, as well as the required Architectural drawing backgrounds.

20.6.3.2 A/E 60% Drawings

The A/E 60% drawings should contain the information in 20.6.3.1 A/E 30% Drawings and the following information:

A. Initial placements of speakers.
B. If there are any other ECS, connections they need to be identified, as well as their future locations.
C. Preliminary sequence of operations.
D. Identification of the Speaker Zone the equipment is part of.

20.6.3.3 A/E 90% Drawings

The A/E 90% drawings should contain the information in 20.6.3.1 A/E 30% Drawings, 20.6.3.2 A/E 60% Drawings, and the following information:

A. Final locations of all emergency communication devices. Emergency Communication System Terminal Cabinets included.
B. Final tap settings of speakers
C. If there are any other life safety systems, they shall indicate any monitoring or controlling of those devices.
D. The Sequence of Operation shall follow the sequence identified in the Life Safety Design Standards Manual Chapter 4.
E. An audio model shall be provided for all areas open to the public to provide an indication if the dBA levels would be met as well as the intelligibility of the area.

End of Chapter

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Chapter 21 - Electrical Drawings

21.0 Electrical Drawings

21.0.1 General Information and Requirements

The electrical drawings described in this chapter shall be prepared as applicable, depending upon the characteristics and complexity of the projects involved. These drawings shall be provided when essential in planning, procurement, construction, evaluation, recording, and use of the projects. The drawings shall indicate complete design. Prior written acceptance is required for any design-build component.

21.0.2 Definition

Facility electrical drawings are graphic representations of facilities electrical design requirements.

21.0.3 Design Requirements

Refer to Electrical DSM for detailed requirements of electrical design, details, and specifications.

Refer to DFI DSM.

21.0.4 Completeness

Facility electrical drawings, when interpreted in association with the construction specifications, shall:

A. Furnish sufficient information to permit installation of manufactured equipment that requires electrical service **WITHOUT CONFLICT WITH WORK OF OTHER DISCIPLINES.**

B. Furnish sufficient information to manufacture equipment that is of special design, made exclusively to meet the requirement of the project. Components and systems shall be UL listed.

C. Describe items so that they may be procured.

D. Furnish sufficient information to permit planning, construction, evaluation, recording, repair, and maintenance of facilities.

E. Furnish the above in sufficient completeness for accomplishment without the need of assistance from the consultant.

21.0.5 Sequence

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

21.0.6 Electrical and Electronic Symbols

Electrical and electronic symbols, when used, shall be in accordance with American National Standards Institute (ANSI). Other symbols, if devised by the consultant, shall be shown in the **ITEM** column, and explained in the **DESCRIPTION** column of the **LEGEND** with indication **FOR THIS PROJECT ONLY.**

21.0.7 Symbols for Other Functional Disciplines

Symbols for functional disciplines other than electrical shall be as specified in the respective sub-sections of this manual.

21.0.8 Functional Designations

Functional designations, when used, shall be in accordance with 21.10: Function Designations.

21.0.9 Delineation Types

Electrical drawings shall generally include, as required, the following types of delineations:

A. Block diagrams
B. One-line diagrams
C. Schematic diagrams
D. Connection diagrams
E. Facility electrical power distribution plans
F. Facility lighting plans. (Outdoor and indoor)
G. Facility communications plans and risers
H. Facility grounding plans and risers
I. Facility security plans and risers
J. Facility lightning protection plans
K. Fire alarm plans and risers
L. Panel, circuit, and other schedules
M. Detail drawings

The number of delineation drawings for a project shall be kept to a minimum, consistent with clarity for constructability.

21.0.10 Delineation Drawings

Subject to City acceptance, the drawings for projects need not contain all delineation types. For example, projects consisting only of a single building and a relatively simple electrical system may not need a block diagrams or single-line diagrams if the information normally found in them is effectively conveyed by other delineation types. Different and various combinations of delineation types may be shown on the same drawing, except that lighting, power, and life safety systems shall always be on separate plans. Each delineation shall be identified by its type below the area where it is displayed, e.g., SCHEMATIC DIAGRAM. These delineations shall not be included on architectural, structural, civil, or mechanical drawings. If delineation drawings are different from outlined herein, then the Drawing Index shall clearly show combination of delineation.

21.0.11 Legend

Electrical drawings shall contain a legend of symbols. The symbols as used in accordance with Section Symbols for Electrical Drawings shall be considered standard for application to electrical drawings. Refer to 21.11: Symbols for Electrical Drawings. If a nonstandard symbol is not fully described by supplementary notation where it is shown, it should be:

A. Contained in the **LEGEND.**
B. Explained in the notes to eliminate possibility of misinterpretation if paragraph (a) is insufficient.Noted
C. **Noted: FOR THIS PROJECT ONLY**.

21.0.12 Specification Relationship

Specifications, which are a portion of a contract package, shall include an electrical section. The electrical drawings, together with the specifications shall specifically describe all the electrical design requirements of the project. Vendor information drawings may be included as reference drawings subject to written approval from the Manufacturer. Electrical drawings, which may form a part of a purchase specification drawing, may be included as reference drawings. The consultant by submitting the documents for Bid ensures that space allocations for equipment specified is adequate and compliant with all code requirements, including clearance requirements and free of conflicting space requirements of all other trades.

21.1 Electrical Plans

21.1.1 Definition

Electrical plans consist of scaled delineations and line symbology arranged to depict circuits and electrical equipment installation. Diagrams and the specifications supplement the plans to present the required information for facilities. The following types of plans are included:

A. Electrical equipment arrangement
B. Facility electrical power distribution, including underground distribution
C. Facility grounding
D. Facility lighting, indoor and outdoor
E. Facility security
F. Facility lightning protection
G. Facility communications
H. Fire alarm

21.1.2 Symbols

Electrical symbols used shall be in accordance with Section- Symbols for Electrical Drawings. Electrical items such as wire, conduit, cable, electrical equipment, etc., shall be delineated by line work distinguishable from line work used to depict items shown for reference or orientation. Lines between boxes on power and lighting circuit plans shall indicate cable, conduit, duct, and wire runs. Separate lines for wires within these carriers are generally not shown except by symbol. Conduit runs shall generally be indicated by straight lines run parallel to building lines, walls, floors, ceilings, etc.

Circuitry not depicting conduit routing shall be generally depicted by curved lines. When these lines are used without additional qualification, they may be interpreted as permitting the most direct, non-interfering route compliant with codes and workmanship standards. This system may ONLY BE USED BY THE DESIGNER IF the designer has professionally designed the system to guarantee no interference to the route during construction. It is the consultant's responsibility to design the project, not the contractors. Assuming the contractor *will figure it out* is not responsible Professional Design. When a specific routing of conduit, wire, and cable run is required, the routing of these runs shall be dimensioned and/or covered by note. Specific routing location run shall be required when routing is buried, to be placed in concrete, or to be routed through penetrations to prevent conflict or to assure clearances. Dimensional locations of routing shall be shown.

Circuit designation shall be shown for feeders, such as:

- A = Alarm Circuit
- C = Control Circuit
- L = Lighting Circuit
- D = DC Circuit

21.1.3 Marking

Requirements for the marking of safety or warning notices, of an electrical nature, on equipment, doors, enclosures, etc., not otherwise provided for in the specification shall be included on the drawings.

21.1.4 Future Space

When space is specifically set aside for the possible future installation of equipment such as a transformer, such space shall be indicated in dashed lines, dimensioned, and labeled.

21.1.5 Spares

Spare wires, cables, conduits, terminals, circuit breakers, etc., shall be shown and identified as spares.

21.1.6 Cross-reference

Applicable drawings, including other discipline drawings, shall be referenced. Reference to vendor information drawings shall not be used. Reference made shall be to specific vendor equipment drawings only when equipment is known or received.

21.1.7 Arrows on Wires

The use of arrowheads on lines, which depict wire, cable, or conduits, shall be limited to the indication of *home runs* (home runs are those returning, without interruption, to the local panel board). Location and elevation of wire ways, electrical bus, and cable trays shall be shown.

21.1.8 Completeness

The completeness of the drawings shall be such that additional drawings need not be made in the field to interpret the design. The drawings shall permit the development and analysis of applicable vendor information drawings. Unless included in the specification, the following items shall be included on the drawings:

A. Extent of utilization of National Testing Laboratory acceptance of items
B. Compliance, as applicable, to the National Electrical Code
C. Marking or tagging requirements, i.e., Underwriter's labels, wire sizes, fuse ratings, etc.
D. Labeling of circuits and equipment

21.1.9 Load Balancing

The plans shall be so delineated that the proximity to balance load conditions can be ascertained.

21.1.10 Special Requirements

Special requirements such as those indicated below shall be included on the drawings:

A. Number, size, and location of building expansion joints
B. Construction details, such as when a conduit passes from a floating floor to a rigid structure

21.1.11 Views

More than one plan view of the same area may be required to show different electrical systems, such as communications on one, power on another, and lighting on another. The plan views shall be supplemented, as required, by sections, elevations, and details.

21.1.12 Details

Details depict features, which require delineation in addition to that provided on the basic plan or elevation.

21.1.13 Devices

Devices, which have different energized and de-energized appearance, shall be shown in the de-energized condition.

21.1.14 Scale

Scales 1/8"=1'0" and larger shall generally be used. Drawings shall be the same scale as the architect's drawings, unless a larger scale is required. Drawing North orientation shall be the same as the architect's drawings. Building areas shall be the same as the architect's drawings and presented in the same order.

21.2 Facility Electrical Power Distribution Plans

21.2.1 Definition

Facility electrical power distribution plans depict primary and secondary power distribution, control, and grounding, excluding lighting, and communications. Plans shall show equipment arrangements, configuration, and information to locate, position, and mount electrical equipment.

21.2.2 Primary Supply

The primary supply cables to, and the secondary feeder cables or busways from, service entrance equipment shall be shown.

21.2.3 Secondary Circuits

Connections of secondary circuits to utilization points and associated equipment such as panel boards, distribution transformers, converting equipment, etc., shall be shown.

21.2.4 Panelboard Schedules

Power panelboard schedules shall be shown. The total connected load (KVA) and the estimated demand load (KVA), including the demand factor used, and shall be shown on the schedule with phases balanced. All panelboard schedules included in project documents shall be notes as new- “NEW” or existing- “EX” near panel name.

Existing circuits on new or existing panelboards shall be indicated with a “(E)” prior to load served on the circuit description to differentiate from new loads added in project scope.

21.2.5 Panelboard Drawings

Panelboards, existing and new, shall be delineated in plan and elevation, showing all equipment adjacent to the installation dimensionally. New and existing equipment shall be indicated to scale. If optional panelboard manufacturers are specified, the LARGEST panel shall be shown, and the code-required clearances shall be indicated on the drawings. Delineation of the equipment shall be provided to the extent that its orientation with surroundings clearly depicts correct top-to-bottom and front-to-back positioning. Plan views shall be oriented the same as architectural plan views. Surrounding equipment and areas shall be identified. Door swings, clear areas required for placement of parts, etc., shall be shown.

21.2.6 Delineation

Equipment shall be dimensionally located from column lines, walls, ceilings, etc.

21.2.7 Grounding

Grounding design shall comply with DEN cathodic protection requirements and shall be delineated on the drawings including detailing of the grounding bars. Grounding paths shall be shown whether made through wires, buses, conduit, ducts, rods, or other items serving as ground conductors. Bonding information shall be included, unless covered in specification. Grounding conductor sizes and locations shall be delineated.

21.2.8 Raceways

Raceway systems and components (cable tray, conduit, pull boxes, wireway, etc.) shall be dimensionally located and described. Coordination of locations with other building systems is the responsibility of the consultant. The consultant shall ensure there are not conflicts with work to be performed by other disciplines.

21.2.9 Equipment

Equipment shall be identified by notes or in a material list. Equipment shall be delineated indicated dimensions of the largest (or equal) manufactured equipment. Access clearances for equipment shall be delineated on the drawings. Provide concrete housekeeping pads for floor-mounted electrical equipment.

21.2.10 Emergency Power

Standby or emergency power systems shall be included and identified.

21.2.11 Transformers

Heat load of the transformers shall be documented on the drawings and shall be addressed in the HVAC cooling calculations.

21.2.12 Receptacles

Receptacles shall be defined by symbol and home run circuit number. Note mounting height when different from typical. The panel for the home run shall be indicated on the drawings and shall be keyed by room number as well as panel number. Intermediate pull boxes shall be designated on the drawings and shall be coordinated with all other building systems to assure access.

21.3 Facility Lighting Plans

21.3.1 Definition

Facility lighting plans are electrical plans, which depict the lighting circuits, lighting control circuits, fixtures, and accessories within a facility. Facility lighting plans delineate the installation of the lighting system beginning with the power source at the service entrance equipment or the lighting transformer and panelboards and extending to the light fixtures.

21.3.2 Circuits

Lighting circuits shall generally be shown separate from other circuits. Lighting circuits may include feeders, transformers, panelboards, wires, cables, raceways, switches, lamps, outlets, emergency lighting batteries, relays, etc.

21.3.3 Delineation

Delineation for systems shall include runs from the service entrance equipment through the lighting control panelboards and conductors to the lights. Size, material, etc., shall be given for wire, conduit, and special fittings.

21.3.4 Panels

Panelboard connection details shall be shown; a panelboard schedule shall be used. The mounting height shall be given by note or in elevation if not covered in the specification. Panel schedules shall describe equipment and its location (room number).

21.3.5 Symbols

The lighting symbols shall include light fixture type number or letter code within or adjacent to them with their home run branch circuit number, and a lowercase letter indicating switches by which they are controlled. Note height if different from typical. Night-lights or security lighting circuits shall be distinguishable from the other lighting.

21.3.6 Layout and Location

Coordinate lighting layouts with location of mechanical and other electrical equipment. Mounting height for fixtures shall be given by note or shown on elevations. The mounting height of switches shall be given by note or in elevation unless covered in the specification.

21.3.7 Emergency Lighting

Emergency battery-powered lighting units, which are activated by power failures, shall clearly indicate the lighting circuits to which they are connected and that they are connected on the line side of all switches per applicable code.

21.4 Facility Communications Plans

21.4.1 Definition

Facility communication plans are electrical plans that depict the interconnecting electrical circuits between devices such as telephones, closed-circuit television, intercoms, public address, etc., as well as the various alarm or signaling systems such as fire detection and alarm, energy management and control system and security alarm, etc.

21.4.2 Locations

The location of the communication equipment shall be shown or noted. The interconnecting wiring and/or cabling shall be shown. When more than one system is shown on a plan, each shall be made clearly discernible. Raceway systems and components (cable tray, pull boxes, conduit, wireway, etc.) shall be located and described as required. Communication systems may be integrated together into common data communication links.

21.5 Diagrams - General

21.5.1 Definition

An electrical diagram is a graphic explanation of the way an electrical installation or system performs its intended function. It depicts the characteristics and relationships of items within a specified area or functional system using symbols and lines. Diagrams, depending upon the type, shall show flow, function, or physical connections.

21.5.2 Layout

The layout of electrical diagrams shall be such that the main features are prominently shown. The parts of the diagram shall be spaced to provide an even balance between blank spaces and lines. A sufficient blank area should be provided near symbols to avoid crowding of notes. Provide blank spaces for planned additions.

A. Diagram line work shall be of medium line width except where otherwise specified in the respective paragraph for a diagram type.

B. A set of electrical drawings shall include either a one-line diagram, schematic diagram, or both. Drawing titles shall include the delineation type, as follows, when the drawing contains only a single delineation:
    a. Block diagram
    b. Single-line diagram
    c. Schematic diagram
    d. Connection diagram

C. When combinations of electrical delineation types are included on the same drawing, the entry for the type of drawing in the title block shall be selected to define the drawing content. Typically, if a drawing combines all the delineation types, the entry in the title block shall be ELECTRICAL DIAGRAMS. Facilities diagrams shall consist of the following types as required by project:
    a. Block diagram
    b. Single-line diagram

c. Schematic diagram
d. Connection diagram

D. When a circuit contains parts, which need to be shown grouped, the grouping shall be indicated by means of a boundary line enclosure.

E. All lines between blocks or symbols shall be vertical or horizontal, with the use of diagonal lines restricted.

F. Lines shall be as direct and short as possible without the use of diagonal lines. Lines shall have a minimum number of turns and crossings, crossings shall be looped.

G. The nomenclature or other designations used for identification of blocks, symbols, equipment, etc., shall be in accordance with the device, equipment marking, or the standards established for the facilities.

H. Interface reference for flow lines, etc., that are from or to features not included on the drawing shall have a direction arrow.

I. Notes concerning physical or functional information shall be used, as required, when it is necessary to have an accompanying description to clarify the graphic presentation.

J. More than one type of diagram may be included on one drawing; however, they should usually be kept separate from plan drawings.

K. Connecting lines should preferably be drawn horizontally or vertically and with as few bends and crossovers as possible. When connecting lines are drawn parallel, the spacing between lines after fifty percent (50%) reduction shall be legible.

L. A specific diagram type may include supplementary information beyond the requirements outlined in its descriptive text. For example, a block diagram or connection diagram may include schematic information, while a schematic diagram may include wiring information. The combination of information on a specific diagram type is dependent upon increasing the utility of the diagram. The entry for the type of drawing in the title block shall be selected based upon the major purpose of the drawing.

21.6 Block Diagrams

21.6.1 Definition

A block diagram describes the concepts and/or organization of an equipment or facility using rectangular blocks, representing functions or groups of functions. Interconnecting lines establish the relationships between blocks and indicate the direction of information flow. A block diagram is used to give a quick over-all picture of a system and the general interrelationships between components of that system. It may be used for general arrangement studies, functional explanations, systematization of facilities, or for design discussion purposes.

21.6.2 Requirements

21.6.2.1 Diagrams

A. A block diagram shall be presented in as simple a form as possible. Rectangular blocks shall be used to represent functional electrical systems or parts thereof and/or major elements of an electrical system or circuit. Various other symbols may be used as supplementary information to increase the utility of the diagram.

B. Identifying nomenclature shall be included within the blocks.

C. Block diagrams may be made for any level of project activity. For example, a block diagram at the highest level may be made for a complete project, or any lower-order stage.

D. Related mechanical, electro-mechanical, or optional apparatus may also be included on block diagrams in rectangular form.

E. Mechanical connections between such elements shall be illustrated with dashed lines connecting the applicable blocks.

F. If the form of the circuit involves multiple sources and common or similar circuits, or variations thereof, tabulations may be used.

G. If a block diagram must be divided and placed on more than one drawing, the division of the circuit should be made in a logical manner, that will avoid confusion and at a point of minimum information transfer.

21.6.2.2 Connecting Lines

A. Lines connecting blocks shall indicate relationships, direction of flow of the system, sequence of operation, etc. The arrangement of lines and blocks shall show action or energy flow in functional sequence from top to bottom and/or left to right of the diagram, starting at the top left or top center, and ending at the bottom right of the diagram.

B. Connection lines shall be labeled, where necessary, to make the meaning clear and unmistakable. When dashed lines are used for more than one purpose on a block diagram, these purposes shall be made clear by label, legend, or note.

C. Connecting lines may include arrows to further define the circuit flow.

21.7 One-Line Diagrams

21.7.1 Definition

A single-line diagram shows, by means of single lines and graphic symbols, the course of an electrical/electronic circuit or system of circuits and the component devices or parts used therein. The principal objective of the single-line diagram is to record a maximum of significant information in a minimum of space. Facilities single-line diagrams are most useful in representing power distribution and communication systems. It may be used in the study and explanation of the facilities. A single-line diagram conveys basic information about the operation of a circuit or system of circuits. It omits much of the detailed information usually shown on schematic or connection diagrams. A single-line diagram delineates, in more detail than a block diagram, information, which will subsequently be shown on other diagrams.

21.7.2 Requirements

The requirements specified in Chapter 4- Schematic Design Phase apply in addition to the following:

A. Complete one-line diagrams are required, except with written permission from DEN PM.

B. Only one phase of a multiphase system and one polarity of a dc system shall be used to simplify the circuit and to include the necessary essentials.

C. Descriptive nomenclature, when used, shall be placed above or to the right of the subject element or connecting line unless other placement has a distinct advantage for the particular application.

D. All symbols shall be of the single-line type.

E. A single-line diagram is termed functional if various line widths are used to separate categories of circuits. When this type of diagram is made, the line widths shall be defined. No more than two widths of lines shall be used. Heavy-width lines represent power circuits and medium-width lines represent control and measurement circuits.

F. Nominal voltages shall be used for supplementary information in the designations of systems.

G. Power transformer impedance shall be indicated on the drawing.

H. Transformer voltage representation shall use the symbols dash (-) and slant (/) as follows:

   a. The dash (-) separates the voltage ratings of separate windings on a transformer, e.g., 13 8 KV -480V.
   b. The slant (/) separates multiple voltages or indicate taps of the same winding, e.g., 208Y/120
   c. Transformation ratios shall use the slant (/) as the separation between the values.

I. A one-line diagram may show only the power circuits or be extended to include secondary and control circuits in the simplified form.

J. The one-line diagram may include pertinent rating information about its items; for example, voltages of potential transformers, ampere rating of current transformers, fault current, interrupting capacity, breaker

frame and trip ratings of circuit breakers, motor horsepower ratings, load estimates, bus ampere and voltage rating.

K. A one-line diagram may also include wire and cable information, and further descriptions of elements; i.e., element categories, models, drawing numbers, functional designations, length of cable.

L. Indicate distribution equipment, power, control, and metering, and protective relay circuits from the incoming feeder to ultimate motor lighting panel or other load, including item names.

M. Winding connection symbols shall be used adjacent to the symbols for the transformer windings.

N. The quantity of a device may be indicated on a single-line symbol when it is necessary to define its quantity in relation to the graphical symbol. The numeral indicating quantity is placed adjacent to the symbol. The number 3 adjacent to the magnetic overload device indicates that there are three circuits like the one shown.

O. A note shall be included with the legend or notes indicating the function of the quantity numeral, e.g., THE **NUMERAL ADJACENT TO RELAYS DENOTES QUANTITY.**

P. Device lists shall be incorporated on the drawings and included as part of the legend, when functional designations per 21.9: Connection Diagrams are used. In addition, the meaning of each suffix used with a device function number should be listed if it is not included with a complete device function number. The following illustrates a device list:

   a. 1A- Master Element
   b. 1M- Master Element
   c. 23- Temperature Control Device
   d. 38- Bearing Protective Device
   e. 43- Manual Transfer Switch
   f. 47- Phase Sequence Voltage Relay
   g. 49- Machine Thermal Relay
   h. 51- AC Time Overcurrent Relay
   i. 51N- AC Time Overcurrent Relay (Neutral)
   j. 52- AC Circuit Breaker
   k. 52X- Auxiliary Relay for 52
   l. 86- Locking-out Relay

Q. Protective relays may be included along with an indication by operator dash lines on the device upon which the relay acts.

R. Electrical values and other functional information shall be included as necessary to allow analysis of the circuit. Examples of some types of information that may apply are as follows:

   a. Current, voltage, and interrupting rating of circuit breakers
   b. Primary and secondary voltages and kVA ratings of power transformers
   c. Voltage and kVA or kW rating of generators
   d. Voltage and HP rating and type of motors
   e. Rating and type of load on feeder circuits
   f. Ratings of power and control sources
   g. Circuit breaker frame trip and interrupting current
   h. Switches ampere rating
   i. Ratings of instrument transformers, fuses, resistors, capacitors, and contractors, motor starters
   j. Resistance to ground, inductance, and temperature ratings
   k. Voltage and current waveforms
   l. Bus amperage, voltage, and fault current capacity

21.8 Schematic Diagrams

21.8.1 Definition

A schematic diagram shows, by means of lines and graphic symbols located in sequence of function, an electrical/electronic circuit, or system circuits. A schematic diagram is particularly useful where the electrical relationships or circuits and device elements are the principal considerations. It may be used in systematization and/or circuit analysis. A schematic diagram emphasizes the device elements of a circuit, as distinguished from the physical arrangement of conductors, devices, etc., of a circuit system. The circuit layout follows the signal or transmission path from input to output, left to right, or in the order of functional sequence without regard to the actual physical shape, size, or location of the device. They show, in straight-line form, all circuits and items within a defined area or portion thereof.

21.8.2 Symbols

Electrical item symbols shall be shown in their de-energized state unless otherwise noted on the drawing. In general, terminal symbols may be omitted unless required for clarification.

A. The diagram shall be arranged so that the drawing user can follow the functional relationships (input to output, source to load, order of potential utilization, etc.). Layout should be such that the path of energy flows from left to right, top to bottom, or a combination thereof.

B. Items of the circuit shall be assigned functional designations. The designations shall be placed adjacent to their symbols, preferably above or to the right of the symbol.

C. Descriptive nomenclature shall be used to label all inputs and outputs of the schematic diagram. Physical operating label nomenclature (for example, PUSH TO TEST) should be placed adjacent to the push-button switch that will have such a label.

D. For interrupted single lines, the line identification may also serve to indicate destination. In general, identification practice for interrupted single lines shall be the same as for grouped and bracketed lines described in the paragraph on interrupted grouped lines. When interrupted lines are grouped and bracketed, line identifications shall be shown. Bracket destinations or connections may be indicated either by means of notations outside the brackets or by means of a dashed line. When the dashed line is used to connect brackets, it shall be drawn so that it will not be mistaken for a continuation of one of the bracketed lines. The dashed line shall originate in one bracket and terminate in no more than two brackets. Letters, numbers, abbreviations, or other identifiers for interrupted lines shall be located as close as possible to the point of interruption.

E. The relation of switch position to circuit function shall be shown on schematic diagrams For simple toggle switches, it may be sufficient to identify position with notations such as ON-OFF For complex switches, position-to-function relations may be shown either near the switch symbol or at a more convenient location on the drawing When rotary switches perform involved functions, a tabular form of presenting supplementary information is preferred, such as a selector switch contact development table.

F. When parts of rotary switches are designated S1A, S1B, S1C, etc , the suffix letters A, B, C, etc, shall start from the knob or actuator end and then be assigned sequentially away from this position Each section of the switch shall be shown viewed from the same end When both sides of a rotary switch section are used to perform separate switching functions, the front (knob or actuator end) and rear symbols should be differentiated by appropriately modifying the reference designation, for example, S1A FRONT and S1A REAR.

G. When portions of connectors and terminal boards are separated on the diagram for drawing convenience, the words **PART OF** shall precede their designation labels or each individual terminal shall be labeled with its reference designation When the separation of portions of connectors or terminal boards on the same drawings, becomes extensive, the separated parts may be identified as individual terminals If individual terminals from different parts, such as connectors, are intermixed, mechanical connecting lines shall be omitted.

H. When mechanical functions are closely related to certain electrical functions, the mechanical components shall be linked to the applicable graphic symbols of the schematic diagram.

I. Connecting points of lines should not be purposely laid out to represent actual physical arrangement of wires. This type of information will be provided by connection diagrams.

J. Terminal identifications may be added to graphic symbols to indicate actual physical markings, which appear on or near item terminations.

K. When terminals or leads of multi-lead items are identified on the item by a wire color, code, letter, number, or geometric symbol, this identification shall be shown on or near the connecting line adjacent to the symbol.

L. When rotary-type, adjustable resistors are shown on schematic diagrams; it is desirable to indicate the direction of rotation with respect to an arbitrary reference point. It is customary to refer to the rotary motion as clockwise or counterclockwise when rotation is viewed from the knob or actuator end of the control.

M. Subdivisions of items may be identified by adding a suffix letter to the designation of the part. For example, CB1A and CB1B identify electrically separate sections of a dual circuit breaker designated CB1. In cases where multiple items are physically integral but are shown separately they shall be identified by suffix letters. Where they are shown together within an enclosure, the assignment of suffix letters is optional.

N. Portions of multi-item components may be shown at different locations on the schematic diagram. In such cases, suffix letters added to reference designations will indicate the relationships of the subdivisions to the whole components.

O. In schematic diagrams for switching circuits, reference designations may be aligned along one edge of the circuit instead of being shown at the symbol. Mechanical linkage lines of multi-item switching devices and reference designations for individual contacts may be omitted when the association of parts is clear.

P. Explanatory information in the form of notes, that describe sequence of operations or the dependence of a circuit upon other actions, may be located adjacent to the related device, schematic delineation, or with the notes of the drawing.

21.9 Connection Diagrams

21.9.1 Definition

A connection diagram shows the general physical arrangement and electrical connections of a unit or of its component devices or parts. It may cover internal or external connections, or both, and contains such detail as is needed to make or trace the connections on the equipment. An interconnection diagram is a form of connection diagram, which shows the external wiring connections between different units of an equipment or different equipment of a system. Connection diagrams are used as a guide for installation of wire or cable. They are used for circuit tracing but not for circuit analysis. They serve the following purposes:

A. Furnish information showing electrical connections for an installation in diagram form.

B. Facilitate determination of electrical connection adequacy.

C. Terminals shall be named, spare terminals indicated.

D. Facilitate maintenance of equipment.

Supplement schematic and single-line diagrams by relating circuit information with the actual wiring and relative location of items. Connection diagrams are classified as either lineless or line types. The line type classification includes two subtypes: the point-to-point and the cable (or highway) type. The point-to-point diagram shall be used when the quantity of connections is small. The cable or highway type, as well as the lineless type, shall generally be used for a complex connection diagram.

21.9.2 Common Requirements

A. The physical arrangement of device terminals and connections thereto are generally pictorially shown.

B. All connections shall be listed, or all lines and symbols required to fully represent wire, cable, and circuit items and their connections within a defined area shall be depicted.

C. Point-to-point wire and/or cable types, connection information, and specific terminal identifications shall be shown.

D. System items, whenever feasible, shall be represented by rectangles and/or circles. Other geometric shapes, which approximate the outline of the item, and are simple in form, may be used. These outlines may encompass portions of their internal circuits in single-line or schematic form where more rapid understanding of the drawing will result, e.g., fuses, circuit breakers, switches, etc.

E. Terminations on items shall be represented by attached lines, rectangles, or circles. They shall be identified by letters, numbers, pigtail colors, or other nomenclature. This identification shall agree with actual marking on the item, when possible, and shall be compatible with other designations of the same item within the drawing set.

F. Item symbols shall be identified with the functional designations or other nomenclature assigned to them on single-line and/or schematic diagrams of the facility.

G. Rating and circuit function information, which is indicated, on single-line and/or schematic diagrams shall not be duplicated on connection diagrams. However, polarities and phase indications shall be included.

H. To avoid possible damage to equipment by improper connections, every consideration shall be given to indicating proper phasing. The diagram shall specify wires, which must be grouped in conduits as well as the proper identification of the wires and conduits. If conduits are not used, the wires must be grouped in a convenient manner to facilitate identification.

I. Pre-wired connections are those made by the equipment or item manufacturer. Pre-wired connections may be indicated by drawing notes directed to the connecting line indicating that the connection is pre-wired.

J. Connections shown with solid lines outside of the symbol outline indicate connections, which are required to be made by those making the installation.

K. The item symbols may be arranged in the manner, which provides the simplest, most diagrammatic form of representation. They may also be arranged to approximate their actual physical relationship with each other.

L. Information notes may be included for clarification and explanation as required.

21.9.3 Requirements for Line-Type Connection Diagram

A. Continuous lines to represent conductors between the terminals of one item and the terminals of another item shall be shown.

B. The lines shall be drawn horizontal or vertical wherever possible and as direct as practical. Double crossovers should be avoided.

C. Wire sizes shall be indicated in terms of American Wire Gage numbers. Insulation and cable composition shall be defined by the drawing note, which may call for the applicable specification When a number of wires are the same size, it is recommended that a general note such as the following be included:

D. ALL WIRES 12AWG (SPECIFICATION NO.) UNLESS OTHERWISE SPECIFIED.

E. Multi-conductor cables shall utilize ICEA/NEMA method 1 (CEA S-19-81 Table 5-2) color coding utilizing colored insulation and contrasting tracers for 127 positive conductor codings. Spare wire shall be indicated

F. Wire colors shall be indicated for wire other than that which is part of cable assembly information included on another drawing or specification. It is preferred that color designations be shown above the line to which they belong. Wire color designations shall be placed at both ends of a connection line unless the connection shown is short, in which case a single indication is sufficient. Wire colors shall be indicated by

showing abbreviations shown below in Table 21-1: Wire Color Abbreviations Shielded wire shall be indicated.

Table 21-1: Wire Color Abbreviations

Abbreviation	Color
BK	Black
W	White (Neutral Conductor Only)
R	Red
G	Green
OR	Orange
BL	Blue
Y	Yellow
BR	Brown

21.9.4 Requirements for Highway Line-Type Connection Diagram

A. The highway line-type connection diagram is the same as the point-to-point line-type diagram with the exception that groups of inter item connecting lines are merged into paths called highways instead of being shown for the entire run as individual lines.

B. From the device or component terminals, short lines or feed line are drawn perpendicular to the cable or highway line. The junction of the feed line with the highway line shall be indicated with an inclined or curved line. The curved or inclined line indicates the run direction in joining the cable or highway line.

C. Crossing of lines shall be avoided. If this is not possible, they should be looped at 90° with respect to each other.

D. Wire data on feed lines shall include wire destinations, color, and wire type.

E. Feed-line destinations may be indicated by specifying function or other designations and terminal number of the component to be connected.

F. Wires which must be segregated for electrical reasons from other wires, or which are otherwise critical, shall be shown separately or run directly from terminal to terminal.

G. More than one cable or highway line may be used to facilitate indication of wire runs or to indicate grouping of particular wires into cable or harness assembles. A drawing note with the aid of a symbol, if necessary, shall identify the highways as being part of the same or different cable assemblies.

H. Wire groupings may be shown as in interrupted line, identified with a symbol, and the destination grouping with the same symbol and letters or numbers.

21.9.5 Requirements for Lineless-Type Connection Diagram

A. Continuous connecting lines between items are omitted. Short spur lines from connectors, terminals, terminal boards, etc., shall be used in conjunction with item and item terminal designations to convey the connection information.

B. Destinations shall be indicated in terms of designators or other nomenclature established on the single-line and schematic diagrams and referred to in or near item symbols on the connection diagram.

C. These designations shall be followed by a dash numbers or letters to indicate to what terminal, connector, pigtail, lead, etc., they are to be connected. If the item description nomenclature is too long, it may be abbreviated.

D. One end of each wire or cable shall specify the wire size and type and be placed, preferably, above one of the spur lines, unless otherwise indicated by note.

E. One end of each wire shall include its color code in the terms specified by Section 1910 3 and be placed above the spur line unless it may be better indicated by note.

F. If the wires for mating between item connections are furnished with items, they shall be labeled PGT (pigtails). In such cases, the wire size and type may be omitted.

21.10 Function Designations

21.10.1 Definitions

Functional designations are words, abbreviations, or meaningful number or letter combinations, usually derived from the function of an item, and used on drawings, equipment, and instructional material to identify items of a complete control system or equipment in terms of function.

21.10.2 General Requirements

Switchgear and control device designations shall be applied as outlined under definitions. In general, on one complete drawing or set of drawings, only one system of designations shall be used. When using functional designations on an individual equipment, supplementary letters or numbers shall have one meaning only and the meaning shall be clearly designated in a device list on the drawing.

21.10.3 Switchgear Designations

Switchgear designations are numbers that describe the functions performed by electric devices in switching circuits used in the generation, transmission, and distribution of electric power. Supplementary letters and numbers are used with the basic designation to permit positive identification of an item.

A device function number, with appropriate suffix letter or letters where necessary, shall be used to identify the function of each device in all types of partial automatic and automatic, and in many types of manual, switchgear. These numbers shall be used on drawings, in publications, and in specifications. In addition, for automatic switchgear, the number shall be placed on or adjacent to each device in the assembled equipment so that the device may be readily identified. Designations shall be in accordance with designations for Electric Power Switchgear Devices and Industrial Control Devices.

21.10.4 Control Device Designations

Control device designations are letters used to identify the function of electric control devices on power utilization equipment. Suitable prefix numbers and letters are added to the basic designation to distinguish between devices performing similar functions.

The assignment of designations to devices on a specific equipment is governed solely by the function or functions performed by each device on a piece of equipment and not by the type or nature of the device or its possible use for other functions in other equipment. Thus, the same type of device may perform different functions in different equipment or even in the same equipment. Therefore, it may be identified by different designations. Designations shall be in accordance with ANSI/IEEE C37.2-1979, Electrical Power System Device Function.

21.11 Symbols for Electrical Drawings

21.11.1 Definition

Electrical/Electronic Symbols for Diagrams are graphical symbols providing coverage for electrical and electronic diagrams. Correlation of symbols with parts lists, descriptions, or instructions may be established by means of reference and functional designations. Symbols shall be in accordance with ANSI Y32.2, Graphical Symbols for Electrical and Electronics Diagrams. Notify DEN of any inconsistency between the DEN Design Standard Symbols and the ANSI Standards.

It should be noted that letter combinations used as part of graphical symbols are not abbreviations. Functional designations shall be assigned in accordance 21.0.8: Functional Designations.

21.11.2 Symbols

Symbols for Electrical Plans are graphical symbols that provide coverage for architectural and electrical layout drawings. Functional electrical and electronic symbols should be used to provide full coverage for these drawings. Symbols shall be in accordance with ANSI Y32.9, Graphic Symbols for Electrical Wiring and Layout Diagrams used in Architecture and Building Construction.

21.11.3 Labels

Labels for panelboards and electrical equipment shall designate the source location (fed from), voltage, and ampacity. The prefixes to be used for panelboard numbers shall be compliant with those designated in the Electrical DSM.

21.12 Electrical Design Submittal Requirements

21.12.1 General

This section addresses the minimum requirements for submittal of Electrical discipline construction or RFP documents during the progress of design. Unless otherwise stated in the consultant's contract or approved task, at a minimum, the consultant shall deliver the following content in the submittal packages to DEN. These requirements are in addition to the requirements detailed in Chapter 32- Submittals of this DSM.

The following are the minimum requirements for each submittal phase. In general, Electrical system designers should focus on large equipment locations and clearances, controls and sequences of operations, and Electrical diagrams in earlier submittals, and work on smaller details such as branch ductwork, selection of smaller equipment, and Electrical details in later submittal packages.

21.12.2 30% Submittal Requirements

The goal of the 30% Electrical submittal is to get agreement on system concepts, the types of systems to be used, space constraints of equipment, control strategies for the new systems and impacts on the existing infrastructure. Load calculations should be complete for adequate equipment selection to provide accurate general equipment selection and dimensional coordination. Phasing of work should be relatively detailed depending on project requirements.

21.12.2.1 General Electrical Notes

Consultant Standard general Electrical notes may be used but must fully comply with all DEN Design Standards and contract requirements.

21.12.2.2 Symbols Legend

DEN Standard symbols shall be used. DEN provides consultants with standard symbols in a Revit family, which shall be used in all contract documents.

21.12.2.3 Demo and Phasing Plans

Provide area of demolition and indicate impacts to systems, tenants and spaces. Indicate how construction will be phased in block floor plans with general narratives of scope in each phase.

21.12.2.4 Site Plan

A preliminary site plan must be provided showing the project location and any associated site work including but not limited to utility transformers and equipment, site lighting, EV charging stations, and security.

21.12.2.5 Floor Plans

Provide floor plans for entire area of construction. Plans shall show general arrangement of Electrical equipment. Room names on every plan showing each area and its purpose. A keymap showing the specific location of the project should be provided.

21.12.2.6 Equipment Placement

The location of equipment such as Electrical switchgear/switchboards, lighting control panels, electrical panels, and HVAC and plumbing equipment should be determined and coordinated with other disciplines. Care should be taken to coordinate with architects, and other disciplines to ensure that required clearances for maintenance and allowances for other systems and Electrical systems are considered. Refer to the Electrical DSM for clearance requirements.

Provide a preliminary single line diagram showing all electrical equipment that is to be added to the project including conduit and wiring between.

21.12.2.7 Electrical Single Line Diagram

Provide a complete single line diagram depicting all new equipment being added to the project.

21.12.2.8 Emergency and Backup Power

Provide preliminary emergency and backup equipment as needed and/or required. Any electrical items that require emergency and/or backup power should be shown on the design drawings. Refer to the Electrical DSM for a complete listing.

21.12.2.9 Grounding

Provide preliminary grounding information including any service grounding if applicable. Ground bar locations should be shown.

21.12.2.10 Power and Telecommunication

Preliminary receptacle layouts must be shown along with any phone/data outlets including any special systems being installed. Security doors should be shown and labeled.

21.12.2.11 Lighting

A preliminary light fixture schedule must be provided along with a preliminary lighting layout for the entire facility being constructed. Switch locations should be shown including any occupancy sensors and/or lighting controls being installed. Preliminary sequence of operations for lighting control devices based on IECC room type requirements to be provided indicating control devices and how room will operate.

21.12.2.12 Load Calculations

A preliminary load calculation must be provided showing a justification for service size and/or how the additional load will impact existing systems.

21.12.2.13 Panel Schedules

Preliminary panel schedules showing anticipated panel ampacities should be shown on the plans. All information such as mounting, ampacity, panel phasing, and voltage should be shown at this stage.

21.12.2.14 Enlarged Plans

Provide general arrangements for new or existing electrical and Telecommunication rooms along with the equipment being installed.

21.12.2.15 Equipment Schedules

Provide schedules for all mechanical and plumbing equipment to be used in the project. Schedules are not required to be completely detailed at this phase, but all ID tags must be populated and be coordinated with other disciplines.

21.12.2.16 Lightning Protection

Review the need for a lighting protection system for the project and/or tie into existing lightning protection systems. Show basic layouts for any required lighting protection equipment.

21.12.2.17 Specifications

Have Technical Specifications TOC at 30% design.

NOTE: Refer to Chapter 32-Submittals for specification requirements.

21.12.3 60% Submittal Requirements

The goal of the 60% Electrical submittal is to get agreement on the progression of design from the previous submittal. The detail levels shall build upon all requirements of the previous design submittal. All comments from the previous submittal shall be addressed and adequately incorporated into this submittal. System concepts, the types of systems to be used, space constraints of equipment, control strategies for the new systems and impacts on the existing infrastructure should be finalized at this phase.

21.12.3.1 General Electrical Notes

Consultant Standard general Electrical notes may be used but must fully comply with all DEN Design Standards and contract requirements.

21.12.3.2 Symbols Legend

DEN Standard symbols shall be used. DEN provides consultants with standard symbols in a Revit family, which shall be used in all contract documents.

21.12.3.3 Demo Plans

Show all existing electrical equipment, systems, lighting, controls, etc. and accessories (supports, enclosures, etc.) to remain including and all equipment, systems, and accessories to be demolished.

21.12.3.4 Site Plan

A site plan must be provided showing the project location and any associated site work including but not limited to utility transformers, site lighting, EV charging stations, and security.

21.12.3.5 Floor Plans

Provide floor plans for entire area of construction. The following shall be shown on floor plans:

A. Room names on every plan showing each area and its purpose.
B. Coordination with Architectural and all other drawings for any items that require electrical power being installed.
C. A keymap showing the specific location of the project should be provided.

21.12.3.6 Electrical Single Line Diagram

Provide a complete single line diagram showing all electrical equipment that is to be added to the project including conduit and wiring between. Voltage drop should be taken into consideration at this point to ensure all wiring is sized correctly. Preliminary fault current calculations should be completed at this point.

21.12.3.7 Emergency and Backup Power

Provide emergency and backup equipment as needed and/or required. Any electrical items that require emergency and/or backup power should be shown on the design drawings. Refer to Electrical DSM for a complete listing.

21.12.3.8 Grounding

Show all major emergency equipment (generators, central battery inverters, etc.) in one-line diagrams and floor plans. Provide preliminary panel schedules for emergency distribution equipment.

21.12.3.9 Power and Telecommunication

All receptacle layouts must be shown along with any phone/data outlets including any special systems being installed. Security doors should be shown and labeled. Preliminary circuiting should be provided on plans for this equipment.

21.12.3.10 Lighting

A light fixture schedule must be provided along with a lighting layout for the entire project. Switch locations should be shown including any occupancy sensors and/or lighting controls being installed. Preliminary circuiting should be provided on plans. Developed sequence of operations for lighting control devices based on IECC room type requirements to be provided indicating control devices and how room will operate.

21.12.3.11 Load Calculations

Load calculations must be provided showing a justification for service size and/or how the additional load will impact existing systems. All major pieces of electrical equipment should have a load calculation provided to justify sizing.

21.12.3.12 Panel Schedules

Panel schedules showing anticipated panel ampacities should be shown on the plans including mounting information.

21.12.3.13 Enlarged Plans

Provide fully detailed floor plans for new or existing electrical and Telecommunication rooms along with the equipment being installed.

21.12.3.14 Equipment Schedules

Provide schedules for all mechanical and plumbing equipment to be used in the project. Schedules are not required to be completely detailed at this phase, but all ID tags must be populated and be coordinated with other disciplines.

21.12.3.15 Lightning Protection

Show layouts for any required lighting protection equipment including tie in into any existing system. If applicable show all lightning rods, down conductors, ground rings including ground rods and provide a lightning protection riser diagram.

21.12.3.16 Specifications

Provide a first draft redline of all specification sections.

21.12.4 90% Submittal Requirements

The goal of the 90% Electrical submittal is to finalize the progression of design from the previous submittal. The detail levels shall build upon all requirements of the previous design submittal and be at a nearly complete phase. All comments from the previous submittals shall be addressed and adequately incorporated into this submittal. All components of Electrical systems shall be in their final form.

21.12.4.1 General Electrical Notes

Consultant Standard general Electrical notes may be used but must fully comply with all DEN Design Standards and contract requirements.

21.12.4.2 Symbols Legend

DEN Standard symbols shall be used. DEN provides consultants with standard symbols in a Revit family, which shall be used in all contract documents.

21.12.4.3 Demo Plans

Show all existing electrical equipment, systems, lighting, controls, etc. and accessories (supports, enclosures, etc.) to remain including and all equipment, systems, and accessories to be demolished.

21.12.4.4 Site Plan

A site plan must be provided showing the project location and any associated site work including but not limited to utility transformers and equipment, site lighting, EV charging stations, and security.

21.12.4.5 Floor Plans

Provide floor plans for entire area of construction. The following shall be shown on floor plans:

A. Room names on every plan showing each area and its purpose.
B. Coordination with Architectural and all other drawings for any items that require the installation of electrical power.
C. A keymap showing the specific location of the of the project.

21.12.4.6 Electrical Single Line Diagram

Provide a complete single line diagram showing all electrical equipment that is to be added to the project including conduit and wiring between equipment. Voltage drop should be taken into consideration at this point to ensure all wiring is sized correctly. Fault current calculations should be completed at this point and shown at each point.

21.12.4.7 Emergency and Backup Power

Show all components of the emergency power distribution system in single-line diagrams and floor plans. Equipment sizing and load calculations must be nearly finalized and shown in the drawings.

21.12.4.8 Power and Telecommunication

All receptacle layouts must be shown along with any phone/data outlets including any special systems being installed. Security doors should be shown and labeled. Circuiting should be provided on plans for this equipment.

21.12.4.9 Lighting

A light fixture schedule must be provided along with a lighting layout for the entire project. Switch locations should be shown including any occupancy sensors and/or lighting controls being installed. Circuiting should be provided on plans. Developed sequence of operations for lighting control devices based on IECC room type requirements to be provided indicating control devices and how room will operate.

21.12.4.10 Load Calculations

Load calculations must be provided at all switchgear/switchboards and panelboards.

21.12.4.11 Panel Schedules

Panel schedules that are completely filled out showing all anticipated circuits and loads should be shown on the plans.

21.12.4.12 Enlarged Plans

Provide fully detailed floor plans for new or existing electrical and Telecommunication rooms along with the equipment being installed.

21.12.4.13 Equipment Schedules

Provide schedules for all mechanical and plumbing equipment to be used in the project. Schedules are not required to be completely detailed at this phase, but all ID tags must be populated and be coordinated with other disciplines.

21.12.4.14 Electrical Diagrams

Electrical Diagrams must be shown for any item that needs detailing on plans.

21.12.4.15 Lightning protection

Show layouts for any required lighting protection equipment including tie in into any existing system. If applicable show all lightning rods, down conductors, ground rings including ground rods and provide a lightning protection riser diagram.

21.12.4.16 Specifications

Provide a redline of all specification sections.

21.12.5 100% Submittal Requirements

The goal of the 100% Electrical submittal is to validate compliance of the previous submittal. The detail levels shall build upon all requirements of the previous design submittal. All details, narratives, and components of Electrical systems shall be complete. All comments from the previous submittals shall be addressed and adequately incorporated into this submittal.

21.12.5.1 General Electrical Notes

Consultant Standard general Electrical notes may be used but must fully comply with all DEN Design Standards and contract requirements.

21.12.5.2 Symbols Legend

DEN Standard symbols shall be used. DEN provides consultants with standard symbols in a Revit family, which shall be used in all contract documents.

21.12.5.3 Demo Plans

Show all existing electrical equipment, systems, lighting, controls, etc. and accessories (supports, enclosures, etc.) to remain including and all equipment, systems, and accessories to be demolished.

21.12.5.4 Site Plan

A site plan must be provided showing the project location and any associated site work including but not limited to utility transformers and equipment, site lighting, EV charging stations, and security.

21.12.5.5 Floor Plans

Provide floor plans for entire area of construction. The following shall be shown on floor plans:

A. Room names on every plan showing each area and its purpose.
B. Coordination with Architectural and all other drawings for any items that require electrical power being installed.
C. A keymap showing the specific location of the project should be provided.

21.12.5.6 Electrical Single Line Diagram

Provide a complete single line diagram showing all electrical equipment that is to be added to the project including conduit and wiring between equipment. Voltage drop should be taken into consideration at this point to ensure all wiring is sized correctly. Fault current calculations should be completed at this point and shown at each point.

21.12.5.7 Emergency and Backup Power

Fully identify all components of the emergency power distribution system in single-line diagrams, floor plans and details as necessary. Provide completed load calculations and selective coordination information as required. Identify all emergency power branch circuit home runs and device connections.

21.12.5.8 Power and Telecommunication

All receptacle layouts must be shown along with any phone/data outlets including any special systems being installed. Security doors should be shown and labeled. Circuiting should be provided on plans for this equipment.

21.12.5.9 Lighting

A complete light fixture schedule must be provided along with a lighting layout for the entire project. Switch locations should be shown including any occupancy sensors and/or lighting controls being installed. Circuiting should be provided on plans. Finalized sequence of operations for lighting control devices based on IECC room type requirements to be provided, indicating control devices and how room will operate.

21.12.5.10 Load Calculations

Load calculations must be provided at all switchgear/switchboards and panelboards.

21.12.5.11 Panel Schedules

Panel schedules that are completely filled out showing all anticipated circuits and loads should be shown on the plans.

21.12.5.12 Enlarged Plans

Provide fully detailed floor plans for new or existing electrical and Telecommunication rooms along with the equipment being installed.

21.12.5.13 Equipment Schedules

Provide schedules for all mechanical and plumbing equipment to be used in the project. Schedules are not required to be completely detailed at this phase, but all ID tags must be populated and be coordinated with other disciplines.

21.12.5.14 Electrical Diagrams

Electrical Diagrams must be shown for any item that needs detailing on plans.

21.12.5.15 Lightning Protection

Show layouts for any required lighting protection equipment including tie in into any existing system. If applicable show all lightning rods, down conductors, ground rings including ground rods and provide a lightning protection riser diagram.

21.12.5.16 Specifications

Provide a redline of all specification sections.

End of Chapter

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Chapter 22 - Communications/Electronic Systems

22.0 Communications/Electronic Systems

22.0.1 General Information and Requirements

This chapter provides engineers and designers performing design work for DEN with systems overviews, configurations, and specific design requirements. Communications and Electronic Systems addressed in this chapter include:

A. Security Card Access System (SCAS)
B. Closed Circuit Television System (CCTV)
C. Fire Alarm System (FAS)
D. Emergency Communication System (ECS)
E. Public Affairs Television System (PATV)
F. Premise Wiring Distribution System (PWCS)
G. Parking/Ground Transportation Revenue Control System (PGTS)
H. Flight and Baggage Information Display System (FIDS/BIDS)
I. Data Acquisition and Control System (DACS)
J. Two-Way Communication System (2-Way)
K. Radio Enhancement Systems (RES)

Refer to the Life Safety DSM for additional information about Life Safety Systems.

22.1 Drawings

22.1.1 Drawings

The communications and electronic systems described in this chapter shall be designed and drawings shall be prepared as applicable, based upon the characteristics and complexity of the projects involved and as determined by each system narrative contained in these DSMs. Drawings shall be provided when essential in planning, procurement, construction, evaluation, recording, and use of the projects. All drawings shall indicate complete design.

22.1.2 Definition

Facility communications and electronic systems drawings are graphic representations of facilities design requirements.

22.1.3 Completeness

Facility communications and electronic systems drawings, when interpreted in association with the construction specifications, shall:

A. Furnish sufficient information to permit installation of manufactured equipment that satisfies the design requirements.
B. Furnish sufficient information to manufacture equipment that is of special design, made exclusively to meet the requirement of the project. Components, assemblies, and systems shall be UL listed.
C. Describe items so that they may be procured.
D. Furnish sufficient information to permit planning, construction, evaluation, recording, repair, and maintenance of facilities.
E. Furnish the above in sufficient completeness for accomplishment without the need of assistance from the consultant.

22.1.4 Drawing Sequence

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project. Refer to DFI DSM.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area

22.1.5 General Notes, Drawing Index, Symbols, and Abbreviations

These sheets shall contain Notes that are applicable (or general) to all sheets in the set of drawings and in addition contain the drawing symbology as required in 22.1.14 Communications and Electronic Systems Symbols. These sheets shall also contain a complete drawing index for the document set.

22.1.6 Site Plan

The site plan shall identify, where applicable, all site facilities required in support of the specified communications and electronic systems including conduits and their interconnection to existing conduits (ductbanks), resources, and cabling systems. In addition, the site plan shall indicate all existing utilities and all communications and electronic systems devices and conduits that are located external to the building and indicate connections (penetrations methods) to internal systems. Where applicable, external devices and equipment e.g., towers, antennas etc., shall be shown including all internal and external connections. Keyed symbology shall be shown which directs the contractor to specific installation, provisioning, and configuration details that shall be included in the detail sheets. All required connections to the grounding system shall be indicated.

22.1.7 Floor Plans/Roof Plans

Plan drawings shall be provided which indicate all communications and electronic systems devices and equipment locations and include conduit interconnection between devices. All device locations shall be coordinated with all disciplines including architectural finishes and features. Keyed symbology shall be shown which directs the contractor to specific installation, provisioning and configuration details which shall be included in the detail sheets.

When more than one system is shown on a plan, each shall be made clearly discernible by system. Conduits indicated on the plans shall either be shown as routed to their specific termination location (Equipment or Terminal cabinet) or be indicated by schedule for termination location. All conduits shall be coordinated with the requirements of the conduit riser diagram. Devices indicated on plans shall be coordinated with the requirements as indicated in point-to-point diagrams.

22.1.8 Equipment Rooms Layouts and Elevations

Coordinated equipment room layouts and wall elevations shall be provided which indicate scaled layout of the equipment room and all Communications and Electronic Systems and facilities co-located within the equipment room. Equipment rooms and layouts shall provide sufficient detail that permit coordinated construction and include the following elements:

A. Interconnection between equipment
B. Conduit terminations
C. Grounding connections
D. Electrical connections and grounding bars
E. Floor mounted and wall hung equipment placement
F. Cable tray configurations
G. All penetration and fire sealant details
H. Clearance zones for servicing equipment
I. Locations and sizing of cooling equipment required

Where new equipment and/or facilities are specified/required for installation in an existing equipment room, layouts shall be provided that coordinate the placement of new equipment with existing equipment. Detail provided shall be as indicated above. New equipment shall be delineated by a different line type from existing equipment so that positive identification between new and existing equipment is assured.

22.1.9 Functional Block Interconnection Diagrams

A block diagram describes the concepts and/or organization of an equipment or facility using rectangular blocks, representing functions or groups of functions. Interconnecting lines establish the relationships between blocks and indicate the direction of information flow. A block diagram is used to give a quick over-all picture of a system and the general interrelationships between components of that system. It may be used for general arrangement studies, functional explanations, systematization of facilities, or for design discussion purposes.

22.1.9.1 Diagrams

A. A block diagram shall be presented in as simple a form as possible. Rectangular blocks shall be used to represent functional electrical systems or parts thereof and/or major elements of an electrical system or circuit. Various other symbols may be used as supplementary information to increase the utility of the diagram.

B. Identifying nomenclature shall be included within the blocks.

C. Block diagrams may be made for any level of project activity. For example, a block diagram at the highest level may be made for a complete project, or any lower-order stage.

D. Related mechanical, electro-mechanical, or optional apparatus may be included on block diagrams in rectangular form.

E. Mechanical connections between such elements shall be illustrated with dashed lines connecting the applicable blocks.

F. If the form of the circuit involves multiple sources and common or similar circuits, or variations thereof, tabulations may be used.

G. If a block diagram must be divided and placed on more than one drawing, the division of the circuit should be made in a logical manner, that will eliminate confusion and at a point of minimum information transfer.

H. When abbreviations or symbols are used on any drawing, provide on that same drawing keynote, abbreviation, and symbol legend.

22.1.9.2 Connecting Lines

A. Lines connecting blocks shall indicate relationships, direction of flow of the system, sequence of operation, etc. The arrangement of lines and blocks shall show action or energy flow in functional sequence from top to bottom and/or left to right of the diagram, starting at the top left or top center, and ending at the bottom right of the diagram.

B. Connection lines shall be labeled, where necessary, to make the meaning clear and unmistakable. When dashed lines are used for more than one purpose on a block diagram, these purposes shall be made clear by label, legend, or note.

C. Connecting lines shall include arrows to further define the circuit flow.

22.1.10 Point-to-Point Wiring Diagrams

Point-to-point wiring diagrams describe the detailed wiring configuration and arrangement of the specific system utilizing lines connected to specific equipment terminals and equipment pieces. Point-to-point wiring diagrams indicate the required system color-coded interconnection details at the component level. Point-to-point wiring diagrams shall be required at the design level only for those electronic and communications systems where interconnection to existing equipment is required. Point-to-point shall be provided only for the specific interface location and configuration. In the cases where new systems are designed and do not require interconnection to existing systems, system concepts and intent shall be conveyed through the functional block diagram, riser

diagrams, floor plans, elevations, and the project specifications. When required, point-to-point wiring diagrams shall contain the following detail.

A. All wiring by type and size required between all system components
B. Indicate wire color coding
C. Indicate terminal strip numbers and positions
D. Indicate current, signal, and data flow

22.1.11 Systems Riser Diagrams

Communications and electronic systems riser diagrams indicate the distribution of major systems components, wiring systems, and their interconnection requirements. Riser diagrams shall always be provided for cabling systems and indicate:

A. Equipment rooms
B. Cable quantities
C. Cable types
D. Termination locations
E. Keyed reference to related details
F. In multi-floor facilities, riser diagrams shall be organized by level

For simpler designs not containing cabling distribution systems specific riser diagram information, (e.g., major component location information may be incorporated into the Functional Block Diagram).

22.1.12 Conduit/Cable Tray Riser Diagrams

Conduit riser diagrams are provided to indicate the configuration, location, quantity, and size of the conduit/cable tray infrastructure required in support of the specified communications or electronic system. In multi-level facilities, conduit riser diagrams shall be organized by level. All conduit riser diagrams shall indicate the following information:

A. Equipment rooms (or conduit termination locations)
B. Conduit quantities
C. Conduit sizes
D. Conduit identification schemes
E. Interfaces to cable trays
F. Grounding and bonding requirements
G. Cable tray systems

Conduits, which are specified or scheduled for installation of fiber optic cables, shall be configured with appropriate bending radii and bend requirements. All conduit and cable tray systems shall be installed in compliance with applicable codes and DEN DSMs. Conduit shall have not more than 270 degrees of bend between pull locations and shall have a minimum of 1" size. Review sizing and bends with Project Manager at Design Development Phase.

Terminal cabinets, equipment backboards, and other conduit termination facilities and locations are considered part of an integrated conduit riser diagram and shall be shown on the conduit riser diagram. Branch conduits installed in support of devices need not be shown on the conduit riser diagram.

The conduit riser diagram shall be coordinated with the system riser diagram, such that cross-reference between systems cables and conduit/tray infrastructure are achievable. All conduit and cable tray systems shall be configured and suitably sized to permit the segregation of cables by conduit/tray segment by signal level as follows:

A. Less than 10V
B. 10V- 70 7V

C. Greater than 70 7 volts
D. Telecommunications cabling (voice and data) cables shall never be mixed with dissimilar resources

22.1.13 Systems Details

Systems details are provided to indicate specific installation techniques and systems configurations. System details shall be provided in support of the design and installation intent indicated on other sheets, and call attention to the specific conditions and requirements necessary to ensure that the installed system configuration is compliant with the design intent and requirements. Details shall be provided for all conditions where specific direction cannot be properly conveyed or is indicated on other sheets.

22.1.14 Communications and Electronic Systems Symbols

Communications and Electronic Systems and electronic symbols, when used, shall be in accordance with ANSI standards, in accordance with 22.1.14 Communications and Electronic Systems Symbols Other symbols, if devised by the consultant, shall be shown in the ITEM column and explained in the DESCRIPTION column of the LEGEND with indication FOR THIS PROJECT ONLY.

22.1.15 Symbols for Other Functional Disciplines

Symbols for functional disciplines other than Communications and Electronic Systems shall be as specified in the respective sub-sections of this manual.

22.1.16 Functional Designations

Functional designations, when used, shall be in accordance with 21.10 Function Designations

22.1.17 Drawing Delineation Types

Communications and Electronic Systems drawings shall generally include the following types of delineations:

A. Block diagrams
B. One-line diagrams
C. Schematic diagrams
D. Connection diagrams
E. Facility communications and electronic systems power requirements plans
F. Facility communications plans and risers
G. Facility grounding plans and risers
H. Facility security plans and risers
I. Facility lightning protection plans
J. Fire alarm plans and risers
K. Emergency Communication plans and risers
L. Two-Way Communication plans and risers
M. Radio Enhancement System plans and risers
N. Panel, circuit, and other schedules
O. Detail drawings

The number of delineation drawings for a project shall be adequate to describe the entire system including existing system and device locations, demolition of systems, reuse of systems or devices, and new work.

22.1.18 Delineation Drawings

Subject to Project Manager acceptance, the drawings for projects need not contain all delineation types. For example, projects consisting only of a single building and a relatively simple communications and electronic systems may not need block diagrams or single-line diagrams if the information normally found in them is effectively conveyed by other delineation types. Each delineation shall be identified by its type below the area where it is displayed, e.g., SCHEMATIC DIAGRAM. These delineations shall not be included on architectural, structural, civil, mechanical, or electrical drawings. If delineation drawings are different from outlined herein, then the Drawing Index shall clearly show combination of delineation.

22.1.19 Specification Relationship

Specifications that are a portion of a contract package shall include communications and electronic systems technical specifications sections. Each communications or electronic system section shall have its own General Requirements section, which is specifically tailored to the requirements of the electronic and communications system requirements. The communications and electronic systems drawings, together with the specifications, shall describe specifically and adequately all the communications and electronic systems design requirements of the project. Vendor information drawings may be included as reference drawings subject to written approval from the manufacturer. Communications and electronic systems drawings that may form a part of a purchase specification drawing may be included as reference drawings. Prior written acceptance is required for any design-build component.

End of Chapter

Chapter 23 - Signage and Graphics Drawings

23.0 Signage and Graphics Drawings

23.0.1 General Design Requirements

Signs shall comply with all federal, state, and local codes and DEN agency requirements.

23.0.1.1 Public Area Signage

Each Project Manager must submit all required project signage to the DEN PM at 30%, 60%, and 95% contract document (drawings and specifications) reviews. Approval of signage is required prior to the completion of construction or procurement documents.

23.0.1.2 Non-Public Area Signage

Non-public area signage is signage viewed only by employees and regulatory officials. This signage shall be submitted to the DEN PM for design, message review, and coordination.

23.0.1.3 Regulatory Signage

Regulatory signage is typically signage that is required by applicable codes and regulatory agencies. Regulatory signage shall be submitted to the DEN PM for design, message review, and coordination prior to fabrication.

Dynamic FIDS, BIDS, and GIDS monitors are addressed in Chapter 22- Communications/Electronic Systems.

23.0.2 Sign Construction

Signs that frequently change must be made of local, readily available materials. All message changes must be streamlined to update changes overnight if necessary. Signs that historically change most frequently at DEN are tenant listings and parking signs.

23.0.3 Flexibility

Frequently updated signs must be easily maintained and not require sole sourced parts. Include spare panels for frequently revised sign faces for DEN Graphic Shop use. Spare panels allow the changes to be made in the shop and changed out in the field. Unique custom signs are not acceptable.

23.1 Drawings

23.1.1 Content

The drawings illustrate and provide all necessary sign information relative to the size, form, location, attachment, and arrangement of the static and dynamic signage components and systems. The following shall be included in the static and dynamic signage and graphics drawings, where applicable. Tracing or copies of manufactured drawings is copyright infringement and is not acceptable.

A. Manufacturer locations of materials, assemblies, products, and accessories
B. Size, thickness, and significant dimensions of all signage elements
C. Gauges, except for prefabricated and assembled units
D. Details of specially fabricated connections
E. Relationship of adjacent dissimilar materials
F. Soil boring or test pit logs including locations for foundations supporting exterior signs
G. Sign location plans shall present all necessary information of all signage system components. Drawings shall indicate, at a minimum, front and back panel designations, sign type, unique sign numbers, and concealed attachment methods.

23.1.2 Static and Dynamic

Signage and graphics drawings are divided into two sections identified as, Static Signage and Dynamic Signage. All static signs are required to have a unique sign number identified on all location plans.

23.1.3 Static Signage Drawings

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

23.1.4 Dynamic Signage Drawings

Construction documents are divided into specific groups per NCS. The group number shall always remain the same no matter how large the project.

A. Numbered sheets for areas for plan views shall remain consistent across disciplines. For example, sheets A2 01, S2 01, M2 01, P2 01, F2 01, E2 01, and T2 01 shall all show work in the same area.

23.1.5 Minimum Requirements

Sign location plans shall present the following minimum information:

A. Unique sign number and sign type symbol
B. Front panel designation
C. Back panel designation
D. Sign type

23.1.6 Sections and Interior Elevations

Sections and interior elevation drawings show typical sign elevations and their relationship, size, mounting dimensions, and location to interior architectural elements.

23.1.7 Details

Detail drawings for both static and dynamic signage showing sign unit elevations, mounting conditions, sizes, graphic layouts, and construction details of each sign and display unit type.

23.1.8 Continuation

Drawings shall indicate, where applicable, any continuation from one drawing to another and where plans and system layouts are continued on another drawing. The location of the drawing on which the continuation appears must be noted at the point of break in the plans.

23.2 Structural Requirements

Structural requirements shall be designed by a licensed Colorado Structural Engineer. The Structural Engineer shall:

A. Confirm existing structure can support anticipated signage loads.
B. Verify imposed loads on signs including seismic, wind, thermal, and impact. For signs designed to be free standing in interior public spaces, the load shall be a minimum of the load required for handrails or guardrails and inclusive of seismic, maintenance, and thermal loads. For exterior sign wind load requirements, refer to current CDOT standards.
C. Design foundations, beam supports, and attachments.
D. Document and verify the design accommodates thermal movement from heat sources.

23.3 Mechanical Requirements

For sign assemblies not provided by the sign manufacturer, include necessary mechanical requirements designed by a licensed Colorado Mechanical Engineer. The Mechanical Engineer shall:

A. Confirm heat loads developed by internal and external lighting.
B. Design ventilation systems both active and passive.
C. Document and verify heat loads contributed to the surrounding space.
D. Design any modifications required by fire protection systems.

23.4 Electrical Requirements

Electrical requirements shall be designed by a licensed Colorado Electrical Engineer. The Electrical Engineer shall:

A. Establish load studies for points of connection for new services.
B. Design raceways, panels, and transformers to support the installation.
C. Design electrical systems within the sign and assure application for UL listing prior to Bid Advertisement.

23.4.1 Building/Structure (Exterior) Numbering

Each building or structure shall have at least one sign located on the exterior structure. Review of the building and site plan must be completed with DFD to confirm location and quantity of the signs. Contact the Project Manager for assignment of the building identifier number.

End of Chapter

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Chapter 24 - Specialty Systems

24.0 Specialty Systems

24.1 Baggage and Material Handling Systems

Design criteria shall be provided by DEN.

24.2 Aircraft Support Systems – Passenger Loading Bridges, PC Air, 400 Hertz

Design criteria shall be provided by DEN. Refer to the Mechanical DSM for PCA requirements.

24.3 People Movers - Trains

Design criteria shall be provided by DEN.

End of Chapter

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Chapter 25 - GIS/CADD Requirements

25.0 GIS/CADD Requirements

As of 2011, all projects are done using Autodesk Revit and Civil 3D.

25.1 Legacy Projects

In some instances, Autodesk Revit and Civil 3D may not be required by the Project Manager. If you have any questions regarding the use of Autodesk Revit and Civil 3D, please contact the Project Manager.

End of Chapter

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Chapter 26 - Surveys

26.0 Surveys

26.0.1 General

This chapter covers the procedures and accuracy requirements for survey services for layout of work and field measurement related to design surveys. Prior to beginning any field survey work, the consultant must meet with the DEN Survey Office to coordinate survey and reporting requirements.

26.0.2 Notice of Survey

Before commencing any field surveys on DEN property, the Consultant must request a pre-survey preparation activity meeting. This meeting is to be arranged through the DEN Project Manager with the attendance of the Consultant and the DEN Survey Section. The Consultant is responsible for obtaining DEN related survey guidance, access to DEN survey network, Primary Control, projection parameters, and training materials from the DEN Survey at the pre-survey meeting and/or prior to beginning any survey work.

Access to the DEN survey network can be requested at in the link below. Under the [Home] menu click on [Register] and follow instructions. Approval will be granted by DEN Survey to Consultants, Contractors or Sub-Contractors with a current contract at DEN.

Tenant Information

26.1 Field Measurements

Field measurements will be performed by the Consultant to verify existing conditions unless this activity is specifically excluded from the contracted scope of work (SOW).

26.1.1 Field Verification of Horizontal Work

Existing Conditions measurement for items that will be hidden or visible including all civil, mechanical, electrical, control work, and all utilities that are placed in concrete, earth, or behind walls must be made by and under the direction of a Colorado licensed Surveyor while the work is exposed, and the measurements submitted to the DEN Project Manager. The Licensed Surveyor must also hold a current FAA IDLE certification. Unless noted otherwise, the measurements must show the final location within tolerance of current requirements, written in design contract. Items located within five feet a building must be referenced to building column lines and finish floor elevations. Special attention must be paid to items requiring service, sensors, and items with moving parts, access points, and locations of junctions, elevation changes, and directional changes. Survey notes must be supplied to the DEN Project Manager prior to covering up the work. Survey notes must be supplied to DEN Survey in an electronic format that can be read in the current approved version of AutoCAD Civil 3D.

Existing Conditions surveys are required to conform to DFI DSM for data collection. Failure to provide acceptable layers, feature collection, attribution, and metadata will render the survey defective. As-built surveys encompassing the entire project scope must be supplied upon completion of construction to the Project Manager prior to project close out. Acceptable formats as established in DFI DSM If a design survey project alters any natural (including topography) or fabricated feature that was not specifically addressed in the project SOW, the designer is responsible for collecting the change in the features affected by the project and supplying those affected features in the final existing conditions survey.

A. Existing Conditions survey data files, DEN GIS File Geodatabase, or Building Information Models (DFI) submitted to the DEN Project Manager will be sent to the DEN for quality assurance. Submitted files will be reviewed for compliance to the DSM including but not limited to:

a. Spatial conformance with DEN Coordinate System
b. DEN File Geodatabase Layer, attribute, metadata conformance with DEN DFI DSM.
c. Completeness of the project Existing Conditions DFI models as required in the contract

The Consultant is responsible to supply Existing Conditions DFI models, geo-tagged photographs (JPG, TIFF), raw point clouds, TIN models, DEM data, point files, and survey field notes to the Project Manager when the consultant is ready to supply the project documentation.

B. Should the submitted drawing or model fail a quality control check, the Consultant is responsible for correcting the survey in compliance with DEN standards.

DEN Survey has the right to enter any surveying site, at any time, and request from the design surveyor any:

a. Survey field notes
b. Airport survey control points used
c. Survey measurement files used in data collection
d. Inspect survey equipment used by design surveyor

The DEN Survey Office may also check site survey work with their survey instruments to ensure survey work is within tolerance requirements. Any problems found by the DEN Survey Office during site inspections will be reported to the DEN Project Manager.

26.2 Site Work Design Surveys

DEN Survey will provide information at a Pre-Survey meeting with Consultant, and their Surveyor, for location of DEN Primary Control points on DEN Property. The Consultant must accurately transfer the survey control information to the points of application to ensure that all elements of the work are correctly located. The Consultant should verify that all Geodetic information in predesign plans is correct, by consulting with DEN Survey.

If Consultant disturbs a survey control point, after being made aware of its location, they will be responsible for reestablishment of said point. If the Consultant is aware that a survey control point is to be destroyed, they must contact the DEN Project Manager and DEN Survey no less than 48 hours prior to the point's destruction.

Design survey work must not begin until; Consultants survey control work is reviewed by DEN Survey and approved by the DEN Project Manager in writing.

Should the original reference points that DEN provided be obliterated or dislodged by operations that the consultant controls, the consultant will be responsible for replacement and all costs associated with replacement. The cost of the re-surveys to replace obliterated or dislodged monuments will be paid for by consultant.

26.2.1 Survey Deliverables

26.2.1.1 Survey Statement of Work (SSOW)

The Consultant must develop a complete SSOW and submit it to the DEN Project Manager. The SSOW is the Consultant's written description of the methodology and items to be surveyed that will be provided by the Consultant's Surveyor as part of the Project.

A. SSOW must be submitted and approved within ten (10) days of the Notice to Proceed (NTP) and prior to commencement of any survey or layout work on the site.
B. The SSOW must be reviewed and stamped by a Professional Land Surveyor (PLS), licensed in the State of Colorado.
C. The SSOW will be reviewed by DEN Survey and approved by the DEN Project Manager. Under no circumstances will work begin until the SSOW has been approved.

26.2.1.2 Survey and Quality Control Plan

The Consultant must develop a complete Survey and Quality Control Plan (SQCP) and submit it to the DEN Project Manager. The SQCP is the Design Surveyor's written description detailing the Consultant's methodologies for data collection, data safeguarding and quality assurance. Provide insight on how the Consultant will completely check all data to ensure it is complete, reliable, and accurate. Identify data safeguards used to protect this sensitive and safety critical data. Utilize a checklist-based quality control process with definable and repeatable standards for each element ensuring consistency of work between different personnel within an organization. Submit the plan in a non-editable PDF.

A. The SQCP:
    a. Must be submitted within ten (10) days of the NTP and prior to commencement of any survey or layout work on the site.
    b. Must be reviewed and stamped by a PLS, licensed in the State of Colorado.
    c. Will be reviewed by DEN Survey and approved by the DEN Project Manager. Under no circumstances will work begin until the SQCP has been approved.
B. Before any hardscape surveying can begin, the Consultant must deliver all survey data related the establishment of the temporary control points.
    a. Raw files: GPS static files, Level files and post-process files that are compatible with Trimble Business Center.
    b. When Consultant provides an Excel file that has combined x, y from post-processing and z from Levels, provide field notes and data that shows where this data came from to verify values. The GPS point numbers or description must match to the Level descriptions.
C. Existing conditions or as-constructed survey submittals will need to be in both PDF and in AutoCAD Civil 3D.
    a. All copies of original pages of field notes or electronic field notes must be in Portable Document Format (PDF).
    b. Scanned copies of all original field notebooks used for this Project must be submitted at the end of Contract.
D. All existing conditions point files must be in CSV format including (at a minimum) Point, Northing, Easting, Elevation, and Description (PNEZD).
E. All CAD drawings must be in current approved Autodesk Civil 3D format.
F. CAD layers are specified in DEN DFI DSM.
G. DEN will provide the Autodesk Civil 3D drawing template.
H. The existing conditions survey must follow the Minimum Standard Detail Requirements for ALTA/ NSPS Land Title Survey (attached) for all sections, in so far as they are applicable to the scope of work for the project and site in question
I. Documentation in accordance with 26.6 Optional Survey Responsibilities and Specifications is filled out with the required content to be submitted.
J. Hard copy of all documentation stamped by licensed Colorado PLS responsible for the work.

26.2.2 Site Work Design Survey Requirements

A. A Site Work Design Survey or Existing Conditions survey providing horizontal location and level information of surface features and both above and below ground services and utilities must be completed. This should also be annotated with information (where applicable) relating to the size, direction of and material type.
B. When collecting utilities, Consultant will be responsible to have all exposed and installed utilities located prior to being covered. If Consultant fails to locate utilities, DEN Project Manager can have the Consultant uncover the utilities, so they can be located.
C. Any temporary works that remain at the completion of the Project should also be surveyed.
D. FAA and DEN Survey Feature Code Library will be provided by The DEN Project Manager via DEN Survey or Designee and will be used throughout the project by Consultant for as surveyed features.

E. The most current DEN Civil 3D template will be provided by The DEN Project Manager via the DEN DFI team. The DFI team will provide a template for Sewer, Storm, IWS, Power and water. Additional fields will also be filled out on other survey points as required according to the provided DEN Civil 3D template.

26.3 Survey Control Points

26.3.1 Survey Control Points

A. DEN has created its own local coordinate system and is using their own Global Positioning System (GPS) Network that is tied to the National Spatial Reference System (NSRS). DEN Survey will provide the data required to use this coordinate system and access to the DEN GPS Network during the mandatory pre-survey preparation activities meeting. DEN Survey will also provide coordinates for all Primary Control Points based upon the location of the Project.

B. The coordinates of the Primary Airport Control Station (PACS) and Secondary Airport Control Station (SACS) were correct at the time of installation (or subsequent date listed on the plan) but may be subject to the effects of subsequent subsidence and/ or disturbance. DEN has established horizontal values on fifteen (15) Control Points that will now be used to validate control used in all DEN projects. In addition, any marks that have been or will be destroyed either before or during Works should be noted and mentioned in the Survey Statement of Work and the Survey and Quality Control Plan. If removed or destroyed, the Consultant will create a plan to replace these control points.

C. Project control points must be established by performing measurements with a digital level from at least two NGS vertical stations. The benchmarks used to establish ties to the North American Vertical Datum of 1988 (NAVD 1988) must be shown in the Consultant's notes and on the design Survey Control Plan (SCP).

D. The Consultant may be provided NGS datasheets for the nearest NGS Vertical Stations from the DEN Survey Section if requested. If the nearest NGS Vertical Station is a considerable distance from the site, the Consultant may establish Temporary Survey Control Points (TSCPs) near the site. Appropriate survey procedures must be used to establish any additional TSCP. If TSCPs are installed, a minimum of 3 TSCPs must be established for the project. Each must be visible and tied to at two (2) NGS Vertical Stations. It is the Consultant's responsibility to verify the stability of the TSCPs over the life of the design project. Where unacceptable discrepancies in TSCPs due to land settlement, disturbance, or from other factors, are apparent, the Consultant must refer the matter to DEN Project Manager for resolution prior to the continuation of Work.

E. Horizontal Control is based on a local coordinate system. The Consultant must establish reliable horizontal control that will last the duration of the design project. Where unacceptable discrepancies in control marks due to land settlement, disturbance or from other factors are apparent, the Consultant must refer the matter to DEN Project Manager for resolution prior to the commencement of Work. The horizontal control establishing ties to the datum must be shown in the Consultant's notes and on the SCD (Survey Control Diagram).

F. DEN requires that all Consultants perform and provide the results of a Geodetic Validation Survey.

G. The DEN GPS Network was created to monitor the fifteen (15) Primary Control Points and set TSCP. The DEN GPS Network is tied to the NSRS. Since the introduction of the DEN GPS Network, DEN has a new method for Consultants to validate Primary Control Points and set TSCP for DEN Projects. The vertical component of the TSCP will still follow the requirements for vertical control by using at least two (2) separate NGS Vertical Stations.

    a. The Consultant must recover at least two (2) Primary Control Points for the validation of the DEN GPS Network.

    b. After recovering the identified Primary Control Points, the procedure to validate the Primary Control Points are as follows:

        1. Using the fast-static method, collect data on each control points for a duration of at least fifteen (15) minutes with a one (1)-second collection interval. Once all observations are collected, process the observation files together with the observation files from DEN's six (6) Base Stations. These base stations make up the DEN GPS Network.

2. The distances between Primary Control Point values provided by DEN Survey and the values the Consultant measures must not exceed 0.07 of a foot. If the tolerances are not met the data must be recollected.
3. Provide the results and comparisons as part of the observational data in a report to the DEN Project Manager to be reviewed and approved by DEN Survey prior to the start of the design survey and include this approved report in the final report.

H. The following are limitations and additional information on NGS Control Stations and NGS Benchmarks:
   a. The use of control monuments and projection parameters for design surveys not furnished by or approved by DEN Survey is STRICTLY PROHIBITED. Use of other monuments is solely at the risk of the Consultants.
   b. DEN Survey will provide the Consultants with the projection parameters and any assistance in implementing the coordinate system and access to the DEN GPS Network. It is up to the Consultant to use the correct methodology in performing any survey task which must be submitted to the DEN Project Manager and reviewed during the pre-survey preparation activities meeting.
   c. The DEN Project Manager will need all pertinent data from the Consultant to check and verify that the Consultant implemented the coordinate system and post-processing correctly.

I. Reporting Damage or Errors of NGS Control Stations:
   a. Report damaged or destroyed airport control points, benchmarks, and section corner monuments promptly to the DEN Project Manager.
      1. If section corner monuments are damaged or destroyed during construction activities, such points must be re-established pursuant to Laws of the State of Colorado Regulating the Practice of Land Surveying by a current Registered Professional Land Surveyor in the State of Colorado.
   b. If NGS control stations or NGS benchmarks will be damaged, moved, altered or destroyed by a Contractor, the Consultant will note DEN's cost of reestablishing such points will be borne by the Contractor.
      1. The Consultant will note in Plans that DEN will not be responsible for any increased costs or delays to the Contractor relating to reference points, airport control points, or benchmarks which are damaged, moved, altered or destroyed by the Contractor or its, suppliers, agents or employees or other Contractors working on the site.

J. Report alleged errors in NGS control stations or NGS benchmarks promptly to the DEN Project Manager.
   a. Discontinue use of NGS control stations or NGS benchmarks alleged to be in error until the accuracy of points can be verified or as directed.
   b. Claims for extra compensation for alteration or reconstruction allegedly due to errors in NGS control stations or NGS benchmarks will not be allowed unless original NGS control stations and NGS benchmarks still exist or substantiating evidence proving error is furnished by the Consultant, and unless the Consultant has reported such errors to the DEN Project Manager as specified herein.

K. All deliverables sent to DEN Survey through the DEN Project Manager, by the Consultant pertaining to Survey issues, must be reviewed and stamped by a PLS, licensed in the State of Colorado.

26.3.2 Temporary Survey Control Point Establishment

A. The Consultant must set a minimum of either ‘chiseled X’ in concrete; a drill hole with lead and tack in concrete; a PK nail with shiner in asphalt or concrete or a 5/8" rebar with plastic cap in natural ground. An ‘Inked X’ set as a control point is UNACCEPTABLE.

B. When a Consultant establishes TSCP for DEN survey work the Consultant must follow CDOT tolerance guidelines. All TSCP must be referenced to the NSRS using the DEN GPS Network provided by DEN Survey. Temporary control may be necessary based on project site location. Below are the acceptable means to establish temporary geodetic control for DEN design projects:
   a. On DEN projects, the Consultant, may use TSCPs on their project site if they are collecting hardscape surfaces. These TSCP must be referenced to the nearest two (2) DEN primary control points and MUST BE referenced vertically to two (2) different NGS benchmarks. Also, all Consultant MUST

obtain permission to establish TSCPs on DEN property by means of communicating with DEN Survey.

b. Using the fast-static method, collect data on each control points for a duration of at least fifteen (15) minutes with a one (1)-second collection interval. Once all observations are collected, process the observation files together with the observation files from DEN's six (6) Base Stations. These base stations make up the DEN GPS Network.
c. All vertical control MUST BE established only by a digital level unless otherwise authorized by DEN Survey.
d. Minimum Design Horizontal and Vertical Accuracy Tolerance:
    1. Horizontal tolerances must meet CDOT tolerance for secondary control points.
    2. NGS vertical station values will be held unless the Consultant has determined that there is an issue with one of the values. If this is the case, the Consultant must notify the DEN Project Manager to determine which other NGS vertical stations can be used.
    3. Vertical tolerances for all secondary control must meet the following requirement:

•The square root of the total horizontal distance of the level loop in miles multiplied by 0.035 feet.
•The results of this evaluation must be recorded in the field book for each level loop. At least two (2) established NGS benchmarks on the same datum must be used to validate that the starting mark has not been disturbed.

e. Whether establishing TSCPs or not, the Consultant must set up a pre-survey preparation activity meeting with the DEN Project Manager to discuss Geodetic Control Validation, obtain pertinent survey data, access to the DEN GPS Network and projection parameters before the commencement of any survey work.
f. If TSCPs are needed, the Consultant must set and collect temporary control as outlined above. The results must be reviewed and approved by the DEN Project Manager, allowing at least seventy-two (72) hours to review and either approve or reject the temporary control. All TSCPs MUST BE approved before any survey work can commence.

26.3.3 Protection

Protect and preserve survey control points and section corners.

26.3.4 Damaged or Destroyed Survey Control Points and Section Corners

Report damaged or destroyed survey control points and section corners to the Project Manager and the Airport Survey Manager.

A. If any Public Land Survey System (PLSS) section corner monuments are damaged or destroyed during surveying activities, such points must be re-established pursuant to Laws of the State of Colorado Regulating the Practice of Land Surveying by a Professional Land Surveyor licensed in the State of Colorado. This work is to be reviewed by DEN Survey.
B. If survey control points are damaged, moved, altered, or destroyed by the consultant, the consultant will be responsible for all replacement costs.
C. DEN will not be responsible for any increased costs or delays to the consultant relating to reference points, survey control points which are damaged, moved, altered, or destroyed by the consultant or its subcontractors, suppliers, agents or employees or other contractors working on the site.

26.4 Design Surveys

26.4.1 Design Surveys

A. DEN will provide surveys and layouts, as necessary, to delineate the area to be surveyed. As a part of such surveys, the Consultant must furnish, establish, and maintain in good order TSCPs that may be required for the completion of the survey subject to the approval of the DEN Project Manager as to their location, sufficiency, and adequacy. However, such approval by the DEN Project Manager must not relieve the Consultant of responsibility for the accuracy of the Consultant's survey work.

B. The DEN Project Manager must have the right to check surveys provided by the Consultant. The Consultant must deliver the final survey, in AutoCAD Civil 3D format, to the DEN Project Manager for Quality Assurance (QA) review.

C. The DEN Project Manager may draw the Consultants attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions must not give the Consultant any right or claim nor must in any way relieve the Consultant of their obligations according to the terms of the Consultant's contract.

D. The Consultant's instruments and other survey equipment must have current certification from the manufacturer's representative.

E. Surveys must be performed under the direct supervision of a current Colorado Professional Land Surveyor.

F. The Consultant must be responsible for any lines, grades, or measurements that do not comply with specified or proper tolerances, or which are otherwise defective, and for any resultant defects in the work. The Consultant will be required to conduct re-surveys or check surveys to correct errors, found by DEN Survey review of Electronic data files.

26.4.2 Field Notes

A. The Consultant must collect survey data using electronic methods, for any submitted survey design work. Electronic data files must be sent to the DEN Project Manager.

B. All editing of computer records will be done on a copy of the original with all changes initialed. Electronic data from data collectors must be provided in a format in accordance with DFI DSM. These will be used to supplement field notes and will be supplied to the DEN Project Manager on digital media. The same method of data collection used by the Consultant at the beginning of the contract must be used throughout the contract duration.

C. If the DEN Project Manager finds errors in the field notes, DEN will have the consultant correct and resubmit the notes. This review does not relieve the Consultant from the responsibility of maintaining accurate survey data.

26.5 Surveying Accuracies and Tolerances in Design Surveys

Refer to the CDOT Survey Manual for acceptable tolerances.

The Consultant must be responsible for any lines, grades, or measurements that do not comply with specified or proper tolerances, or which are otherwise defective, and for any resultant defects in the work. The Consultant will be required to conduct re-surveys or check surveys to correct errors, found by DEN Survey review of Electronic data files.

26.6 Optional Survey Responsibilities and Specifications

Figure 26-1: Optional Survey Responsibilities and Specifications

6.2 ALTA Table A

American Land Title Association® (ALTA®)
National Society of Professional Surveyors (NSPS)

Minimum Standard Detail Requirements
For ALTA/NSPS Land Title Surveys

TABLE A

OPTIONAL SURVEY RESPONSIBILITIES AND SPECIFICATIONS

NOTE: The twenty (20) items of Table A may be negotiated between the surveyor and client. Any additional items negotiated between the surveyor and client shall be identified as 21(a), 21(b), etc. and explained pursuant to Section 6.D.ii.(g). Notwithstanding Table A Items 5 and 11, if an engineering design survey is desired as part of an ALTA/NSPS Land Title Survey, such services should be negotiated under Table A, Item 21.

If checked, the following optional items are to be included in the ALTA/NSPS LAND TITLE SURVEY, except as otherwise qualified (see note above):

1. ☑ *Monuments placed (or a reference monument or witness to the corner) at all major corners of the boundary of the property, unless already marked or referenced by existing monuments or witnesses in close proximity to the corner.*
2. ☑ *Address(es) of the surveyed property if disclosed in documents provided to or obtained by the surveyor, or observed while conducting the fieldwork.*
3. ☑ *Flood zone classification (with proper annotation based on federal Flood Insurance Rate Maps or the state or local equivalent) depicted by scaled map location and graphic plotting only.*
4. ☑ *Gross land area (and other areas if specified by the client).*
5. ☑ *Vertical relief with the source of information (e.g., ground survey, aerial map), contour interval, datum, and originating benchmark identified.*
6. ☐ *(a) If set forth in a zoning report or letter provided to the surveyor by the client, list the current zoning classification, setback requirements, the height and floor space area restrictions, and parking requirements. Identify the date and source of the report or letter.*

   ☐ *(b) If the zoning setback requirements are set forth in a zoning report or letter provided to the surveyor by the client, and if those requirements do not require an interpretation by the surveyor, graphically depict the building setback requirements. Identify the date and source of the report or letter.*
7. ☑ *(a) Exterior dimensions of all buildings at ground level.*

   (b) Square footage of:

   ☑ *(1) exterior footprint of all buildings at ground level.*

   ☑ *(2) other areas as specified by the client.*

   ☑ *(c) Measured height of all buildings above grade at a location specified by the client. If no location is specified, the point of measurement shall be identified.*

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8. ☑ *Substantial features observed in the process of conducting the fieldwork (in addition to the improvements and features required pursuant to Section 5 above) (e.g., parking lots, billboards, signs, swimming pools, landscaped areas, substantial areas of refuse).*

9. ☑ *Number and type (e.g., disabled, motorcycle, regular and other marked specialized types) of clearly identifiable parking spaces on surface parking areas, lots and in parking structures. Striping of clearly identifiable parking spaces on surface parking areas and lots.*

10. ☐ *(a) As designated by the client, a determination of the relationship and location of certain division or party walls with respect to adjoining properties (client to obtain necessary permissions).*

☐ *(b) As designated by the client, a determination of whether certain walls are plumb (client to obtain necessary permissions).*

11. ☑ *Location of utilities existing on or serving the surveyed property as determined by:*
- *observed evidence collected pursuant to Section 5.E.iv.*
- *evidence from plans requested by the surveyor and obtained from utility companies, or provided by client (with reference as to the sources of information), and*
- *markings requested by the surveyor pursuant to an 811 utility locate or similar request*

Representative examples of such utilities include, but are not limited to:
- *Manholes, catch basins, valve vaults and other surface indications of subterranean uses;*
- *Wires and cables (including their function, if readily identifiable) crossing the surveyed property, and all poles on or within ten feet of the surveyed property. Without expressing a legal opinion as to the ownership or nature of the potential encroachment, the dimensions of all encroaching utility pole crossmembers or overhangs; and*
- *Utility company installations on the surveyed property.*

Note to the client, insurer, and lender - With regard to Table A, item 11, source information from plans and markings will be combined with observed evidence of utilities pursuant to Section 5.E.iv. to develop a view of the underground utilities. However, lacking excavation, the exact location of underground features cannot be accurately, completely, and reliably depicted. In addition, in some jurisdictions, 811 or other similar utility locate requests from surveyors may be ignored or result in an incomplete response, in which case the surveyor shall note on the plat or map how this affected the surveyor's assessment of the location of the utilities. Where additional or more detailed information is required, the client is advised that excavation and/or a private utility locate request may be necessary.

12. ☐ *As specified by the client, Governmental Agency survey-related requirements (e.g., HUD surveys, surveys for leases on Bureau of Land Management managed lands).*

13. ☑ *Names of adjoining owners according to current tax records. If more than one owner, identify the first owner's name listed in the tax records followed by "et al."*

14. ☐ *As specified by the client, distance to the nearest intersecting street.*

15. ☑ *Rectified orthophotography, photogrammetric mapping, remote sensing, airborne/mobile laser scanning and other similar products, tools or technologies as the basis for the showing the location of certain features (excluding boundaries) where ground measurements are not otherwise necessary to locate those features to an appropriate and acceptable accuracy relative to a nearby boundary. The surveyor shall (a) discuss the ramifications of such methodologies (e.g., the potential precision and completeness of the data gathered thereby) with the insurer, lender, and client prior to the performance of the survey, and (b) place a note on the face of the survey explaining the source, date, precision, and other relevant qualifications of any such data.*

16. ☑ *Evidence of recent earth moving work, building construction, or building additions observed in the process of conducting the fieldwork.*

17. ☑ *Proposed changes in street right of way lines, if such information is made available to the surveyor by the controlling jurisdiction. Evidence of recent street or sidewalk construction or repairs observed in the process of conducting the fieldwork.*

18. ☑ *If there has been a field delineation of wetlands conducted by a qualified specialist hired by the client, the surveyor shall locate any delineation markers observed in the process of conducting the fieldwork and show them on the face of the plat or map. If no markers were observed, the surveyor shall so state.*

19. ☑ *Include any plottable offsite (i.e., appurtenant) easements or servitudes disclosed in documents provided to or obtained by the surveyor as a part of the survey pursuant to Sections 5 and 6 (and applicable selected Table A items) (client to obtain necessary permissions).*

20. ☐ *Professional Liability Insurance policy obtained by the surveyor in the minimum amount of $_____ to be in effect throughout the contract term. Certificate of Insurance to be furnished upon request, but this item shall not be addressed on the face of the plat or map.*

21. ☑ FAA IDLE survey data requirements submission.

Adopted by the Board of Governors, American Land Title Association, on October 8, 2015.
American Land Title Association, 1800 M St., N.W., Suite 300S, Washington, D.C. 20036-5828.
www.alta.org

Adopted by the Board of Directors, National Society of Professional Surveyors, on October 9, 2015.
National Society of Professional Surveyors, Inc., 5119 Pegasus Court, Suite Q, Frederick, MD 21704.
http://www.nsps.us.com/

NSPS

AMERICAN LAND TITLE ASSOCIATION

End of Chapter

Chapter 27 - Testing Agency Reports

27.0 Testing Agency Reports

27.0.1 Testing Requirements

Unless specifically excluded in the consultant's contract, the consultant shall provide testing services and analysis in the locations and quantities to satisfy data and analysis information required so the consultant can provide a complete and accurate design.

These surveys and testing programs shall include but not be limited to all soils tests and any other investigations of surface or subsurface conditions, which would be required to design the projects. The scope of such surveys, tests, and investigations shall be submitted to DEN for its review and acceptance before the surveys or investigations are commenced. The scope shall include consultant's consideration of information, which DEN has provided such as topographic maps, site preparations drawings, and the results of available soils investigations. All surveys shall conform to the DEN LDP Coordinate System established by DEN and shall be coordinated with the DEN Survey Office. The consultant shall perform any and all surveys and soils investigations required by any governmental agencies, regulatory bodies, and authorities having jurisdiction before they will issue construction acceptances for any project. The consultant shall be solely responsible for contact and coordination with all utility companies for establishment of utility locations prior to site investigations.

27.0.2 Testing Agency

Laboratory and field-testing will be conducted by an independent testing laboratory retained by the consultant. DEN may request additional testing beyond the minimum requirements of the contract documents.

27.1 Testing Agency

27.1.1 General

The consultant shall employ the services of an independent testing agency. Prior to performing any tests, the consultant shall submit the following information to DEN:

A. Evidence of license to operate as a commercial testing laboratory.
B. Evidence that the laboratory has been inspected by AASHTO Materials Reference Library (AMRL) or Cement and Concrete Reference Library (CCRL) within the last three years.
C. Copies of the AMRL or CCRL inspections along with documentation showing correction of deficiencies (if any).
D. AMRL or CCRL reference sample program test results from the previous two (2) years.
E. Affidavit of compliance with applicable national certification and/or accreditation program stating that the laboratory performing the work is qualified to perform the tests and work in accordance with the technical requirements required by the contract specifications.
F. Name, registration number, and engineering discipline of the Registered Professional Engineer (Colorado) in charge of the laboratory. The engineer shall be a full-time employee of the laboratory and have a minimum of five (5) years of experience in construction materials testing.
G. Evidence that the laboratory and field technicians are qualified for performing the work Qualifications can be demonstrated through certification by LEED, National Institute for Certification in Engineering Technologies (NICET), American Concrete Institute (ACI), National Ready-Mixed Concrete Association (NRMCA), Portland Cement Association (PCA), American Welding Society (AWS), American Society of Nondestructive Testing (ASNT), or a degree in a related engineering field with construction field experience.
H. A list of testing equipment proposed for each test procedure.

I. A copy of the certification and latest calibration data for all laboratory and field equipment to be used for this project verifying their conformance to national standards.

J. Estimated number of each type of test.

27.1.2 Control of Measuring and Test Equipment

The testing laboratory shall select the measuring and test equipment in such a manner as to provide proper type, range, accuracy, calibration, and tolerance for determining compliance with specified requirements. Measuring and test devices shall be calibrated, adjusted, and maintained at prescribed intervals prior to use, based upon equipment stability and other conditions affecting measurement. Provisions shall be made for the proper handling and storage of equipment. Calibration shall be accomplished using certified standards that have a known traceable relationship to the National Institute of Standards and Technology. Every calibrated measuring and test device shall show the current status, date of last calibration, and the due date for the next calibration. Calibration records shall be maintained as quality records and shall be made available for inspection upon request of the Project Manager.

27.1.3 Surveillance of Inspections

When the laws, ordinances, rules, regulations, or orders of any public agency having jurisdiction require DEN's surveillance of inspections or tests, the consultant shall notify DEN of the place, date, and time forty-eight (48) hours prior to the inspection/test operation.

27.1.4 Retain Tested Materials and Data

The consultant shall be responsible for maintaining tested materials and testing data until Final Completion of the project or construction contract, or at such time as DEN notifies the consultant in writing. Tests and tested materials shall be available at time of Bid and during the Bidding process for review by proposers.

27.2 Soils Testing Precautions

27.2.1 General

A Colorado Licensed Surveyor shall layout and locate all test pit locations for soils tests. Thirty (30) days prior to beginning soils testing, a geometry study showing vertical clearance and lighting requirements must be submitted to DEN Planning, DEN Operations, and the DEN Project Manager for review. Refer to Chapter 28- Planning Study for additional information required for assessment of any Operational interference.

27.2.2 Protection of Property and Work in Progress

The consultant shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to prevent damage, injury, or loss to the following:

A. Property at the worksite or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement during construction.

B. The consultant shall give all notices and comply with all applicable laws, ordinances, rules, regulations, and lawful orders of any public authority bearing on the safety of property or its protection from damage, injury, or loss and further, shall cooperate and keep DEN and other contractors informed of all the consultant's precautions for the protection of the work.

C. If any of the consultant's operations destroy or damage any real or personal property, public or private, the consultant shall promptly repair or replace such property before DEN will accept the work performed under this contract. This paragraph applies unless written release is provided by Airport Legal Services.

27.2.3 Protection of Municipal and Public Service System

Before any work is started, the consultant shall communicate with all governmental agencies and private entities that have jurisdiction over municipal or other public service systems that might be affected by the work. After work is begun, the consultant shall perform in a manner designed to reduce to a minimum the potential for disrupting

the operations of municipal and other service systems. In particular, when a municipal or other public service system can be affected by work done by the consultant, the consultant is required to contact the agency responsible for operation of that system for instructions on how best to proceed.

27.2.4 Protection of Drainage Ways

The consultant shall be responsible for the preservation and protection of storm water collection systems and drainage ways, which may be affected by the consultant's work. This municipal service system is operated by the Wastewater Management Division, and the consultant is required to notify the Director of the Wastewater Management Division and City when the work may diminish the system's capabilities or may redirect water flows. This notification process does not relieve the consultant of the responsibility for damage to persons and property, which may result from changes to that system caused by the consultant's operations.

27.2.5 Protection of the Environment

The consultant shall comply with the following:

A. The consultant shall comply with all applicable federal, state, and local environmental protection rules, laws, and regulations and accept responsibility for compliance with all environmental quality standards, limitations, and permit requirements promulgated there under, including but not limited to DEN's noise control (NC) ordinance, federal and state air quality standards for fugitive dust control, prevention of surface and groundwater contamination, and hazardous and other waste disposal practices and procedures

B. If DEN, as owner, is determined by any federal, state, or local government agency, department, board, or commission, or in any judicial proceeding to have violated any such environmental protection rules, laws, or regulations because of the consultant's acts or omissions, the consultant agrees to indemnify and hold harmless DEN from any and all prosecutions, payment of any and all fines or penalties, and the cost of abatement and remediation

27.2.6 Hazardous and Explosive Materials

The consultant shall exercise the utmost care and caution in the storage or use of hazardous materials required for the performance of the work. Activities related to the purchase, storage, use, removal, treatment, and disposal of such hazardous materials shall at all times be the sole responsibility of the consultant and shall be supervised and carried out by personnel properly qualified to perform such activities. However, in no circumstances shall activities requiring the purchase, storage, use, removal, treatment, or disposal of hazardous materials be started without first notifying DEN in writing of the proposed activity and receiving DEN's written acceptance of that action. The use and storage of explosives will not be allowed on site.

27.2.7 Archeological and Historical Discoveries

The consultant is required to inform DEN of any evidence which might suggest to a layperson that archaeological or historical materials or human remains may be present in the work area. Upon making such a discovery, the consultant shall do whatever is necessary to avoid disturbing that work area. This could require that the consultant's activities be redirected or stopped until DEN determines how to proceed.

27.3 Documentation

27.3.1 Submittal

The consultant shall submit reports of testing and testing analysis to DEN.

27.3.2 Document Control

All records and documents, which are quality related shall be prepared, identified, and maintained by the consultant and shall be submitted to DEN. Records shall be protected from damage, deterioration, or loss. Retention time for all quality records shall be not less than three (3) years from date of final payment.

27.3.3 Test Results

Test results shall be submitted to DEN after completion of inspections/tests and prior to incorporation of the items into the work unless the test or inspection must be done after installation. Field density and moisture tests shall be reported in draft form immediately at the test site with typed/printed final test results given with 48 hours. If the DEN inspector is not present for the actual test, the draft results shall be given to DEN at the end of the shift. All other inspection and test results shall be submitted within forty-eight (48) hours of the inspection or test. Test reports shall include worksheets showing any and all calculations used in obtaining the test results. All test results must be reviewed and signed by a registered licensed engineer in the state of Colorado. The signature represents that the test procedures used are in strict conformance with the applicable testing standard, the calculated data are true and accurate, the tools and equipment used were in calibration, the sample was not contaminated, and the persons running the test were qualified.

In addition, the testing laboratory shall prepare and submit to DEN a Monthly Summary Report, which summarizes the activities and results for the quality control tests and inspections conducted during that period. The Monthly Summary Report shall consist of both graphics and text and at a minimum shall identify all test types, test locations, testers, test results, any calculations used, specifications, whether the test passed or failed, and the material supplier, installer, and consultant. Material performance trends shall include a statistical evaluation of each type of test, results of which shall be clearly stated in an overview for each Monthly Report. The Monthly Report shall be submitted per requirements.

27.3.4 Records

Records (reports) of inspection and test activities are quality records and shall be maintained, in a manner that provides integrity of item identification, acceptability, and traceability. Reports shall identify the following:

A. Consultant's name
B. Contract number and title
C. Testing laboratory name
D. Name of items inspected/tested including a physical description and as applicable, model and make
E. Quantity of items
F. Inspection/test procedure used. If national standards are used, any deviation from these standards
G. Date the samples were taken and the date the test was made
H. Where tests were performed including environmental condition where applicable
I. Name of inspector/tester
J. Observations/comments
K. Specified requirements in the contract that the item must meet
L. Acceptability
M. Deviations/nonconformance
N. Corrective action
O. Evaluation of results
P. Signature of authorized evaluator
Q. Where the material was installed

End of Chapter

Chapter 28 - Planning Study

28.0 Planning Study

28.0.1 Purpose

The purposes of the Planning Study are to:

A. Verify compliance with approved DEN development plans and criteria.
B. Ensure operational and safety needs are met during construction.
C. Allow adequate coordination with FAA and DEN Operations during the design process.

The Study should initially be completed as part of Design Analysis and Schematic Design and updated as may be required during the other phases of the design process. While the Airport Layout Plan Review and supporting studies are not part of the Issue for bid documents, restrictions/limitations and other controls on the design and construction equipment, which may result from these studies, shall be incorporated in the bid documents.

28.0.2 FAA Contact and Coordination

The consultant shall not contact the FAA directly unless directed in writing by DEN or a representative of the DEN DEC Division. The consultant, at the direction of DEN, shall assist the Department of Aviation to establish and maintain coordination of the project with the FAA Airport District throughout the consultant's contract duration. This will ensure early resolution of issues and smooth and timely FAA acceptances of construction. All such coordination shall be through DEN and include representatives of the Department of Aviation.

28.0.3 FAA Review and Acceptance

The DEN DEC Division shall submit documents provided by the consultant to the FAA for review at the initial stage of the design process. These documents shall be provided by the consultant consistent with the requirements contained in this chapter and other direction as provided by DEN. Submittal of the documents DOES NOT assure acceptance. Building and/or Construction envelopes, project phasing, contractor staging, construction equipment erection and use, building materials, geometry of construction, geometry of operation, and other elements may require design changes to meet acceptance of the FAA prior to moving forward with any design.

28.0.4 FAA Review Period

The consultant shall allow in the design schedule 80 calendar days for FAA review and comment period. The consultant may proceed with design phases of work, pending completion of FAA review subject to written authorization from DEN.

28.1 Database and Resources

28.1.1 Airport Layout Plan

DEN DEC may provide BIM files of the Airport Layout Plan (ALP) or portions of the ALP as may be appropriate for the consultant's use in the development of the required Planning Study.

28.1.2 DEN Datum Base and Stationing

DEN DEC may, on written request from the consultant, provide plan drawings with locations of pre-established Benchmark stations and associated data. The consultant shall allow two weeks after requesting this information for delivery of the stationing.

28.1.3 Stationing within Project Limits

The consultant shall be responsible for establishment of survey points and verification of horizontal and vertical locates within the proposed project limits as well as verification of inverts and elevations of adjacent systems.

28.2 Submittal Requirements

28.2.1 General

The Planning Study is a separate, standalone submittal package required during all phases of design. This submittal is to be included in the DARs and shall be submitted separately to the DEN Maintenance and Engineering Director. Throughout the design process, the consultant shall provide geometric studies and documentation to assist the DEN DEC Division in assuring that all design elements comply with FAA requirements and agreed-upon criteria. The initial submittal during the Design Analysis Phase should establish the envelope and construction operations envelope, including construction site lighting, permanent site lighting, crane sizes, etc. Submittal of the package in subsequent phases is to assure compliance with approved parameters. The consultant shall in subsequent submittals note any deviations from the initially set and approved parameters.

Such studies and documentation shall include, but not be limited to, full site plans with all paving, contours, buildings, and structures depicted and exterior elevation drawings of those identified items along with limitations (as surveyed) resulting from FAR Part 77 imaginary surfaces and Control Tower lines of sight. All features of these building and structures, such as corners, parapets, or appurtenances; any mounted antennae, aerial masts or other structures projecting into space above the building mass; all ground-mounted antennae, aerial masts or other structures projecting into space above the building mass; all ground-mounted antennae, aerial masts or other free-standing structures; and all exterior lighting, whether building mounted or ground mounted, must be uniquely identified by Northing and Easting based on the Airport Grid and elevations based on the Datum Base.

The elevations at grade and at the highest point for the building mass and each identified feature must be depicted on the site plans and exterior elevation drawings in feet above mean sea level (MSL). Due to the potential interference, these items may pose to the safe and efficient use of airspace above and around the structures, the consultant must warrant the accuracy of such submitted data.

Latitude and longitude of the proposed improvements must be provided for the FAA to evaluate the proposal. The coordinates source must state if it is based upon the 1927 or the 1983 North American Datum. This information is typically found on the USGS 7-1/2" quad map.

28.2.2 Submittal Content

The consultant may extract drawings or sketches developed for submittal in the various design phases for use in the submittal. Mark-up and annotation of the documents may be included as part of the submittal. The consultant shall submit plan drawings/tabulations/explanations to DEN. Prior to the submittals, the consultant shall meet with DEN to review the submittal requirements. In some cases, subject to acceptance of DEN, drawings and other portions of the submittal elements may be combined to simplify the submittal. Each submittal shall be organized and presented as detailed in the following paragraphs:

28.2.2.1 Summary Statement

Summarize the overall project indicating the present stage or phase of the design, the general height above grade, and location of the project. Include a letter size ALP drawing indicating the location and limits of the project.

28.2.2.2 Plan Drawings of Constructed Work

Include horizontal and vertical controls of planned elements (including comparisons with Control Tower lines of sight and FAR Part 77 imaginary surfaces). Dimensioned drawings prepared for the design documents will be prepared conforming to the intent of the Airport Layout Plan and all applicable DEN DSMs. Paving limits shall be specifically identified. Drawings shall include plan geometry stations identified by Northing and Easting based on the Airport Grid. For all vertical work, elevations based on DEN Datum Base shall be indicated at horizontally identified locations.

28.2.2.3 Plan Drawings of Constructed Work Lighting

Annotate drawings as necessary to indicate exterior lighting elements and photometric diagrams. Type and color of lighting shall be identified.

28.2.2.4 Plan Drawings of Constructed Work Emissions

Annotate drawings as necessary to indicate calculated emissions and/or plumes that may be emitted by the constructed facility. Include locations, extent, and weather conditions anticipated. This shall include but not be limited to cooling tower equipment, wash facilities, restaurant hoods, soil stacks, emergency generator exhausts, etc.

28.2.2.5 Plan Drawings of Constructed Work Traffic Impact

Annotate drawings as necessary to indicate existing traffic loads and anticipated contributed loads of traffic created by the planned use or operation of the project. This shall include but not be limited to aircraft movement, ground service operations, delivery services, refuse storage and service, automobile movement, emergency access, and staging areas for emergency vehicles.

28.2.2.6 Plan Drawings of Construction Phasing

Annotate drawings as necessary to indicate XYZ dimensioned limits of construction, construction staging, haul routes, stockpiling locations, and vertical envelopes of construction equipment. Include photometric diagrams and heights of lighting required during construction. Provide notation of required access points and notation of areas of work in restricted areas and means of access to the restricted areas.

28.2.2.7 Elevation Drawings

Provide elevations of the facility keyed to large-scale plan drawings. Indicate the types of materials to be used for project and the radio opacity of the materials. Indicate the types of control of glare from reflected sunlight on project.

28.2.2.8 Operations Phasing Drawings

As applicable, the concept for phasing and related maintenance of aircraft and/or vehicular traffic (landside and airside) in conformance with established safety criteria for operations during construction. Note that FAA review may result in limitations on contractor equipment sizes, placements, temporary lighting, and other elements. Any restrictions shall be transcribed by the consultant onto the Construction Document Phasing and Staging Plans.

28.2.2.9 Utility Location Plans and Protection

As applicable, note the location of FAA facilities (including power and communications lines), which may be impacted by construction activities.

28.2.2.10 Calculations

Provide calculations used in establishing each of the above items. Station points used in calculations shall be keyed to locations noted in drawings.

28.2.2.11 BIM Model Contained in The Submittal

Disks shall be placed in a paper jacket with directories of files and descriptions of files keyed to drawings submitted.

The consultant shall be responsible to ensure, by field surveys engineering studies, etc., that the plan drawings remain consistent with the evolving design and verify that agreed-upon criteria is maintained by the final bid documents.

28.3 Submittal Format

28.3.1 Binding

The consultant shall submit each submittal in letter size format bound in 3-ring binders with the jacket edge and front labeled as follows:

A. Submittal title (planning study) and sequence number
B. Date of submittal
C. Project title and number
D. Consultant name, and consultant contract number (or tenant name and tenant project number)

28.3.2 Organization

Each submittal shall be organized and presented in the order stipulated in 28.3.2 Organization.

28.3.3 Drawings

Drawings larger than letter size drawings shall be folded and placed in vinyl jackets within each respective section of the submittal. Drawings 11 x 17 may be folded and 3-hole punched.

28.3.4 Quantity

Submit three (3) complete copies to DEN at each Phase of Design.

28.4 Supporting Studies

At the request of DEN, the consultant may be requested (under a separate authorization) to provide additional focused planning studies and/or analysis directly related to the project beyond those normally required for the design process and related coordination. The purposes for these supporting studies may include documentation for grants, additional justification, design refinement, etc.

28.5 Incorporation into Bid and Construction Documents

During the development of the construction documents, unless otherwise determined by DEN, the consultant shall provide all necessary information required by the Department of Aviation for submittal of Form 7460-1s (Notice to Proposed Construction) to the FAA for acceptance of both the constructed project and temporary construction equipment (cranes, etc.) and material stockpiles. Subject to compliance of the design to previous submittal and FAA review comments, the form 7460-1s review and acceptance period shall be 60 days. The submittal of the form shall therefore take place at least 80 days prior to advertisement of any construction contract to perform work. If the project is a City project, the submittal of the form shall take place 80 days prior to bid of the work.

The completed bid documents shall depict any limitations regarding allowable heights, construction lighting, horizontal locations, and construction equipment and/or stockpile/staging area restrictions. In the event timeframes and duration of occupation of vertical envelopes are limited, such restrictions shall be so documented in the construction documents by the consultant.

End of Chapter

Chapter 29 - Codes and Compliance

29.0 Codes and Compliance

29.0.1 Consultant Responsibility

The consultant shall be responsible for ensuring that all designs at the time the Issue for Bid are complete and are compliant with all building code regulatory requirements. Design and construction shall be based on the latest edition of the referenced codes, including additions and revisions in effect at the time of project bidding, unless specifically indicated otherwise.

The consultant shall schedule a series of project familiarization meetings with applicable building code and fire prevention officials to review project development. The consultant and all applicable subconsultants shall attend these meetings to discuss code issues and design direction.

The consultant shall submit documents in a timely manner to all required review agencies to ensure that permits are available at the time of bid advertisement. This shall include intergovernmental agreements and acceptances to tap water and sewer lines. The Designer is responsible for submitting the specifications and drawings to Denver's Building Inspection Division for the division's plan review and receiving acceptances thereon sufficient to allow the contractor to obtain the necessary building permits so as not to cause any delay.

29.0.2 Compliance

The codes contain specific references that define the Engineer of Record's responsibility for reviewing of contractor submittal for compliance to the code, establishing construction acceptance criteria, special inspections requirements and procedures, and the engineer's review of contractor-engineered items. As a requirement of its contract responsibilities, the consultant is responsible for the development of all code-required items, which are directed by the applicable project regulations and codes and reviewing of all contractor submittals for compliance to the building codes applicable to the project.

29.0.3 Variances

All requests for code and compliance variances must be accepted by DEN prior to requesting a formal variance from any code agency.

29.1 Agencies

The following is a partial listing of agencies that have jurisdiction over projects at DEN.

29.1.1 Building Code

All design and construction work shall be governed by the amendments to the International Building Code for DEN, latest edition. Particular attention shall be directed to Appendix N of this code, which addresses the construction of DEN buildings and structures.

Review and acceptance of all construction documents for compliance to the Denver Building Code as it applies to DEN.

City and County of Denver
Denver Development Services
201 West Colfax Avenue, Department 205
Denver, Colorado 80202

29.1.2 Denver Fire Department

Review and acceptance of plans for compliance with the DFD's requirements as it applies to DEN.

Denver Fire Department
201 West Colfax Avenue, Department 205
Denver, Colorado 80204

29.1.3 Department of Health and Hospitals

The enforcement of the Denver Health Code, latest edition, is under the jurisdiction of:

City and County of Denver
Department of Environment Health
201 West Colfax Avenue, Department 1009
Denver, Colorado 80204

29.1.4 Wastewater Management Division

Review and acceptance of plans for compliance with Chapter 56 of the Revised Municipal Code and enforcement of the Rules and Regulations Governing Sewer Charges and Fees and Management of Wastewater.

City and County of Denver
Department of Public Works
Wastewater Management Division
2000 West 3rd
Denver, Colorado 80223

29.1.5 Denver Zoning Administration

Review and acceptance of plans for compliance with the Denver Zoning Ordinance as it applies to DEN.

City and County of Denver
Denver Zoning Administration
201 West Colfax Avenue, Department 205
Denver, Colorado 80202

29.1.6 FAA Requirements

Design and construction shall be in accordance with the requirements of the FAA Design Standards criteria, as set forth in applicable FAA advisory circulars. The consultant shall submit FAA submittals to DEN Maintenance and Engineering, not directly to the FAA. The following FAA Standards govern the height and location, with respect to runways and taxiways, of all DEN structures:

A. FAR Part 77, “Objects Affecting Navigable Airspace”
B. AC 150/5300-13, “Airport Design”
C. AC 150/5370-2D/E, “Operational Safety on Airports During Construction”
D. AC 70/7460-1K, “Obstruction Marking and Lighting
E. Latest edition Advisory Circulars may be obtained from:

FAA U S. Department of Transportation
5440 Roslyn Street, Suite 300
Denver, Colorado 80216-6026
(303) 286-5538

U S. Department of Transportation
Subsequent Distribution Section, M-4943
Washington, D C 20590
Superintendent of Documents

U S. Government Printing Office
Washington, D C 20402

29.1.7 United States Customs Service

The United States Customs Service (USCS), Department of the Treasury, is authorized to control the entrance and clearance of aircraft arriving in and departing from the United States and to inspect the crews, passenger, baggage, stores, and cargo carried thereon (Tariff Act of 1930 and Section 1109 of the FAA Act of 1958). Customs enforces approximately 400 different laws for forty other agencies in protecting the borders of the United States.

Commissioner of Customs
U.S. Customs Service
1301 Constitution Avenue N.W.
Washington, D.C. 20229
Attention: Chief, Space Management Branch
(202) 566-5471

29.1.8 Immigration and Naturalization Service

The Immigration and Naturalization Service (INS), Department of Justice, examines all persons arriving in the United States to determine their admissibility under the provisions of the Immigration and Nationality Act (66 Statute 163). Section 239 of the Act (Title 8, U.S. Code 1229) and Part 239, Title 8, Code of Federal Regulations, pertain specifically to aircraft and airports of entry.

Associate Commissioner, Management
Immigration and Naturalization Services
425 I Street N.W.
Washington, D.C. 20536
Attention: Chief, Facilities, and Engineering Branch
(202) 633-4448

29.1.9 Public Health Service

The Assistant Secretary for Health, Department of Health and Human Services, is authorized to make and enforce such regulations that are necessary to prevent the introduction, transmission, or spread of communicable diseases from foreign countries into the United States or its possessions (Section 361, Public Law 410, 78th Congress).

Director, Division of Quarantine
Public Health Service
Center for Prevention Services
Centers for Disease Control
Atlanta, Georgia 30333
Attention: Chief, Program Operations Branch
(404) 639-2574

29.1.10 Animal and Plant Health Inspection Service

Animal and Plant Health Inspection Service (APHIS) provides inspection services for all aircraft, crew, passengers, stores, and cargo arriving from foreign countries into the United States, its territories and possessions or departing from Hawaii, Puerto Rico, and the U.S. Virgin Islands destined for the U.S. mainland. The purpose is to protect American agriculture by preventing the introduction of injurious plant and animal pests and diseases not previously known to occur in the United States (Plant and Animal Quarantine Acts- 21 U.S. Code 111, 7 U.S. Code 151 et seq.).

Plant Protection and Quarantine Programs
Animal and Plant Health Inspection Service
Federal Building
Hyattsville, Maryland 20782

Attention: Chief, Port Operations
(301) 436-8295

End of Chapter

Chapter 30 - Construction Cost Estimates

30.0 Construction Cost Estimates

The consultant shall submit a verifiable cost estimate for completing the construction of each project or task based on total area, unit prices, or other appropriate units and alternate designs, in accordance with instructions received from DEN and in a format as required by DEN. Cost estimates shall include but not be limited to the costs of permitting, mobilization, General Conditions, as described in the technical specifications for Division 01- General Requirements and drawings, bonding, and insurance.

The consultant shall routinely notify DEN when changes occur which have the potential of affecting the project budget. Cost trends are not official changes but reflect potential cost impacts if action is not taken.

30.1 Schedule of Values

The work specified in this chapter consists of preparing and submitting the schedule, which shall include a schedule of values and a schedule of material allowances. The schedule of values will be built upon a breakdown of the work using specification sections and milestones. The work also includes the preparing and submitting of updated copies of the schedule, if the schedules are affected by design changes or delays in issue of documents for bid.

Identify items in the schedule of values and schedule of material allowances with the specification section numbers, specification section title, and the bid item number used for the schedule of prices and quantities.

Breakdown of the items used in the schedule shall include costs as follows:

A. Product cost
B. Delivered cost of product with taxes paid
C. Total installation cost, with overhead and profit
D. Breakdown costs of each lump sum item with a list of products and major operations
E. Each unit price item, as listed in the bid schedule of prices and quantities
F. Material allowances
G. Testing

30.2 Preliminary Cost Estimate

The consultant shall prepare a preliminary construction cost estimate for each design and construction alternative for each project in a format established by DEN, which shall include a complete list of bid and proposal items. The Estimates shall be based on total area, unit prices, or other appropriate units, and shall include itemization of each building system. The consultant shall assure that in all estimates the Part I contract requirements have been incorporated in the estimates. The consultant shall include a comparison of the consultant's estimate with the construction budget for each project and make detailed recommendations for conformance with the construction budget.

30.3 Schematic Design Estimate

The consultant shall prepare a preliminary construction cost estimate for each design and construction alternative for each project in a format established by DEN, which shall include a complete list of bid and proposal items. The estimates shall be based on total area, unit prices, or other appropriate units, and shall include itemization of each building system. The consultant shall assure that in all estimates the Part I contract requirements have been incorporated in the estimates. The consultant shall include a comparison of the consultant's estimate with the construction budget for each project and make detailed recommendations for conformance with the construction budget.

30.4 Design Development

The consultant shall prepare a Preliminary Construction Cost Estimate for each project, format established by DEN, which includes a complete list of bid items. Preliminary quantities, units, unit prices, and appropriate totals shall be included in the consultant's estimate along with a comparison of the estimate with the construction budget for that project. If DEN notifies the consultant that more than one (1) construction contract or design/build contract is required to construct the project, consultant shall prepare a separate bid list and cost estimate for each construction contract and design/build contract. If the consultant's cost estimate exceeds the construction budget (for any project), the consultant shall recommend to DEN appropriate measures to reduce costs so that the amount set forth in each contract's Construction Budget is not exceeded. The consultant will implement all changes required by DEN and the project.

30.5 Construction Document Estimate

The consultant shall prepare a final cost estimate for completing each project that includes a complete list of bid and RFP items with correct final quantities, estimated unit prices, construction labor man-hours, extensions, and totals for each. If more than one construction contract or design/build contract is required to complete any of the projects, the consultant shall prepare a separate cost estimate for each contract. Final cost estimates shall include sufficient verifiable backup data to allow DEN to perform a detailed review and verification of the consultant's estimate.

At the 100% submittal phase, the designer shall submit to DEN a full Schedule of Values (SoV), to include at minimum the values of bid items, units, unit of measure, and unit price. The DEN PM shall provide the Consultant with a Standard DEN Schedule of Values.

30.6 Change and Substitution Cost Estimates

During the bid and evaluation and during the construction administration phases, the consultant shall prepare cost estimates for changes and/or substitution requests initiated by the consultant, City, or contractor. The Designer of Record (DOR) will participate in construction change request review as needed by the Project Manager.

30.7 Submittal Format

Submittals shall be prepared in letter size (8.5 x 11). Each page of each cost estimate shall identify the following: consultant Name and contract Number, City Construction contract or Package Number, Date, Construction contract tracking item (change notice, construction change request, RFI, change directive, etc.)

End of Chapter

Chapter 31 - Construction Schedule

31.0 Construction Schedule

The consultant shall provide DEN with a construction schedule for each project. The schedule data and information shall be prepared and submitted in accordance with the following requirements. The construction schedule is an integral part of the design process and serves to edify the design. Staging, sequencing, work constraints, and submittal requirements contained in the technical specifications must be coordinated and integrated into the construction schedule. In some cases, DEN and/or tenants may require completion, sequencing, or work activities during given timeframes. The consultant is responsible for delivery of a design that can be completed and that has been coordinated to assure that work can be prosecuted in given timeframes. Incomplete and poorly coordinated documents may result in project delays.

31.1 Schedule Requirements

The consultant shall prepare for each project a detailed construction schedule in graphic, Critical Path Method (CPM) precedence diagram, and bar chart format.

The schedule shall show construction phasing and sequencing, the number of days required to complete major construction activities, and the number of days required to complete each construction contract.

A. Identify any work that will be performed by others which could affect the contractors' ability to meet the schedule in any way including work items or milestones that affect or are affected by DEN, other contractor's work, utilities, and other third parties.

B. Identify any important interrelationships or dependencies between major construction, design, procurement, and tenant supplied systems and activities performed by others and program milestones.

C. Identify and show all significant work tasks including planning, mobilization, shop submittals and acceptances, procurement, fabrication, and construction.

D. Testing and inspection. The schedule shall list major data submittals required by the contract. The total contract time including project milestones shall be identified and incorporated in the construction contract documents.

E. Work items shall be identified in accordance with the anticipated bid form units, prices, tasks, and/or CSI UniFormat division classifications. The order, sequence, and interdependence of all significant work items including construction; procurement, fabrication, testing, start up, and inspection and delivery of critical or special materials and equipment; submittals and acceptances of critical samples, shop drawings, procedures, or other documents that could have a schedule impact. The work items shall be sorted by float, early start, Subcontractor, or other sorts mutually agreed to. The schedule shall also show the logic ties of successor and predecessor work items.

31.2 Submittal Format

Schedule shall be submitted electronically in PDF format.

End of Chapter

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Chapter 32 - Submittals

32.0 Submittals

32.0.1 General Information and Requirements

This chapter addresses the minimum requirements for submittal of construction or RFP documents during the progress of design and construction. Unless otherwise stated in the consultant's contract or approved task, at a minimum, the consultant shall deliver the following submittals to DEN. The consultant shall submit to DEN progress review submittals of design and contract documents, cost estimates, design-build phasing plans, and schedules. These submittals shall contain the information that DEN requires to monitor the consultant's progress and to monitor compliance with the applicable DEN DSMs, the master schedule, and master budget. DEN will provide the consultant with its written comments, recommendations, instructions, and assistance after it has reviewed these submittals.

32.0.2 Submittal Certification

Each required submittal shall be accompanied by written certification by the design contract signatory that the submittal is complete and in compliance with the contract and DEN DSMs. The consultant is solely responsible for completion and coordination of work by subconsultants. Any deviation shall be so noted in the certification and shall be accompanied by a copy of the written authorization of deviation by DEN.

32.0.3 Consultant Design Quality Control Program

The consultant shall have in place a quality control program. Quality controls are those actions taken to maintain a level of quality in the work product that is consistent with the project objectives and client requirements. The consultant's principal shall stamp and sign as reviewed and approved as complying with contract requirements, prior to submission to DEN. Preliminary submittals shall be noted as preliminary. Licensing stamp and signature shall be required on submittals to the following: government agencies, DEN for bid set, record set.

32.0.3.1 City Review

Submittal documents will be reviewed by DEN for conformance to requirements of the contract drawings and specifications. Review of a separate item will not constitute review of an assembly in which the item functions. DEN will withhold acceptance of submittals, which depend on other submittals not yet submitted. Review and acceptance will not relieve consultant from their responsibility for accuracy of submittals, for conformity of submittal document to requirements of contract drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection and completion of the contract in accordance with the contract drawings and specifications. The consultant is responsible for the interdisciplinary coordination and communication within their design contracts and with other consultants with whom their work may interface.

32.0.3.2 Consultant Design Standards Monitoring

The consultant shall monitor and review all the documents for design integrity and compliance to the appropriate Design DSM criteria, codes, and standards.

32.0.4 Review by DEN

Review and comments by DEN do not relieve the consultant from liabilities of providing complete design services and is not an acceptance of any errors or omissions that may be contained in the documents. Review by DEN shall NOT be construed by the consultant as replacing the consultant's quality control program. Submittals by the consultant must be reviewed by the consultant and corrected PRIOR to submittal to DEN.

DEN reserves the right to reject any submittals described below when DEN determines they do not adequately represent the required level of completion, do not include all relevant design disciplines, systems, approved tenant

requirements or do not include all the required documents. Partial or incomplete submittals will be accepted by DEN for review purposes only when DEN requires them for a specific purpose or has otherwise authorized their submittal. Such partial submittals to DEN shall not relieve the consultant of its commitments to meet schedule and budget requirements contained in the agreement.

32.0.5 Schedule of Review of Submittals by DEN

Review timeframes shall be consistent with the agreed upon or contract design schedule. If no timeframes for review are stated, the consultant shall assume the DEN review will be forwarded to the consultant 18 calendar days after delivery to DEN. In the event the submittal is not accepted, DEN shall include specific reasons for the rejection and the consultant shall commit to a date for re-submittal after the necessary corrections, instructions, or changes have been incorporated. If the rejection resulted in part from the consultant's failure to comply with the terms of the consultant's contract or authorized task, the consultant shall also provide at no cost to DEN its plan for recovering any time lost caused by the rejection. During this review period, the consultant will continue with any other work required by this agreement unless it is notified specifically to the contrary by DEN in writing.

32.0.6 DEN Review Format

Construction document review comments will be returned to the consultant in the form of electronic mark-up of documents.

32.0.7 Consultant Response to Reviews

After DEN has provided the consultant with its review of the submittal, the consultant shall provide DEN with a written reply that states the consultant's disposition, resolution, or action to be taken on each of DEN's or approved tenant's comments, instructions, or recommendations. The consultant shall submit its reply to DEN within seven (7) calendar days after it receives DEN's comments unless a different timeframe is specifically provided in the agreement or as approved by the Project Manager.

Responses shall be in the same format that comments were presented to the consultant. Responses to PDF comments shall be made using the Reply feature of each individual comment. The original PDF with comment replies shall be returned to the Project Manager in the timeframe defined above. In no case shall mixed formats (letter response to PDF comments) be used unless approved by the Project Manager.

32.0.8 Submittal to Code Agencies

The consultant is solely responsible for acquiring acceptance from review agencies. The consultant shall identify is its design schedule submittal its scheduled submittals to code agencies to ensure that at the time of bid advertisement the documents comply with all required code agency requirements.

32.1 Typed Submittals – Specifications, Tables, Estimates, Design Analysis

32.1.1 Format

All typed submittals shall be in hard copy form and in Microsoft Word for Windows 10 and all subsequent versions of Windows or other previously authorized format. These electronic submittals shall be via Unifier. The files shall not be protected. Files shall contain the text, illustrations, tables, schedules, and exhibits contained in the document.

32.1.2 Specifications

The consultant shall use the uniform format established in these DSMs for all reports, contract documents, and technical specifications. Technical specifications and reports shall be provided on reproducible copy and in Microsoft Word for Windows 10 and all subsequent versions of Window unless otherwise specified in the consultant contract. Electronic submittal shall be via Unifier according to City guidelines. Files shall not contain

macro language; nor shall files be protected. The files shall contain the illustrations, tables, and exhibits contained in the document.

Specifications shall be submitted as files containing all specification sections relevant to the project. The Consultant shall, at minimum, submit a single .pdf file containing tracked changes to all specifications included in the project. The Consultant can additionally submit a "clean" file with no tracked changes, but these are not necessary for DEN's submittal review process.

32.1.3 Data and Product Cut Sheets

The consultant shall submit copies of specifications that incorporate behind each specification section sheets cut sheets, product data sheets and back-up materials for the items specified in the respective section. Cut sheets and product date shall identify system or item performance criteria, size, weight, and color. If color selection is requested of DEN, original manufacturer color samples shall be included. Selected products shall be marked or noted in BLACK to facilitate reproduction. This submittal shall be provided at the 60% construction document submittal and at the 100% construction document submittal. Each specification volume shall be submitted electronically.

32.2 Submittal Format - Drawings

Drawings shall be submitted in the format and size as required by DEN. The consultant shall contact DEN in writing prior to each submittal for clarification of the drawing size to be submitted (full size, half size, or reduced size).

32.3 Building Information Management/Revit

32.3.1 Submittal Schedule

Refer to DFI DSM.

32.3.2 Labeling of Media

Consultants must label media with the following information:

A. Consultant name
B. Contract number
C. DEN project number
D. Submittal date
E. Submittal level
F. Contact phone number

Additionally, a hard copy file list must accompany the submitted disc.

32.4 PDF Submittal Requirements

32.4.1 Specifications

In addition to other formats required, specifications shall be submitted as a single PDF file. The file shall be an Adobe Acrobat, PDF file version 6 or later containing all pages in each submittal. This PDF file shall contain all pages rotated to correct orientation. The PDF file shall be delivered to DEN in the unlocked, security-free state. All sections shall have a bookmark. All bookmarks shall be subdivided by discipline and specification number-title. As much as it is possible, documents shall be directly converted to PDF format. Scanning of files to PDF is acceptable only with written permission from the Project Manager. Additionally, all pages within or printed from the PDF file must match the pages submitted. Single PDF files of each separate specification section are only acceptable with written permission of the Project Manager.

32.4.2 Drawings

In addition to other formats required an Adobe Acrobat, PDF file version 6 or later containing all sheets in each submittal or Volume submitted together with the CADD files at each submittal level. This PDF file shall contain all sheets rotated to correct orientation and plotted to full extents for to-scale printing. The PDF file shall have and be delivered to DEN in the unlocked state. All bookmarks shall be subdivided by discipline and drawing number-title for drawings, as shown in Figure 32-1: Drawing Bookmark. As much as it is possible, be directly converted to PDF format. Scanning of files to PDF is acceptable only with written permission Project Manager. Additionally, all sheets within or printed from the PDF file must match the drawings submitted. Single PDF files of each separate drawing are only acceptable with written permission of the Project Manager.

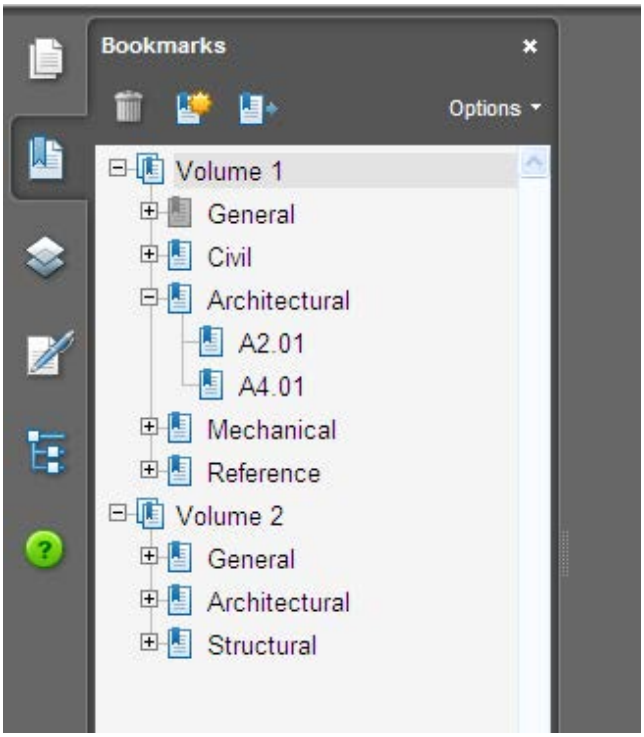

Figure 32-1: Drawing Bookmark

32.4.3 Reports

In addition to other formats required, reports shall be submitted as a single PDF file. The file shall be an Adobe Acrobat, PDF file version 6 or later containing all pages in each submittal. This PDF file shall contain all pages rotated to correct orientation. The PDF file shall be delivered to DEN in the unlocked, security-free state. All sections shall have a bookmark. All bookmarks shall be subdivided by chapter/title and subchapter numbers/headings. As much as it is possible, documents shall be directly converted to PDF format. Scanning of files to PDF is acceptable only with written permission from the Project Manager. Additionally, all pages within or printed from the PDF file must match the pages submitted.

32.4.4 Calculations

In addition to other formats required, calculations shall be submitted as a single PDF file. The file shall be an Adobe Acrobat, PDF file version 6 or later containing all pages in each submittal. This PDF file shall contain all pages rotated to correct orientation. The PDF file shall be delivered to DEN in the unlocked, security-free state. All sections shall have a bookmark. All bookmarks shall be subdivided by discipline and equipment/system number-title. As much as it is possible, documents shall be directly converted to PDF format. Scanning of files to

PDF is acceptable only with written permission from the Project Manager. Additionally, all pages within or printed from the PDF file must match the pages submitted.

32.5 Design Analysis/Programming Phase

32.5.1 General

The consultant shall deliver its complete design analysis to DEN in accordance with the project schedule accepted by DEN. This submittal shall include all the requirements set forth in Chapter 3- Design Analysis Report by DEN.

After the submittal has been made, the consultant shall present it to and discuss it with DEN at a meeting scheduled by DEN. DEN will then submit comments, instructions, and requirements on the submittal to the consultant within fourteen (14) calendar days after the meeting. The consultant shall have seven (7) calendar days to incorporate DEN's comments and requirements into the design analysis and resubmit it to DEN.

32.5.2 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities. Specifications shall be submitted in the redline format, refer to 11.9.9 Design Standards.

32.6 Schematic Design Phase

32.6.1 General

The consultant shall deliver schematic design documents to DEN in accordance with the project schedule accepted by DEN. This submittal shall include all the requirements set forth in Chapter 4- Schematic Design Phase The consultant shall schedule a meeting with DEN to review its preliminary schematic design in accordance with the individual project schedules accepted by DEN. At this preliminary review meeting, the consultant shall present drawings and documents in sufficient detail to illustrate concepts, issues, problems, and proposed solutions.

32.6.2 Review by DEN

The consultant shall schedule a meeting with DEN to review its preliminary schematic design in accordance with the individual project schedules accepted by DEN. At this preliminary review meeting, the consultant shall present drawings and documents in sufficient detail to illustrate concepts, issues, problems, and proposed solutions.

Final schematic design review – The consultant shall schedule a final review of its schematic design documents with DEN within the timeframe identified in the accepted design schedule. The consultant shall present the documents.

After this submittal has been delivered and presented at the final review meeting, DEN and Senior Director will then have a minimum fourteen (14) calendar days to provide the consultant with their written acceptance or rejection and any written comments, instructions, and information requirements they may have. In the event the submittal is not accepted, DEN shall include specific reasons for the rejection and the consultant shall commit to a date for resubmitting the schematic design documents after the necessary corrections, instructions, or changes have been incorporated. If the rejection resulted in part from the consultant's failure to comply with the terms of this agreement, the consultant shall also provide at no cost to DEN its plan for recovering any time lost caused by the rejection. During this review period, the consultant will continue with any other work required by this Agreement unless it is notified specifically to the contrary by DEN in writing.

32.6.3 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities Specifications shall be submitted in the Redline format, refer to 11.9.9 Design Standards.

32.6.4 Schematic Design Submittal

The objectives of the pre-design programming and schematic design are to define the project criteria, formulate the design philosophy, and to develop design solutions, including alternate schemes for the project. During programming, the consultant shall provide the client data and documentation that will assist in establishing the validity of the overall program, schedule, limitations, and other requirements that serve as the basis in the development of the schematic design and identifying issues that may require adjustments to the program. During the schematic design effort, the consultant shall develop a design solution to the program and alternative schemes and associated site development plans.

These drawings and/or models shall illustrate the general scope, compatibility with FAA Part 77 guidelines, scale, and relationship of project components for conceptual or schematic approval by the client. The schematic design submittal shall include information that is sufficient in detail to define and quantify system requirements and interrelationships, and shall comprise drawings, list of specification sections, cost estimates, and design reports for alternative design solutions as required by the SOW.

32.6.4.1 Drawings

A. The schematic design submittal drawings shall define site, utility, and floor layouts; floor and building heights and elevations; structural and mechanical systems; overall electrical, utility, and other system requirements; and provide overall dimensions of major systems and elements. The submittal will generally include the following drawings for each alternative:
    a. Cover sheet, drawing index
    b. Survey of existing conditions
    c. Site layout, civil and utility plans, and requirements
    d. Floor plans
    e. Architectural sections and elevations
    f. Structural drawings, soil analysis if available
    g. MEP drawings
    h. Perspective sketches and study models

B. At the end of the schematics design stage, upon selection of accepted alternatives, the consultant shall provide to the client a list of expected construction document drawings.

32.6.4.2 Specifications

The consultant shall prepare a list of proposed Construction Specifications Institute (CSI) Specification Sections that will eventually be incorporated into the Construction documents and furnish a brief outline description of all major systems selected by each discipline.

32.6.4.3 Cost Estimates

The schematic cost estimate will be used to validate the project budget. The cost estimates for the schematic submittal shall be conceptual in nature, based on systems and unit costs of the work developed. Allowances may be applied to work that is known, but not yet detailed. The estimate submitted at this stage of the work need not be in CSI format.

32.6.4.4 Calculations

By the completion of the schematic design the consultant shall size major systems for disciplines, determine total load requirements, and shall furnish all calculations for the establishment of those quantities.

32.6.4.5 Design Report

The design report shall address all major design characteristics; summarize all major design issues, confirm project criteria, design assumptions, field findings. Provide floor area calculations, spatial and functional relationships, and describe how the design meets or differs from the requirements of the SOW. In the design report the consultant

shall include a description of all systems for each discipline and specialty contractors/suppliers, including analysis of those and alternative system attributes. The design report shall provide information on the preliminary geotechnical report and data. As part of the design report, the consultant shall explain building code requirements and compliance issues and provide a building code analysis and an egress analysis of all structures covered by the international building code (IBC) and Denver amendments. At a minimum, the analyses shall state the type of construction; use group; occupancy load for all parts of the building; live load for each floor; any special stipulations, conditions, and/or modifications to the IBC; and a schematic diagram indicating corridors, exits, and maximum travel distances to the outside of the building. The code analysis shall contain the analyses for all disciplines, included but not limited to architectural, structural, plumbing, EMCS, and electrical.

32.6.4.6 Schedule

As part of this submittal, the consultant shall update the design schedule and provide a broad scope construction schedule defining overall construction times and phasing requirements.

32.7 Design Development

32.7.1 Design Development

The consultant shall deliver the complete design analysis to DEN in accordance with the project schedule accepted by DEN. This submittal shall include all the requirements set forth in Chapter 5- Design Development.

32.7.2 Review by DEN

The consultant shall schedule a meeting with DEN to review its preliminary design development in accordance with DEN accepted design schedule. At this preliminary review meeting, the consultant shall present drawings and documents in sufficient detail to establish and describe the size, scope, character, and other important features of the projects.

The consultant shall schedule a final review of its design development documents with DEN and present the documents described in the DSMs to DEN at this meeting. For the design development documents submittal, the consultant shall provide six (6) copies of the following documents to DEN:

A. Design development drawings
B. Outline technical specifications
C. Preliminary DAR
D. Preliminary cost estimate
E. Preliminary construction schedule
F. Lists of acceptances
G. Equipment and long-lead items
H. Construction contract bid packaging and RFP recommendations
I. Value engineering report

After this submittal has been delivered and presented at the final review meeting, DEN and Senior Director will then have a minimum fourteen (14) calendar days to provide the consultant with their written acceptance or rejection and any written comments, instructions, and information requirements they may have. In the event the submittal is not accepted, DEN shall include specific reasons for the rejection and the consultant shall commit to a date for resubmitting the design development documents after the necessary corrections or changes have been incorporated. If the rejection resulted in part from the consultant's failure to comply with the terms of this agreement, the consultant shall also provide at no cost to DEN its plan for recovering any time lost caused by the rejection. During this review period, the consultant will continue with any of the work required by this agreement unless it is notified specifically to the contrary by DEN in writing.

32.7.3 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

32.8 Contract Documents Phase, 30% Submittal

32.8.1 General

The consultant shall be required to prepare a minimum of three submittals in the contract documents phase, a 30% submittal, a 60% submittal and a final review submittal, unless otherwise required by the prime agreement. Each submittal shall be comprised of those elements of the documents begun in the preliminary design and additional documents/reports as necessary or requested.

DEN will schedule a meeting to take place no later than fourteen (14) calendar days after the in-progress submittal is received to review and discuss its comments with the consultant and to resolve any issues, which are identified. All of DEN's and approved tenant's written comments and requirements shall either be incorporated in the contract documents or addressed in some other appropriate written manner satisfactory to DEN within fourteen (14) calendar days after they are received. During this review period the consultant shall continue with any other work required unless is notified specifically to the contrary by DEN in writing.

32.8.2 30% Submittal

The percentage does not mean 30% of the drawings. EACH drawing required for the construction document package shall be 30% complete, including but not limited to title block, background annotations, object placements, annotations, key note development, key plan development, schedules if approved by City, etc. This submittal is a step beyond the typical cartoon or mock-up of a package. All CADD layering, annotation, and line systems shall be in place. This submittal shall be reviewed and commented on by DEN for:

A. Compliance with CADD standards. Refer to DFI DSM
B. Compliance with DEN DSMs
C. Compliance with contract document requirements
D. Compliance with the DEN Life Safety DSM and Life Safety Master Plan

32.8.3 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

Refer to the following chapters for systems specific design submittal requirements:

- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems

32.8.4 Construction Documents 30% Submittal

The objective of this phase is to refine the elements defined and information gained during programming and schematic design to define the final details, sizes, connections, material selections, and to resolve interdisciplinary relationships. By the conclusion of design development, the consultant shall have developed all data required for the preparation of the contract documents. The design development submittal shall include drawings, specifications, calculations, schedules, and the design report to the following levels of completeness.

32.8.4.1 Drawings

The design development drawings shall be in the final format of the contract documents and shall be presented in corresponding scale across all disciplines. Dimensioning shall be sufficient to define sizes of details, material thickness, equipment, and fixture sizes, etc. The submittal generally comprises the following drawings:

A. Cover sheet, list of drawings, legends, and general notes
B. Site surveys and boring location plans
C. Civil, landscaping, and utility plans and details, and schedules
D. Measured drawings of existing conditions and demolition plans
E. Building Code Analysis and Diagrams
F. Architectural plans
G. Architectural sections
H. Typical wall sections
I. Reflected ceiling plans
J. Interior elevations
K. Typical architectural details
L. Architectural schedules
M. Structural plans
N. Structural sections
O. Structural details
P. Structural schedules
Q. Mechanical plans
R. Riser diagrams
S. Mechanical isometrics
T. Mechanical details. Refer to Table 18-1: Submittal Requirements for additional requirements.
U. Mechanical schedules
V. Building management and automation systems
W. Plumbing plans
X. Plumbing riser diagrams
Y. Plumbing details
Z. Plumbing schedules
AA. Electrical site plans
AB. Electrical floor plans
AC. Electrical Schedules
AD. Fire alarm and fire protection drawings
AE. Public address system
AF. Baggage handling systems
AG. Special Systems including, but not limited to:
    a. Master clock system
    b. Security system (ACAM, CCTV)
    c. Automated external defibrillator (AED) cabinet monitoring system
    d. Multi-user flight information systems (MUFIDS)
    e. Common use terminal equipment (CUTE)
    f. Premise distribution system
    g. Information network infrastructure design

h. Telecommunication room design
i. UPS requirements to support special systems
j. Blue light emergency telephones (BL-ETELs)
k. Fire fighter emergency telephones (FFETs)
l. 800 MHz emergency radio supplemental radiating system (SRS)
m. Cable television (CATV)
n. Furniture, fixture, and equipment layout and design
o. Color selections
p. Other systems as required

If applicable, the design development submittal should also include drawings, specifications, and calculations of specialty subconsultant's work, such as baggage handling system, interior designer, acoustical, and lighting consultants, etc. The consultant shall furnish a revised and detailed list of drawings required for the construction documents.

32.8.4.2 Specifications

The design development submittal shall include an outline specification of all applicable sections and shall be developed using the most recent edition of the MasterSpec format.

32.8.4.3 Cost Estimate

The cost estimate at the design development submittal will be used to verify compliance with the authorized construction budget. The cost estimate for the design development submittal shall include actual quantities and the unit costs for the major portions of the work developed. Approximate quantities and unit costs shall be developed for work not clearly defined. Allowances may be applied for work that is known, but not yet detailed. The construction cost contingency at this level should not exceed 15%. A section of the estimate shall include a budget reconciliation detailing major variances between the total amount of the current construction estimate and that of the schematic submittal.

32.8.4.4 Calculations

The calculations shall be sufficiently detailed to quantify individual elements of the systems defined during design development. Calculations shall be given for determination of sizes, grade/quality of materials, sizing, and location of details and equipment, such as, wall/floor thickness, column/beam/ connection sizes, equipment sizes, spatial requirements, etc.

32.8.4.5 Design Analysis Report

The design report shall be updated to address how the information gained from the schematic design review and comments has been carefully coordinated, cross-referenced, and incorporated into the design development documents; how the design development documents address further developments in design characteristics; code compliance issues; and description of how the design meets or differs from the requirements of the SOW. The design report shall discuss the characteristics of selected materials, equipment, and fixtures, and considered alternates. The design report also should identify issues that may have a long-term effect on the execution of the work, such as long-lead delivery items and other critical activities.

32.8.4.6 Schedule

In addition to an updated design schedule, the consultant shall finalize the construction document production schedule and formulate and outline the anticipated construction schedule, including phasing of the work.

32.9 Contract Documents Phase, 60% Submittal

32.9.1 General

An in-progress submittal of the contract documents shall be scheduled by the consultant when the contract documents are approximately 60% complete. If DEN determines that major items of work have been omitted in this submittal, DEN may reject the submittal.

32.9.2 Review by DEN

DEN will schedule a meeting to take place no later than fourteen (14) calendar days after the in-progress submittal is received to review and discuss its comments with the consultant and to resolve any issues, which are identified. All of DEN's and approved tenant's written comments and requirements shall either be incorporated in the contract documents or addressed in some other appropriate written manner satisfactory to DEN within fourteen (14) calendar days after they are received. During this review period the consultant shall continue with any other work required unless is notified specifically to the contrary by DEN in writing.

32.9.3 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

Refer to the following chapters for discipline specific design submittal requirements:

- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems

32.9.4 Construction Documents 60% Submittal

Upon receipt of client comments and approval of the design development submittal, the consultant shall commence with preparation of the construction documents. The objective of the construction document phase is to refine and further develop the information attained during design development that provides detailed information for the execution of the work. The construction documents comprise drawings, specifications, and contractual information that define in detail all materials, quantities, systems, interrelationships, work methods and limitations, and contractual requirements for the execution of the project. The construction documents must be completely coordinated with the solicitation provisions, special provisions, and contract provisions of the client. The construction documents will usually be submitted for review and approval in stages at 60%, 90%, and 100% of completion. The requirements for these submittals and their levels of completion are described below. The 60% submittal shall represent the continuation of the 30% submittal, incorporating 30% review comments, and shall be in the final format of the construction documents. The 60% submittal, at a minimum, shall comprise the following documents:

32.9.4.1 Drawings

The drawings shall include all required sheets of the final construction working drawings defined by the drawing list, each at least to the 60% level of completion, with sufficient information included for the preparation of a detailed cost estimate. Refer to the following chapters for additional 60% drawing submittal requirements for each discipline:

- Chapter 14- Civil Drawings
- Chapter 15- Landscape Drawings
- Chapter 16- Architectural Drawings
- Chapter 17- Structural Drawings
- Chapter 18- Mechanical Drawings

- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems
- Chapter 23- Signage and Graphics Drawings

32.9.4.2 Specifications

The specifications shall be in the final format in the most recent edition of the MasterSpec format and shall address all applicable subdivisions and shall contain adequate technical information to supplement the drawings to quantify sizes, capacities, and qualify grade, strength, workmanship finishes, and other characteristics of applicable materials and equipment. Provide a list of sole-source items included in the design document and provide sole-source justifications for all items not on the pre-approved list.

32.9.4.3 Cost Estimate

The cost estimate for the construction documents submittal shall include accurate quantities, material, and labor unit costs for the major portions of the work developed to date and will be used to verify the compliance with the authorized construction budget. A limited number of items may require approximate quantities and the unit costs or allowances. The construction cost contingency at this level should not exceed 10%. A section of the estimate shall include a budget reconciliation detailing major variances between the total amount of the current construction estimate and that of the design development submittal.

32.9.4.4 Calculations

The consultant shall furnish calculations for all disciplines that are necessary to determine the final requirements and configuration of all parts of all systems required for the execution of all construction work.

32.9.4.5 Design Analysis Report

The design report shall address how the information gained from the design development review has been carefully coordinated, cross-referenced, and incorporated into the construction documents, how the construction documents address further developments in design characteristics, code compliance issues, and description of how the design meets or differs from the requirements of the SOW. The design report shall be in its final format and shall include, at a minimum, the following data:

A. Executive summary
B. Existing site conditions
C. Utilities
D. Contractor access and facilities
E. Potential coordination conflicts/phasing issues
F. Overall design philosophy and criteria by disciplines
G. Floor area calculation and allocations
H. Material descriptions and properties
I. Equipment description and properties
J. Coordination of maintenance and operational issues
K. Code report and compliance issues

32.9.4.6 Schedule

The consultant shall furnish a revised design schedule and updated probable construction schedule, including consideration of all major systems and long-lead items. The probable construction schedule shall contain a level of detail necessary to identify individual portions of the work. An electronic medium of a compressed back up shall be provided on CD or DVD with each submittal.

32.9.4.7 Spare Parts and Long Lead Items List

During the 60% submittal phase, the project manager will coordinate with the consultant and appropriate maintenance personnel to evaluate the requirements for spare parts and long lead items by identifying the spare parts and their quantities. The base specifications identify materials that are required or not required to be provided as spare parts. These specifications will be tailored to address requirements that are specific to each project. The consultant will use the information from these discussions to prepare specifications to accomplish these goals and provide a list of all items that may need to be purchased in advance by the client or the contractor to meet the construction schedule.

32.10 Contract Documents Phase, 90% Submittal

32.10.1 General

An In-Progress Submittal of the contract documents shall be scheduled by the consultant when the contract documents are approximately 90% complete or substantially complete. If DEN determines that major items of work have been omitted in this submittal, DEN may reject the submittal. The consultant shall provide a separate written report addressing comments and direction provided the consultant by DEN after the 60% submittal.

32.10.2 Review by DEN

DEN will schedule a meeting to take place no later than fourteen (14) calendar days after the in-progress submittal is received to review and discuss its comments with the consultant and to resolve any issues, which are identified. All of DEN's and approved tenant's written comments and requirements shall either be incorporated in the contract documents or addressed in some other appropriate written manner satisfactory to DEN within fourteen (14) calendar days after they are received. During this review period the consultant shall continue with any other work required unless is notified specifically to the contrary by DEN in writing.

32.10.3 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

Refer to the following chapters for discipline specific design submittal requirements:

- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems

32.10.4 Construction Documents 90% Submittal

The 90% submittal shall incorporate the comments and information gained from the 60% submittal and is a comprehensive and complete pre-final construction contract document, suitable for public procurement and construction. The documents shall essentially be 100% complete, pending any work for only minor corrections to resolve discrepancies discovered during the final review and for the incorporation of final client comments.

32.10.4.1 Drawings

The drawing set shall include all required construction working-drawing sheets completed to practically 100% level of completion. Refer to chapters 14 through 23 for additional 90% drawing submittal requirements for each discipline.

- Chapter 14- Civil Drawings
- Chapter 15- Landscape Drawings
- Chapter 16- Architectural Drawings

- Chapter 17- Structural Drawings
- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems
- Chapter 23- Signage and Graphics Drawings

32.10.4.2 Specifications

Specifications shall be complete, comprehensive, and fully coordinated with the working drawings between disciplines and with the contract and special provisions. Consultant shall coordinate with the DEN PM to ensure the contract and special provisions are projects specific. The specifications shall include the following contract requirements:

A. Supplemental conditions
B. Division 01- General Requirements
C. Division 02 through Division 48: All other technical specification sections

32.10.4.3 Cost Estimate at the 90% Submittal

The construction cost estimate accompanying the 90% submittal shall consist of a detailed line item estimate that shall include accurate unit costs and final quantities and will be used to verify compliance with the authorized construction budget. No contingency and minimal allowances should be required. This estimate shall be of sufficient detail to adequately analyze the contractor's proposal documents prior to contract award. A section of the cost estimate shall include a budget reconciliation detailing major variances between the total amount of the final proposal document estimate and that of the last estimate submittal.

32.10.4.4 Calculations

All calculations shall be finalized; incorporating all resolved comments and corrections of the 60% submittal.

32.10.4.5 Design Analysis Report

The Design Report shall be finalized by carefully coordinating, cross-referencing, and incorporating all resolved comments and corrections of the 60% submittal and the contents of all previously submitted design reports and revised to reflect the final design.

32.10.4.6 Schedule

The consultant shall furnish a finalized probable construction schedule for the overall times of procurement, fabrication, delivery, and installation of various systems of the projects, including consideration for phasing the construction work. The finalized probable construction schedule shall contain a level of detail consistent with the requirements of the applicable Construction Specification, as edited by the consultant and included in the construction documents. An electronic medium of a compressed back up shall be provided on CD or DVD with each submittal. As part of the 90% submittal the consultant shall include a draft of the schedule of construction submittals that lists all items, by specification section, that the construction contractor will have to submit for review and approval during the execution of the work. The consultant shall also provide a record *as executed* design schedule, indicating all significant changes from the original design schedule agreed upon at the NTP.

32.10.4.7 Spare Parts and Long Lead Items List

At the 90% submittal phase, the consultant shall have finalized the requirements for spare parts and long lead items. DEN shall schedule a meeting prior to submission of 90% submittals with design consultant and other DEN stakeholders to make project specific determination about what spare parts will be required.

32.11 Contract Documents Phase 100% Final Submittal

32.11.1 General

This submittal shall include all the requirements set forth in Chapter 6- Contract Documents.

32.11.2 Review by DEN – Final Review Meeting

The consultant shall schedule a meeting to review these documents with DEN. This meeting must be scheduled no later than thirty (30) calendar days prior to the date shown in the master schedule for completing these documents for each project. The consultant shall resubmit the in-progress submittal with all omissions corrected as instructed by DEN.

DEN will schedule a meeting no later than fourteen (14) calendar days after the Final Review meeting referred to above to discuss City questions, comments, or requirements and to resolve any disagreements between the parties. Prior to this meeting, DEN shall provide the consultant with their comments, requirements, approved tenant comments, and specific instructions on data or information that they require be incorporated into the RFP, contract documents, or other deliverables.

32.11.2.1 Certification

The consultant shall certify in writing that all the RFP or contract documents are in conformance with the DEN DSMs, all code agency requirements, and that the documents are complete. This certification will be forwarded to the FAA for acceptance when AIP funding is to be used for the projects. On federally funded projects, these documents will be submitted to the appropriate federal agency for review.

32.11.2.2 Documents

Comply with requirements of the DEN DSMs. All contract and RFP documents shall be complete. All design, drafting, coordination, dimensioning and cross references shall be complete, all agency plan comments shall be resolved, and DEN's and approved tenant's comments from all previous reviews must be incorporated into the documents or otherwise be addressed to the satisfaction of DEN. It is necessary that drawings be signed and stamped for this submittal.

32.11.2.3 Specifications

Comply with the requirements in Chapter 11- Specification Requirements including the Data and Product Submittal. Part I and Part II Specifications shall be complete. They will be in final draft format and shall be submitted in loose-leaf binders. The specifications shall include all DEN comments and approved tenant comments from all previous reviews or otherwise address them to the satisfaction of DEN.

32.11.2.4 Final Bid Items

The final bid items list or RFP items list shall be submitted complete with unit prices extended and totaled and with sufficient verifiable back-up data in a form acceptable to DEN, to allow DEN to review and verify the consultant's estimated unit prices.

32.11.2.5 Soils Reports

The consultant shall bind separately soils investigations performed by the consultant to establish design criteria for the project. This report shall be issued as an information attachment to the bid documents.

32.11.3 Construction Documents, 100% Submittal

The final submittal of the 100% construction contract documents shall incorporate all client comments developed by the 90% review, with all outstanding actions resolved. Deliverables shall include the following documents:

A. Consultant annotated responses to the design review comments from the 90% submittal.

B. Final drawings
C. Final specifications
D. Final cost estimate
E. Final Calculations
F. Final DAR
G. Final construction schedule, including phasing considerations.
H. Spare parts and long lead items list. At the 100% submittal phase, the consultant of record shall have finalized the requirements for spare parts and long lead items.
I. An original letter signed and sealed by the consultant and addressed to the client providing a list of the special inspections required by the Universal State Building Code (USBC) for the proposed work.
J. An original letter signed and sealed by the consultant of record and addressed to the client certifying that the design as submitted is in accordance with prevailing and applicable codes. Letter shall include a list of such codes used in the design.
K. An original letter signed and sealed by the consultant of record and addressed to the client for the temporary Support of Excavation (SOE) system, when applicable.
L. A complete list of all drawings submitted for final code review.
M. The final construction submittal schedule, listing all submittals required of the contractor by specification section.

32.11.4 Final Construction Documents

The final construction documents shall be comprehensive, clear, and suitable for the purposes of procurement, contracting, and construction, and shall incorporate the final, client-approved solicitation provisions, contract provisions, special provisions, conditions of the contract, and general requirements.

Refer to the following chapters for discipline specific design submittal requirements:

- Chapter 18- Mechanical Drawings
- Chapter 19- Plumbing Drawings
- Chapter 20- Fire Protection Drawings
- Chapter 21- Electrical Drawings
- Chapter 22- Communications/Electronic Systems

32.11.5 Certification Requirements

Final construction documents, including drawings, specifications, and calculations shall be sealed and signed by the appropriate Professional Registered Architect or Engineer-of-Record. Plans and specifications prepared for asbestos abatement, hazardous materials remediation, wetland delineation or other environmental activities shall be signed and sealed in accordance with federal and state regulations.

32.12 Submittals Concurrent to Final Contract Document Submittal

32.12.1 Agency and Utilities, Applications, and Permits

A. Identify all design or construction related governmental permits, licenses or other acceptances that are required to complete each project.
B. Prepare and submit to DEN technical data and information required to prepare any federal grant application and any State of Colorado or federal permit application. These submittals shall include the number of copies of contract drawings and specifications, which any State of Colorado, utility, and/or regulatory body requires in connection with their review and acceptance of the individual applications. DEN shall submit these applications to the appropriate agency, utility, and/or department.

C. During all phases of work, prepare and submit technical data and information to all government agencies, regulatory bodies, and public utilities necessary to obtain the required permits or acceptances to design and construct each project. A copy of this information shall be sent to DEN. The consultant shall either:
    a. Obtain, on behalf of DEN, and deliver to DEN's Building Inspection Division prior to publication of the Notice for Invitation to Bid, the permits and acceptances described above, or
    b. Confirm that these permits and acceptances have been obtained and all other requirements including the Building Division requirements have been satisfied by delivery to DEN, a letter signed by the Building Division and other authorized representatives of each government agency or regulatory body stating that the necessary building and other permits are ready to be issued to successful proposers for each construction contract.
    c. The consultant shall not be responsible for paying any construction permit fee unless the consultant is performing construction work or the activities of the consultant during testing require code agency reviews and permits.

D. The consultant shall also during the bidding and construction phases of this agreement submit to the government department, agency, regulatory body and/or public utilities technical data or information contained in addenda, change requests, change directives, and/or change orders, which those agencies, departments, regulatory bodies, or utilities need to issue any new or modified permits or acceptances and shall obtain those permits and acceptances on behalf of DEN and deliver them to the Building Division.

E. Incorporate in the contract documents submitted all revisions necessary to obtain the governmental permits and licenses or other acceptances.

F. Document all discussions relating to permits, licenses, and acceptances with City, State, and Federal agencies, regulatory bodies, departments, and with public utilities. Within 24 hours of meetings or discussions, provide DEN with copies of all meeting minutes and all serialized correspondence sent to and received from such agencies, departments, and public utilities relating to permits or acceptances, including copies of the permits, licenses, and acceptances.

32.13 Other In-Progress Submittals

DEN may require in-progress submittals at any time during the term of this agreement. These submittals may be required to address specific questions or issues related to matters such as interface problems or other issues associated with work performed by other consultants, tenants, design-build contractors, and contractors, and any special problem areas that are identified by DEN. DEN shall provide the consultant with its requirements for in-progress submittals with reasonable advance notice to allow the consultant to schedule and prepare the submittal.

32.14 Building Department Document Review Submittal

32.14.1 Building Department Review

Upon completion of the final review submittal and the written acceptance of this submittal by DEN and Senior Director, the consultant shall complete the contact documents and bind them, so they are ready for distribution to the Building Department for plan review. The contract documents shall be completed, reviewed, checked, signed, and sealed by the consultant. DEN's comments and approved tenant comments from previous reviews shall be incorporated in the contract documents and all outstanding issues shall be resolved to the satisfaction of DEN.

The consultant shall then schedule a meeting with the Project Manager for document review by the DEC Director. Upon review, the consultant will receive a letter of payment for plan review to accompany the plan review documents. The consultant shall deliver these documents to the Building Department for review and notify the Project Manager of the Building Department log number and provide a weekly update of the review status. The consultant shall address all Building Department issues at no additional cost to the project.

Immediately after acceptance by the Building Department, the consultant shall prepare the bid documents as indicated in the section below.

32.15 Bid or RFP Document Submittal

32.15.1 Bid and RFP Document Submittal

Upon completion of the final review submittal, DEN's and Senior Director's written acceptance of this submittal and approval of the Building Department Review, the consultant shall complete the Contract Documents and bind them, so they are ready for distribution to prospective bidders and/or proposers. The Contract Documents shall be completed, reviewed, checked, signed, and sealed by the consultant. DEN's comments and approved tenant comments from previous reviews shall be incorporated in the contract or RFP documents and all outstanding issues shall be resolved to the satisfaction of DEN. The consultant shall then, no later than seven (7) calendar days prior to when Notice of Invitation for Bids or Proposals is advertised, deliver electronic sets of the finalized contract documents to DEN for final conformance review and acceptance. Immediately after acceptance by DEN, the consultant shall prepare the following number of contract documents as indicated in Table 32-1: Minimum Submittal Requirements and Quantities.

The consultant shall prepare additional sets of contract documents for sale and distribution per direction from DEN.

32.15.2 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

32.16 Issue for Construction Submittals

32.16.1 General

Within fourteen (14) calendar days after bids or proposals are opened, the consultant shall incorporate or bind in all addenda issued by DEN during the bidding or RFP process into the construction or RFP contract documents as directed by DEN.

32.16.2 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

32.17 Record Document Submittal

32.17.1 General

Submit in compliance with Chapter 9- Record Documents.

32.17.2 Minimum Submittal Requirements and Quantities

For minimum submittal requirements and quantities, refer to Table 32-1: Minimum Submittal Requirements and Quantities.

Table 32-1: Minimum Submittal Requirements and Quantities

	Design Analysis Programming	Preliminary Design or Schematic Drawing	Design Development	Contract Documents				Plan Review		Bid Phase		Construction Administration		
				30%	60%	90%	100%	Bid Doc	Addenda	Bid Doc	Addenda	Conformed Document	CR	Record Docs
Reports	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Soils Report	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cost/Schedule Analysis	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PDF File	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SPECIFICATIONS														
Cut Sheets/ Specification Set	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Original Elec File	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Stamped & Sealed (Hard Copy)								1	1					
PDF File	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DRAWINGS														
Mylar 6 Mil														
½ Size Drawings														
CADD/3-D Model– Original Elec	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Navisworks Model	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Planning Study	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Composite Drawings	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Stamped & Sealed (Hard Copy)								2	2					
PDF File	1	1	1	1	1	1	1	1	1	1	1	1	1	1
REPORTS														
Refer to Requirements of Each Phase	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hard Copy	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bid Evaluation														
Certificate of Compliance	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PDF File	1	1	1	1	1	1	1	1			1		1	1
ELECTRONIC MEDIA														
Containing all the above Electronic Files	3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Contract Documents			Plan Review			Bid Phase	Construction Administration	
	90%	100%	Bid Doc	Addenda	Bid Doc	Addenda	Conformed Document	CR	Record Docs
Reports	1	1	1	1			1	1	1
Soils Report									
PDF File	1	1	1	1	1	1	1	1	1
SPECIFICATIONS									
Cut Sheets/ Specification Set	1	1	1	1			1	1	1
Original Elec File	1	1	1	1			1	1	1
Stamped & Sealed (Hard Copy)			1	1					
PDF File	1	1	1	1			1	1	1
DRAWINGS									
Mylar 6 Mil									
½ Size Drawings									
CADD/3-D Model– Original Elec	1	1	1	1			1	1	1
Navisworks Model	1	1	1	1			1	1	1
Planning Study	1	1	1	1			1	1	1
Composite Drawings	1	1	1	1			1	1	1
Stamped & Sealed (Hard Copy)			2	2					
PDF File	1	1	1	1			1	1	1
REPORTS									
Refer to Requirements of Each Phase	1	1	1	1			1	1	1
Hard Copy	1	1	1	1			1	1	1
Bid Evaluation									
Certificate of Compliance	1	1	1	1			1	1	1
PDF File	1	1	1				1	1	1
ELECTRONIC MEDIA									
Containing all the above Electronic Files	3	3	3	3			3	3	3

End of Chapter

Chapter 33 - Quality Control Plan

33.0 General

33.0.1 General Information and Requirements

The consultant shall develop, implement, and regularly utilize a document Quality Control Plan (QCP) for the project contract documents. The objective of the QCP is to achieve the following objectives to produce the contract documents:

A. The design is capable of being constructed with minimal/critical design modifications
B. The drawings and specifications accurately define the work to be performed
C. The drawings and specifications are produced without negligent errors or omissions
D. Drawings and specifications conform to the standards and criteria presented in this DSM
E. Construction can be accomplished in accordance with drawings and specifications and will result in functional systems that meeting the owner's intended use

The contract documents QCP established herein is to provide a consistent framework for review and communication between the architectural/engineering team disciplines. This framework is not intended to describe the full extent of the consultant's quality control efforts or the complete development of a checklist specific to the project. The consultant shall review this checklist and matching its level of detail, develop a similar checklist of applicable systems, materials, procedures, etc. of the project that are necessary for the complete development and proper functioning of the project and which are not identified in the checklist. These additional systems, materials, procedures, etc. shall be defined during the programming phase of the project and the quality control checklist developed accordingly.

During the design development phase, the consultant shall start the document quality control checklist process. At a minimum, each successive submittal during the design development and construction documents phases shall contain a completed Quality Control Checklist. The submittal shall provide evidence that a formal process of verification of quality, accuracy, and coordination of the project contract documents was taken place within the context of the consultant's overall quality assurance process.

33.1 Quality Control Plan

33.1.1 General

The consultant is responsible for making sure that each project discipline establishes and adheres to a quality control plan. The consultant shall actively monitor each discipline's use of the plans procedures and that the checklist is being utilized to monitor the development of the document packages. Each member of the project team is responsible for the finished quality of all designs and documents produced by them.

At a minimum, the consultant's quality control plan shall achieve the following:

A. All disciplines define their quality control approach detailed form.
B. Complete and thorough information is shown, checked, and reviewed.
C. Contents are without negligent errors and omissions.
D. CADD standards conform to the standards presented in DFI DSM.
E. Drawings and specifications conform to the standards presented in this DSM.
F. Conflicts between documents; whether between different discipline drawings, electronic media, or between the plans and specifications; minimized.
G. Issuance of drawings and specification conform to the standards presented in this DSM.
H. The contract documents quality control plan provides evidence that the consultant/subconsultants will check the quality, accuracy, and coordination of the project's contract documents. All documents will be checked using a formal procedure.

33.1.2 Quality Control Checklist

A quality control checklist is available to establish a minimum level of thoroughness for the development of a project specific document quality control checklist. The consultant shall obtain a copy of this checklist from the DEN Project Manager, review this checklist and based upon the specifics of the project, modify this checklist to meet the specific need for document quality control for its design. The quality control checklist is to be submitted with each design development and construction document submittal as defined in this standard presented in this DSM.

Complete the following steps to create a customized project Quality Control Checklist:

A. Unprotect document form control.
B. Edit the Header information for the project.
C. Lock the document to use the checklist features.

End of Chapter