EXPRO National Manual for Projects Management

Volume 6, chapter 7

Mechanical Design Aids

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1.0 PURPOSE

The purpose of this section is to provide the Entity-A/E the templates, checklists, design guidelines, etc. (collectively called Design Aids) to comprehensively define the Mechanical design of a Project and ensure that the design is complete, uses appropriate templates and has undergone the necessary checks to achieve the quality design which can be used to purchase fit for purpose material/ equipment and safely install all facilities under Entity's project.

Refer to Volume 6 Chapter 7 - General Design Guidelines (Document No EPM-KE0-GL-000016) for the definition of terms used and the instructions on the use of every element of Design Aids. Section 12 also covers non-discipline specific Design Aid such as Calculation Templates, Calculation check list, Design software list, etc. which apply to all engineering disciplines including Mechanical. Users are urged to carefully read the instructions provided in Chapter 7, Section 1 to fully understand the purpose and use of all documents listed in this section.

The Entity-A/E shall review the list of documents in both sections (Section 12 and 13) of Volume 6 Chapter 7 and determine the templates, check lists, etc. applicable to its project. The list of applicable templates/ checklists/ etc. may vary from project to project depending upon the Design Scope of Work of every Project.

2.0 REFERENCE

1. EPM-KE0-GL-000016 - General Design Guidelines
2. EPM-KEM-GL-000001 - Mechanical Design Guideline
3. EPM-KEM-GL-000003 – District Cooling Design Guidelines

3.0 MECHANICAL DESIGN AID

The Mechanical Design Aids developed for use on Entity's projects are listed below, each issued as a standalone document.

3.1 Mechanical Design Guideline

Refer to Chapter 7 of Volume 6- General Design Guidelines (Document No EPM-KE0-GL-000016) for the purpose and the instructions on the use of discipline Design Guidelines issued for use in the design of Entity's Projects.

Refer to the document EPM-KEM-GL-000001 for the details of Mechanical Design Guideline.

3.2 Mechanical Design Deliverables

Refer to Chapter 7 of Volume 6- General Design Guidelines (Document No EPM-KE0-GL-000016) for the purpose and the instructions on the use of List of Design Deliverables issued for use in the design of Entity's projects.

Refer to the document EPM-KEM-RG-000009 for a typical list of design deliverables applicable for the Mechanical design discipline.

3.3 Design Check Lists

Refer to Chapter 7 of Volume 6- General Design Guidelines (Document No EPM-KE0-GL-000016) for the purpose and the instructions on the use of Checklists issued for the use in the design of Entity's projects.

The Table below lists Mechanical check lists issued for use on Entity's Projects.

List of Mechanical Checklists

SN	Checklist for	Document No.
1	Mechanical Plant Room Layout	EPM-KEM-TP-000001
2	HVAC Riser Diagram	EPM-KEM-TP-000002
3	HVAC Layout	EPM-KEM-TP-000003
4	P&ID	EPM-KEM-TP-000004
5	Equipment Schedule	EPM-KEM-TP-000005
6	Fire Protection Layout	EPM-KEM-TP-000006
7	Under Ground Utility Layout	EPM-KEM-TP-000007
8	Standard Mechanical Design Deliverables	EPM-KEM-TP-000026

3.4 Templates

Refer to Chapter 7 of Volume 6- General Design Guidelines (Document No EPM-KE0-GL-000016) for the purpose and the instructions on the use of Templates issued for the use in the design of Entity's projects.

Table below lists Mechanical templates issued for use on Entity's Projects.

List of Mechanical Templates

SN	Template for	Document No.
1	Diesel Engine Data Sheet	EPM-KEM-TP-000010
2	Mechanical Equipment List	EPM-KEM-TP-000012
3	Mechanical Design Criteria	EPM-KEM-TP-000014
4	MED Desalination System – Process Data Sheet	EPM-KEM-TP-000015
5	Miscellaneous Chemical Feed Systems Data Sheet	EPM-KEM-TP-000016
6	Atmospheric Bulk Chemical Storage Tank Data Sheet	EPM-KEM-TP-000017
7	Horizontal Centrifugal Pumps Data Sheet	EPM-KEM-TP-000018
8	Sump Pump Data Sheet	EPM-KEM-TP-000019
9	Roof Mounted Ventilation Fan Assembly Data Sheet	EPM-KEM-TP-000020
10	Sewage Lift Station Data Sheet	EPM-KEM-TP-000021
11	Hydropneumatics Tank / System Data Sheet	EPM-KEM-TP-000022

3.5 Typical Construction Detail Drawings (TCDDs)

Refer to 11.6 of Chapter 7, Section 1 - General Design Guidelines (Document No EPM-KE0-GL-000016) for the purpose of issue of TCDD in the design of Entity's projects.

Table below lists examples of Mechanical TCDD's issued as sample for use by Entity.

SN	Title of Drawing	Drawing Number
21	Fire Water Sprinkler Nozzles	EPM-KEM-05-000001
22	Typical Take Off from Rectangular Duct to Round Duct - Duct Transitions	EPM-KEM-05-000002
23	Emergency Shower/Eye-Wash Detail	EPM-KEM-05-000003
24	Elevator Sump Pump Piping Detail	EPM-KEM-05-000004
25	Installation Detail of Fire Hydrant (Wet-Barrel)	EPM-KEM-05-000005

3.6 District Cooling Regulatory Requirements

Pursuant to Ministers Council Resolution No. 27 dated 3 Nov 2015, the Electricity and Cogeneration Regulatory Authority (ECRA) have issued a Regulatory Framework No. ERD-TA-010 (v-17) dated 29 Ausust 2017 for District Cooling. The ECRA resolution mandates the use of District Cooling systems by all government Entities for new projects requiring cooling loads/ building coefficient values specified in the Regulatory Frameworks. The frameworks also defines procedures for licensing, national criteria for district cooling implementation, etc. Refer to Document No: EPM-KEM-GL-000003 – District Cooling Guideline for as a guide in the design of cost and energy efficient District Cooling Systems. Just like any other design guidelines included in the Mashroat Projects White book, this guideline is also for reference purposes and not mandatory. Entity shall hold A/E's responsible for the efficient and compliant designs of their projects.

Entities shall consider all applicable requirements of ECRA regulatory framework in the initial planning and design of all new government infrastructure projets across the KSA.

4.0 ATTACHMENTS

1. EPM-KEM-TP-000001 - Checklist - Mechanical Plant Room Layout
2. EPM-KEM-TP-000002 - Checklist - HVAC Riser Diagram
3. EPM-KEM-TP-000003 - Checklist - HVAC (Duct) Layout Drawing
4. EPM-KEM-TP-000004 - Checklist - P&ID
5. EPM-KEM-TP-000005 - Checklist - Equipment Schedule
6. EPM-KEM-TP-000006 - Checklist - Fire Protection (Pipe) Layout Drawing
7. EPM-KEM-TP-000007 - Checklist - U/G Utility (Pipe) Layout Drawing
8. EPM-KEM-TP-000026 - Checklist - Standard Mechanical Design Deliverables
9. EPM-KEM-TP-000010 - Template - Diesel Generator Data Sheet
10. EPM-KEM-TP-000012 - Template - Mechanical Equipment List
11. EPM-KEM-TP-000014 - Template - Mechanical Design Criteria
12. EPM-KEM-TP-000015 - Template - MED Desalination System Data Sheet
13. EPM-KEM-TP-000016 - Template - Miscellaneous Chemical Feed System Data Sheet
14. EPM-KEM-TP-000017 - Template - Atmospheric Bulk Chemical Feed System Data Sheet
15. EPM-KEM-TP-000018 - Template - Horizontal Centrifugal Pump Data Sheet
16. EPM-KEM-TP-000019 - Template - Sump Pump Data Sheet
17. EPM-KEM-TP-000020 - Template - Roof Mounted Vent Fan Assembly Data Sheet
18. EPM-KEM-TP-000021 - Template - Sewage Lift Station Data Sheet
19. EPM-KEM-TP-000022 - Template - Hydropneumatics Tank System Data Sheet
20. EPM-KEM-RG-000001 - List of Mechanical Deliverables
21. EPM-KEM-05-000001 - Fire Water Sprinkler Nozzles
22. EPM-KEM-05-000002 - Typical Take Off from Rectangular Duct to Round Duct - Duct Transitions
23. EPM-KEM-05-000003 - Emergency Shower/Eye-Wash Detail
24. EPM-KEM-05-000004 - Elevator Sump Pump Piping Detail
25. EPM-KEM-05-000005 - Installation Detail of Fire Hydrant (Wet-Barrel)

Attachment 1 - EPM-KEM-TP-000001 - Checklist - Mechanical Plant Room Layout

PROJECT NAME:	Mech. Plant Room Layout Drawing No.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Was the latest background for the building/structure used?	☐	☐	☐	☐	☐	☐
3	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Is the layout drawing number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
5	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
6	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
7	Are equipment names and tag or mark numbers shown on the layout drawing?	☐	☐	☐	☐	☐	☐
8	Are building columns identified and dimensioned (with coordinates for "X" and "Y" axis directions)?	☐	☐	☐	☐	☐	☐
9	Are vertical dimensions shown on elevation sections (e.g., from floor to equipment connections/nozzles and top of equipment)?	☐	☐	☐	☐	☐	☐
10	Are horizontal dimensions shown (e.g., from centerline of building column or wall: to closest edge of equipment and any connections/nozzles)?	☐	☐	☐	☐	☐	☐
11	Is the equipment layout optimized for total installed cost (e.g., to allow for the most efficient pipe and duct runs while maintaining appropriate access to equipment)?	☐	☐	☐	☐	☐	☐
12	Are the control cabinets and electrical modules (e.g., motor control centers or switchgear) associated with the mechanical equipment located on the drawing?	☐	☐	☐	☐	☐	☐
13	If electrical/control equipment is present, is any pipe routed to avoid the space directly above this equipment and to meet any required separation criteria?	☐	☐	☐	☐	☐	☐
14	Are elevator shafts and hoist ways shown if required?	☐	☐	☐	☐	☐	☐
15	Is space shown (or reserved) for any pipe chases and duct shafts?	☐	☐	☐	☐	☐	☐
16	If permanent monorails are required to lift heavy equipment, are the rails located and are the lifting capacities identified?	☐	☐	☐	☐	☐	☐
17	If equipment removal hatches are required, is space reserved to access the hatch?	☐	☐	☐	☐	☐	☐
18	Are doorways shown for personnel and vehicle access (with direction of opening)?	☐	☐	☐	☐	☐	☐
19	Are aisles wide enough to meet local safety codes for personnel passageway?	☐	☐	☐	☐	☐	☐
20	Are aisles wide enough for a forklift (or other vehicle) to perform equipment maintenance or removal?	☐	☐	☐	☐	☐	☐
21	Are curbs or diked walls required to contain any hazardous materials?	☐	☐	☐	☐	☐	☐
22	For areas with hazardous materials, are Eye Wash Stations or Safety Showers located in easily accessible locations (to make a direct run using existing aisle)?	☐	☐	☐	☐	☐	☐
23	Is the floor material identified (e.g., grating, concrete, checkered plate, etc.)?	☐	☐	☐	☐	☐	☐
24	If sumps are required, are they shown with dimensions (length, width, and depth)?	☐	☐	☐	☐	☐	☐
25	Have floor drains been provided in convenient locations to allow for easy drainage of equipment if required for maintenance?	☐	☐	☐	☐	☐	☐
26	If there are any platforms or mezzanine levels, is the extent of the partial floor area identified in plan view (or in a section detail)?	☐	☐	☐	☐	☐	☐

Attachment 2 - EPM-KEM-TP-000002 - Checklist - HVAC Riser Diagram

PROJECT NAME:	HVAC RISER DIAGRAM NO.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
3	Is the HVAC Riser Diagram number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
5	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
6	Are the symbols for equipment, lines, ducts, valves, dampers, and in-line specialty components in accordance with the Project's standard symbols and legends?	☐	☐	☐	☐	☐	☐
7	Are tag numbers assigned to equipment, lines, ducts, valves, dampers, and in-line specialty components in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
8	Are line or duct sizes shown on the HVAC Riser Diagram, and are they appropriate for the fluid service?	☐	☐	☐	☐	☐	☐
9	Is there a note on the HVAC Riser Diagram to identify the material and thickness of the pipe or duct shown on the drawing?	☐	☐	☐	☐	☐	☐
10	Are flows and equipment ratings shown on the drawing? (Check "N/A" if there is a note referencing the associated Equipment Schedule with this information.)	☐	☐	☐	☐	☐	☐
11	Do calculations for line or duct sizing support the sizes shown on the drawing?	☐	☐	☐	☐	☐	☐
12	Do fluid velocities fall within industry guidelines?	☐	☐	☐	☐	☐	☐
13	Is there a calculation for the pressure class of the system?	☐	☐	☐	☐	☐	☐
14	Are the pipe or duct materials used rated for the design conditions of the system?	☐	☐	☐	☐	☐	☐
15	Is the direction of flow indicated (if not obvious) for all pipelines or duct runs?	☐	☐	☐	☐	☐	☐
16	Were all the match lines checked on this drawing and found to be correct?	☐	☐	☐	☐	☐	☐
17	Do the line or duct sizes on this HVAC Riser Diagram sheet match other HVAC Riser Diagram sheets at the interfaces (for all off-page connector match points)?	☐	☐	☐	☐	☐	☐
18	Are precise scope boundaries shown on the HVAC Riser Diagram to clearly show the scope of supply for each separate subcontractor and the associated interfaces?	☐	☐	☐	☐	☐	☐
19	Does the system design comply with applicable codes, standards, and regulatory requirements?	☐	☐	☐	☐	☐	☐
20	Does the system design comply with the applicable Project Mechanical Design Criteria, Project Scope Book, or any other Project Design Basis Documents?	☐	☐	☐	☐	☐	☐
21	Are the notes appropriate and are they marked in applicable places on the drawing?	☐	☐	☐	☐	☐	☐
22	Are Standard Details or other drawings referenced in the notes where appropriate?	☐	☐	☐	☐	☐	☐
23	Has appropriate interdisciplinary and intradepartmental coordination of the HVAC Riser Diagram been completed?	☐	☐	☐	☐	☐	☐
24	Has the Originator of the HVAC Riser Diagram resolved coordination comments and incorporated changes where required?	☐	☐	☐	☐	☐	☐
25	On HVAC Riser Diagrams "Issued for Use" (Rev. 000 or higher), have areas of the drawing with incomplete designs or preliminary information been placed on hold?	☐	☐	☐	☐	☐	☐

Attachment 3 - EPM-KEM-TP-000003 - Checklist - HVAC (Duct) Layout Drawing

PROJECT NAME:	HVAC LAYOUT DWG NO.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Was the latest background for the building/structure used?	☐	☐	☐	☐	☐	☐
3	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Is the layout drawing number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
5	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
6	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
7	Are the symbols for HVAC equipment, ducts, and any other specialty components in accordance with the Project's standard symbols and legends?	☐	☐	☐	☐	☐	☐
8	Are the tags assigned to equipment, ducts, dampers, specialty components, and floor/wall penetrations consistent with the associated riser diagram?	☐	☐	☐	☐	☐	☐
9	Are the equipment, duct, and damper sizes, materials/thicknesses, and configuration consistent with the latest version of the associated riser diagram?	☐	☐	☐	☐	☐	☐
10	Are there any markups on the master red-lined riser diagram (showing pending riser diagram changes) that need to be incorporated into the layout on this drawing?	☐	☐	☐	☐	☐	☐
11	Are there any changes that need to be marked up on the master red-lined riser diagram to reflect the "as-built" configuration shown on this layout drawing?	☐	☐	☐	☐	☐	☐
12	Are duct sizes shown on main runs and branches (height x width for rectangular ducts or diameter for round ducts)?	☐	☐	☐	☐	☐	☐
13	Are duct materials and ratings (with correct thicknesses) shown on the drawing (or in the notes) and are they appropriate for the service?	☐	☐	☐	☐	☐	☐
14	Are duct elevations shown (e.g., from floor to: bottom of rectangular ducts or centerline of round ducts)?	☐	☐	☐	☐	☐	☐
15	Are duct horizontal dimensions shown if required (e.g., from centerline of building column or wall: to closest edge of rectangular ducts or centerline of round ducts)?	☐	☐	☐	☐	☐	☐
16	Are balancing dampers provided at each branch?	☐	☐	☐	☐	☐	☐
17	Are fire dampers included in duct penetrations through fire-rated walls if required?	☐	☐	☐	☐	☐	☐
18	Are backdraft or isolation dampers provided at fan/blower discharges if required?	☐	☐	☐	☐	☐	☐
19	Are ducts at equipment connections the correct sizes (to match information on supplier drawings) or are transition pieces included to mate up with equipment?	☐	☐	☐	☐	☐	☐
20	Are flexible connections or expansion joints shown where required for equipment connections?	☐	☐	☐	☐	☐	☐
21	Do calculations for duct sizing support the duct sizes shown on the drawing?	☐	☐	☐	☐	☐	☐
22	Do air velocities fall within industry guidelines?	☐	☐	☐	☐	☐	☐
23	Is the direction of flow indicated (if not obvious) for all duct runs?	☐	☐	☐	☐	☐	☐
24	Have Constructability requirements been considered?	☐	☐	☐	☐	☐	☐
25	Have Operability requirements been considered?	☐	☐	☐	☐	☐	☐
26	Has Accessibility for repair, maintenance, and inspection been considered?	☐	☐	☐	☐	☐	☐
27	Are duct and equipment access doors shown with appropriate space to open?	☐	☐	☐	☐	☐	☐

Attachment 4 - EPM-KEM-TP-000004 - Checklist - P&ID

PROJECT NAME:	P&ID NO.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
3	Is the P&ID drawing number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
5	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
6	Are the symbols for equipment, lines, valves, and in-line specialty components in accordance with the Project's standard symbols and legends?	☐	☐	☐	☐	☐	☐
7	Are tags assigned to equipment, instruments, lines, valves, and in-line specialty components in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
8	Are line sizes, material classes, and ratings (indicating schedule/thickness) shown on the drawing, and are they appropriate for the fluid service?	☐	☐	☐	☐	☐	☐
9	Do calculations for line sizing support the line sizes shown on the P&ID?	☐	☐	☐	☐	☐	☐
10	Do fluid velocities fall within industry guidelines?	☐	☐	☐	☐	☐	☐
11	Is there a calculation for the design pressures and temperatures of the system?	☐	☐	☐	☐	☐	☐
12	Are the pipe materials used rated for the design conditions of the system?	☐	☐	☐	☐	☐	☐
13	If a lower rated pipe class is used downstream of a pressure reduction device, is a pressure relief valve or rupture disk required and included in the scope?	☐	☐	☐	☐	☐	☐
14	Is the direction of flow indicated (if not obvious) for all lines?	☐	☐	☐	☐	☐	☐
15	Is control logic shown correctly for automatic operation of equipment/system?	☐	☐	☐	☐	☐	☐
16	Were all the match lines checked on this P&ID sheet and found to be correct?	☐	☐	☐	☐	☐	☐
17	Do the line sizes and pipe classes on this P&ID sheet match other P&ID sheets at the interfaces (for all off-page connector match points)?	☐	☐	☐	☐	☐	☐
18	Are precise scope boundaries shown on the P&ID to clearly show the scope of supply for each separate subcontractor and the associated interfaces?	☐	☐	☐	☐	☐	☐
19	Are flush-out connections shown (if required)?	☐	☐	☐	☐	☐	☐
20	Does the system design comply with applicable codes, standards, and regulatory requirements?	☐	☐	☐	☐	☐	☐
21	Does the system design comply with the applicable Project Mechanical Design Criteria, Project Scope Book, or any other Project Design Basis Documents?	☐	☐	☐	☐	☐	☐
22	Are the notes appropriate and are they marked in applicable places on the P&ID?	☐	☐	☐	☐	☐	☐
23	Has appropriate interdisciplinary and intradepartmental coordination of the P&ID been completed?	☐	☐	☐	☐	☐	☐
24	Has the Originator of the P&ID resolved coordination comments and incorporated changes where required?	☐	☐	☐	☐	☐	☐
25	If required, has the P&ID been stamped by a registered Professional Engineer?	☐	☐	☐	☐	☐	☐
26	On P&IDs "Issued for Use" (Rev. 000 or higher), have areas of the drawing with incomplete designs or preliminary information been placed on hold?	☐	☐	☐	☐	☐	☐

Attachment 5 - EPM-KEM-TP-000005 - Checklist - Equipment Schedule

PROJECT NAME:	EQUIPMENT SCHEDULE NO.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct Equipment Schedule template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
3	Is the Equipment Schedule number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
5	Is there an Intellectual Property (IP)/Disclaimer Statement on the document?	☐	☐	☐	☐	☐	☐
6	Is each piece of equipment associated with the particular system design on a given drawing listed with an appropriate description and ratings as listed below?	☐	☐	☐	☐	☐	☐
7	Is there a unique Tag Number or Mark Number given for each line item?	☐	☐	☐	☐	☐	☐
8	Is a Location, Service, and/or System included for each line item?	☐	☐	☐	☐	☐	☐
9	Is an Equipment Rating/Capacity shown as appropriate for each line item? (e.g., flow, head, pressure differential, duty or load, surface area, volume, etc.)	☐	☐	☐	☐	☐	☐
10	Are inlet/outlet fluid conditions listed for all appropriate line items? (e.g., fluid type, pressure and temperature or differentials, velocity, etc.)?	☐	☐	☐	☐	☐	☐
11	Is motor/power information provided (e.g., RPM, kW, Voltage, Phase, etc.)?	☐	☐	☐	☐	☐	☐
12	Are the Manufacturer and Model Number show for each item?	☐	☐	☐	☐	☐	☐
13	Are the Notes, Remarks, and References appropriate and correct?	☐	☐	☐	☐	☐	☐
14	Has appropriate interdisciplinary and intradepartmental coordination of the Equipment Schedule been completed?	☐	☐	☐	☐	☐	☐
15	Has the Originator of the Equipment Schedule resolved coordination comments and incorporated changes where required?	☐	☐	☐	☐	☐	☐
16	On Equipment Schedules "Issued for Use" (Rev. 000 or higher), have line items that have not been confirmed been placed on hold?	☐	☐	☐	☐	☐	☐
17	If the Equipment Schedule is being revised, are changes clearly shown (e.g., using clouds, revision triangles, or notes in the revision line of the title block)?	☐	☐	☐	☐	☐	☐
18	If the Equipment Schedule is being revised, are all previous revision markings (clouds or triangles) removed?	☐	☐	☐	☐	☐	☐

No.	Reviewer's Comments (against each SLD)	Resolution

Originator's Name / Signature and Date:	Checker's Name / Signature and Date:

Attachment 6 - EPM-KEM-TP-000006 - Checklist - Fire Protection (Pipe) Layout Drawing

PROJECT NAME:		FIRE PROTECTION LAYOUT DWG NO.			REV.		
No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Was the latest background used?	☐	☐	☐	☐	☐	☐
3	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Is the layout drawing number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
5	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
6	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
7	Are the symbols for piping, valves, and any other specialty components in accordance with the Project's standard symbols and legends?	☐	☐	☐	☐	☐	☐
8	Are the line tag numbers, sizes, materials, and configuration consistent with the latest version of the associated riser diagram?	☐	☐	☐	☐	☐	☐
9	Is the configuration for valves, branch lines, and in-line specialty equipment consistent with the latest version of the associated riser diagram?	☐	☐	☐	☐	☐	☐
10	Are there any markups on the master red-lined riser diagram (showing pending riser diagram changes) that need to be incorporated into the pipe layout on this drawing?	☐	☐	☐	☐	☐	☐
11	Are there any changes that need to be marked on the master red-lined riser diagram to reflect the "as-built" configuration shown on this layout drawing?	☐	☐	☐	☐	☐	☐
12	Does the water supply to the building/facility include a post-indicator valve located at the appropriate (safe) distance from the structure (e.g., ≥ 40 ft / 12 m)?	☐	☐	☐	☐	☐	☐
13	Is the fire protection main isolation valve conveniently located (either in the sprinkler valve room, at the main entrance door, or in the main stairwell)?	☐	☐	☐	☐	☐	☐
14	If the fire protection line is fed from the potable water supply, is there a backflow preventer in the branch line to the fire protection system?	☐	☐	☐	☐	☐	☐
15	Do the standpipe pressures stay within the allowable range while meeting the minimum pressure at the top of each standpipe to meet the fire protection code?	☐	☐	☐	☐	☐	☐
16	Are standpipe hose connections provided within the structure to supplement yard hydrant coverage of the structure in accordance with the fire protection code?	☐	☐	☐	☐	☐	☐
17	Does the number of sprinklers and associated sprinkler head spacing meet the fire protection code requirements?	☐	☐	☐	☐	☐	☐
18	Does the pressure at the most hydraulically remote sprinkler head meet the minimum pressure required by the fire protection code?	☐	☐	☐	☐	☐	☐
19	Are sprinklers located under any obstructions that are ≥ 4 ft / 1.2 m wide (e.g., platforms, ducts, grating, etc.) where required by the fire protection code?	☐	☐	☐	☐	☐	☐
20	Are the K-factors identified for all the sprinkler heads, and are they all appropriate for the area hazard?	☐	☐	☐	☐	☐	☐
21	Are the temperature ratings identified for all automatic sprinkler heads, and are they all appropriate for the area hazard?	☐	☐	☐	☐	☐	☐
22	Is a main drain test connection provided for each sprinkler system?	☐	☐	☐	☐	☐	☐

Attachment 7 - EPM-KEM-TP-000007 - Checklist - U/G Utility (Pipe) Layout Drawing

PROJECT NAME:	U/G UTILITY LAYOUT DWG NO.	REV.

No.	QUESTIONS	ORIGINATOR			CHECKER		
		N/A	YES	NO	N/A	YES	NO
1	Was the correct drawing template used (title block and borders)?	☐	☐	☐	☐	☐	☐
2	Was the latest background used?	☐	☐	☐	☐	☐	☐
3	Does the title block show the reason for issue/revision, and is the associated revision letter or number appropriate and consistent with Project Procedures?	☐	☐	☐	☐	☐	☐
4	Is the layout drawing number in accordance with Project Procedures?	☐	☐	☐	☐	☐	☐
5	Have all outstanding change papers (e.g., DCNs, FCDs, NCRs, etc.) been incorporated and noted as such in the title block?	☐	☐	☐	☐	☐	☐
6	Is there an Intellectual Property (IP)/Disclaimer Statement on the drawing?	☐	☐	☐	☐	☐	☐
7	Are the symbols for piping, valves, and any other specialty components in accordance with the Project's standard symbols and legends?	☐	☐	☐	☐	☐	☐
8	Are the line tag numbers, sizes, materials, and configuration consistent with the latest version of the associated P&ID?	☐	☐	☐	☐	☐	☐
9	Are there any markups on the master red-lined P&ID (showing pending P&ID changes) that need to be incorporated into the pipe layout on this drawing?	☐	☐	☐	☐	☐	☐
10	Are there any changes (e.g., branch take-off order) that need to be marked on the master red-lined P&ID to reflect the "as-built" configuration on this layout drawing?	☐	☐	☐	☐	☐	☐
11	Are any specialty fittings clearly identified (e.g. reducing tee, 45° elbow, long-radius vs. short radius 90° elbow, etc.)?	☐	☐	☐	☐	☐	☐
12	Are valve boxes shown to allow access to any valves located below grade and are reach rods or extension stems show on such valves?	☐	☐	☐	☐	☐	☐
13	If back-flow preventers or check valves are required in the underground lines, is the orientation (direction of flow) of each valve correctly shown?	☐	☐	☐	☐	☐	☐
14	Are sufficient dimensions shown to precisely locate and describe the pipe configuration (with dimensions indicated for all horizontal and vertical runs)?	☐	☐	☐	☐	☐	☐
15	Is the pipe sloped properly (per the applicable plumbing code) and to allow for drainage if required?	☐	☐	☐	☐	☐	☐
16	Are field welds/fusions/connections shown and are they in appropriate locations (outside the bend clamp length where applicable for flexible, non-metal pipe)?	☐	☐	☐	☐	☐	☐
17	Are individual spool lengths (between field welds/fusions/ connections) appropriate for transport to the project site?	☐	☐	☐	☐	☐	☐
18	Do valve end-to-end dimensions match the appropriate supplier drawings?	☐	☐	☐	☐	☐	☐
19	Is the direction of flow indicated (if not obvious) for all lines?	☐	☐	☐	☐	☐	☐
20	Have Constructability requirements been considered?	☐	☐	☐	☐	☐	☐
21	Have Operability requirements been considered?	☐	☐	☐	☐	☐	☐
22	Has Accessibility for repair, maintenance, and inspection been considered?	☐	☐	☐	☐	☐	☐
23	Is cathodic protection indicated if required?	☐	☐	☐	☐	☐	☐
24	Has an interference check been performed and have clashes been resolved?	☐	☐	☐	☐	☐	☐
25	Were all the match lines checked on this drawing and found to be correct?	☐	☐	☐	☐	☐	☐
26	Do the line sizes and material/ratings on this drawing match other drawings at the interfaces (for all off-page connector match points)?	☐	☐	☐	☐	☐	☐

Attachment 8 - EPM-KEM-TP-000026 - Checklist - Standard Mechanical Design Deliverables

PROJECT NAME:		DISCIPLINE:	REV.
EQUIPMENT TYPE: STANDARD MECHANICAL DESIGN DELIVERABLES	EQUIPMENT TAG:	EQUIPMENT LOCATION:	

No.	QUESTIONS	ORIGINATOR		
		N/A	YES	NO
	HVAC SYSTEM DELIVERABLES			
1	HVAC Plan and Drawing which includes the following:			
	a. General Notes, Legends, and Abbreviation	☐	☐	☐
	b. Drawing List	☐	☐	☐
	c. Standard Detail Drawings	☐	☐	☐
	d. Ducting Floor Plan Layout Drawings showing Uniform Friction Losses (UFL) and air velocity. UFL is shown to ensure oversizing is avoided and velocity to avoid excessive noise generation.	☐	☐	☐
	e. Chilled/condenser Water or Refrigerant Piping Floor Plan Layout Drawings. UFL and fluid velocity is shown to ensure oversizing is avoided and velocity to avoid excessive noise generation.	☐	☐	☐
	f. Steam and Process Hot Water Piping Floor Plan Lay-out Drawings. Fluid velocity is shown to ensure excessive sizing is avoided.	☐	☐	☐
	g. Plant Room Lay-out Drawing	☐	☐	☐
	h. External/Underground mechanical piping services drawings (as applicable)	☐	☐	☐
	i. Single Line Diagram for chilled water distribution systems. UFL and velocity is indicated.	☐	☐	☐
	j. Single Line Diagram for air distribution systems. UFL and velocity is indicated.	☐	☐	☐
	k. Single Line Diagram for steam systems. Fluid velocity is indicated.	☐	☐	☐
	l. Equipment Schedule	☐	☐	☐
	m. BMS Process and Instrumentation Diagram for equipment, water and air distribution system	☐	☐	☐
	n. BMS Sequence of Operation for equipment, water and air distribution system	☐	☐	☐
	o. Based on Psychrometric Analysis, the AHU internal arrangement for cooling coil, humidifier, dehumidifier and heating coil (as applicable)	☐	☐	☐
2	Calculations which includes:			
	a. Cooling and heating load output from Hevacomp, HAP, TRACE, and other reputable HVAC software	☐	☐	☐
	b. Airflow calculation for application with minimum ACH (Air change per Hour) requirement- e.g. Healthcare, Laboratories, cleanrooms, semi-conductors, etc.	☐	☐	☐
	c. Psychrometric Process and calculation for cooling, heating, humidification, and dehumidification- applicable for complex HVAC system (healthcare, medicine factory, paper factory, etc.) Centralized AHU process, with minimal allowed precise room temperature/RH fluctuations, low temperature or %RH application, and dual external seasons (hot and cold ambient conditions).	☐	☐	☐
	d. Fresh Air requirements for Indoor Air Quality and Building Pressurization	☐	☐	☐
	e. Exhaust requirements for toilets, kitchen, isolation, etc.	☐	☐	☐
	f. HVAC Equipment calculation which includes:	☐	☐	☐
	• Cooling capacity for AHU, FAHU, and FCU	☐	☐	☐
	• Heating capacity for AHU, FAHU, and FCU as applicable	☐	☐	☐
	• Energy Recovery Unit for AHU and HRF (Heat Recovery Fan)	☐	☐	☐
	• AHU Fan flowrate, ESP (External Static Pressure), and consumed power based on TSP (Total Static Pressure).	☐	☐	☐
	• Supply/Exhaust Fan flowrate, ESP (External Static Pressure), and consumed power.	☐	☐	☐
	• Chilled Water Pump flowrate and head	☐	☐	☐
	• Condenser Water Pump flowrate and head	☐	☐	☐
	• Cooling Tower Capacity and CT Fan flowrate/Power Consumption	☐	☐	☐
	• Process Heating Circulating Pump flowrate and head	☐	☐	☐
	• Chiller nominal capacity based on target de-rating factor	☐	☐	☐

Attachment 9 - EPM-KEM-TP-000010 - Template - Diesel Generator Data Sheet

1	EQUIPMENT NUMBER(S)			
2	MAKE & MODEL OF ENGINE / TWO OR FOUR CYCLE			
3	ENGINE POWER @ 100% LOAD	(kW)		
4	EXHAUST MANIFOLD TEMPERATURE @ 100% LOAD	(°C)		
5	EXHAUST GAS FLOW @ 100% LOAD	(l/s)		
6	RATED SPEED	(rpm)		
7	TYPE AND MODEL OF SUPERCHARGER			
8	BRAKE MEAN EFFECTIVE PRESSURE	(psig)		
9	PISTONS: SINGLE ACTING / DOUBLE / OPPOSED			
10	NUMBER OF CYLINDERS / ARRANGEMENT			
11	BORE / STROKE	(mm)		
12	PISTON COOLING MEDIUM / MAX. PISTON SPEED (MPM)			
13	STANDBY RATING	(kW)		
14	CONTINUOUS RATING	(kW)		
15	FUEL CONSUMPTION			
16	@ FULL LOAD / @ 3/4 LOAD / @ 1/2 LOAD	(m³/day)		
17	OVERALL LENGTH, WIDTH, HEIGHT (INCLUDING GENERATOR)	(m)		
18	TYPE OF BARRING DEVICE			
19	TYPE OF LUBRICATION OF MAIN PARTS			
20	CYLINDER LUBRICATION (SPLASH OR FORCE FEED)			
21	LUBE OIL FLOW REQUIRED	(m³/hr)		
22	MAX. LUBE OIL TEMPERATURE @ FULL LOAD	(°C)		
23	JACKET COOLING WATER REQUIRED	(m³/hr)		
24	MAX. JACKET COOLING WATER TEMP	(°C)		
25	MAX. JACKET COOLING WATER PRESSURE	(barg)		
26	RESERVOIR CAPACITY (COOLING WATER)	(l)		
27	EMISSIONS: REQUIRED	ACTUAL		
28	CO_2	(kg/hr)		
29	NO_x	(kg/hr)		
30	PM	(kg/hr)		
31	SO_2	(kg/hr)		
32	Opacity	(%)		
33	AUXILIARIES Size Model Rating			
34	INTAKE SILENCER			
35	LUBE OIL PUMPS			
36	JACKET WATER PUMPS			
37	JACKET WATER HEAT EXCHANGER			
38	EXHAUST SILENCER			
39	FUEL OIL PUMPS			
40	AIR COOLED RADIATOR			
41	WEIGHT (lbs):			
42	ALL EQUIPMENT/ENGINE LESS FLYWHEEL/ FLYWHEEL			
43	HEAVIEST PIECE			
44	HEAVIEST PIECE HANDLED IN MAINTENANCE			
45	MAXIMUM ALLOWABLE NOISE LEVELS	(_ dBA at _ m)		
46				
47				
48				

REV	DATE	REASON FOR REVISION	BY	CHK'D	APPROVALS

DIESEL ENGINE DATA SHEETDATA SHEET EMERGENCY DIESEL GENERATOR	Job No. :	
	MR No. :	
PROJECT NAME	Attachment :	
		Sheet 1 OF 1

Attachment 10 - EPM-KEM-TP-000012 - Template - Mechanical Equipment List

Tag or Mark No.	Equipment Description*	Manufacturer	Model No.	Equipt Size/ Rating**	Power (kW)	P&ID No.	Outline Drawing No.	Equipt Sched No.	Remarks	PO or Subcontract No.	Supplier***

Legend:
- * *Equipment Type, System, Fluid, Function, etc.*
- ** *Add Critical Size/Rating Information from Equipment Schedule Drawing*
- *** *PO or Subcontract Awarded to this Company*

Attachment 11 - EPM-KEM-TP-000014 - Template - Mechanical Design Criteria

EXPRO

Template – Mechanical Design Criteria

Table of Contents

EXPRO

Template – Mechanical Design Criteria

Table of Contents

EXPRO

Template – Mechanical Design Criteria

1.0 SCOPE

This design criteria document should contain a brief statement of the scope of the Project as it applies to Mechanical design. This document should focus on the Mechanical design basis only, not the design basis for the entire project. There is no need to repeat a list of standard project information that might change and require revising the Mechanical document, when in fact it is not relevant to the Mechanical design basis. The Mechanical design criteria document should be prepared on a building or facility prototype basis because there is no need to have a separate document for each building or facility if several buildings will have identical or similar designs.

The outline presented in this template is to be followed as closely as possible. Sections and subsections that are not applicable to the Scope of Work (SOW) for this project can be deleted (with the remaining sections renumbered accordingly.) The design criteria need not contain the list of deliverables to be prepared for the project. The complete list of Mechanical deliverables should be covered elsewhere in the SOW documents for the project.

References for design criteria inputs should be listed in each section (as appropriate) and should also be included in Section 11.0 of this design criteria document.

2.0 SERVICE CONDITIONS

The purpose of this section is to establish the design criteria related to ambient conditions that are to be used for Mechanical design. It is not necessary to list all of these elements for every project because not all of these criteria will apply to every geographic location. Rather, this list is intended to provide a comprehensive set of all possible criteria that should be considered by the Responsible Engineer for applicability to the Mechanical design. Most of these criteria should have been defined in the SOW documents for the project. But if they were not, they should be included here to establish the basis for Mechanical design before proceeding.

2.1 Temperature and Humidity

The HVAC design basis shall follow the guidelines in the Energy Conservation Code portion of the applicable building code. Temperature and humidity design criteria can be provided one of two ways: either as a dry bulb temperature and associated relative humidity (as a percent of saturation) or as dry bulb temperature and coincident wet bulb temperature.

Two different sets of ambient temperature and humidity conditions are normally required for Mechanical design. One set contains average and extreme minima (winter) and maxima (summer) for the location. These temperature (and associated humidity) values define the basis for any equipment located outdoors, including rooftops. The other set form the basis for HVAC design. HVAC design should not be based upon extreme minima and maxima because that results in significant over-sizing and inefficient operation for most of the year. The HVAC design basis temperature must be agreed to by the Entity if not already provided in the SOW documents.

2.2 Wind Speed and Direction

Wind is typically not a consideration for MEP equipment that is located indoors but can affect outdoor and roof-mounted equipment. If a design value is not provided in the project SOW documents or applicable building code, then this value should be taken from ASHRAE for the nearest weather station location. The predominant wind direction may dictate the orientation of some mechanical equipment, such as cooling towers used for air conditioning mounted outside or on rooftops.

2.3 Precipitation

Maximum rainfall amounts are important for the design of building roof and storm drains along with any outdoor collection basins (e.g., sump) and transfer pumps (e.g., sump pumps). Roof and storm drains are typically included as part of the Civil design SOW, but Mechanical often sizes the collection basins and transfer pumps. The applicable building code defines the design storm event. Two scenarios are of concern: the maximum 1-hour rainfall (the peak short-term event) and the 10-year design storm (typically a 24-hour event). These criteria should be coordinated with the Civil Discipline to confirm that the correct bases are being used.

2.4 Air Quality

This section should address any special conditions unique to the site location that could affect Mechanical equipment and require special design features. Air quality can be a concern both for design of outdoor/roof-mounted equipment and for HVAC intake filters. If the building is located near a coastal area, the ambient air can contain highly corrosive salts making special coatings necessary for outdoor equipment. Buildings in urban areas are sometimes subject to air that contains high levels of airborne pollutants making it necessary to install special filters in HVAC intakes to protect building occupants from breathing that air. Desert areas with wind and sand may require special shelters and/or air filters to prevent dust and sand from penetrating equipment located outside or getting into areas that are indoors.

2.5 Elevation

Site elevation relative to mean sea level (MSL) is typically provided but doesn't normally affect Mechanical design, except at extreme elevations (e.g., greater than 3000 feet above MSL). The higher the site elevation, the lower the air density will be. This does affect HVAC calculations, but most computer codes will correct for this automatically. It is not usually necessary to have the exact elevation at the building site, because the general elevation of the city where the project is located is usually close enough for Mechanical design purposes. This information can be found in ASHRAE climatic tables if it is not provided in the project SOW documents.

2.6 Seismic Zone

The seismic design basis from the appropriate building code should be listed here. The seismic site class and design category along with mapped spectral acceleration forces (for both short and long periods) should be included for the project site. Mechanical equipment must be specified that can withstand the seismic event described in this section.

2.7 Design Life

The required design life of Mechanical equipment and systems shall be stated here. Normal maintenance and replacement parts may be required to meet this design life expectancy.

2.7.1 Erosion and Corrosion Control

Effects of any anticipated erosion and corrosion on both internal or external surfaces must be considered on the design life of mechanical components. Particulates may impact external (e.g., sand, salt, or other debris in the atmosphere) or internal (e.g., suspended solid, including corrosion products) surfaces of equipment, pipe, and ducts. Soil with high conductivity or with high water content can affect external surfaces of underground pipe and associated components (e.g., buried valves and fire hydrants). Corrosive fluids (e.g., demineralized water, acid/caustic solutions, cooling water with high levels of dissolved solids, such as seawater, etc.) will impact internal surfaces. Methods to mitigate the impacts of anticipated internal and external erosion and corrosion shall be described here or in the appropriate subsections of this design criteria document (e.g., electrical cathodic protection for underground pipes, excess wall thickness added as a corrosion allowance for pipes or ducts, external wrapping/coatings on equipment or components, etc.).

2.8 Enclosure Protection

The minimum degree of enclosure protection for indoor and outdoor mechanical equipment shall be provided here. Enclosure requirements shall consider air quality (e.g., wind, dust, salt, etc.), safety (e.g., for personnel protection from rotating equipment, high temperatures, or noise), and aesthetics (to meet the Entity's requirements as described in the SOW documents).

2.9 Sustainability Requirements

Requirements for sustainability shall be stated here. For LEED Projects, target accreditation shall be provided (platinum, gold, silver, or certified) together with the summary of planned credits on how to achieve the required accreditation.

2.10 Mechanical Fire and Life Safety Requirements

The required Mechanical Fire and Life Safety Systems as per coordination with the FLS Consultant to comply with the Fire Code, shall be indicated here. This shall include requirements to create pressure differential across zones to avoid migration of smoke from fire compartment to other protected compartments. The system shall include, but not limited to; staircase pressurization, zoned smoke control system, lift lobby or lift shaft pressurization, atrium smoke extraction, car parking ventilation and smoke management. This section shall include all required parameters to arrive with the volumetric flow requirements such as number of open doors considered, differential pressure and air velocity across doors and compartments. All other design conditions shall also be indicated such as dedicated or non-dedicated system, compensated or non-compensated system, anticipated plume temperature for building with or without sprinkler, and source of make-up air for smoke exhaust. Computerized assisted strategy to determine effective smoke flow and evacuation, such as CFD (computational fluid dynamics) modelling shall also be indicated here.

The mechanical design engineer shall conform to the smoke zoning indicated in the architectural FLS plan to ensure coordination with life safety system zoning.

2.11 Integration Requirements

Integration requirements of mechanical FLS, HVAC accessories (motorized dampers), sprinkler supervisory and flow switch, clean agent control, pre-action system control panels, LPG solenoid valves, kitchen hood suppression system, elevator control panels, the BMS, and other mechanical appurtenances to the Fire Detection and Alarm System Control Panels shall be indicated here. Integration of mechanical FLS systems to the FDAS is required for the Life Safety System to work and function as one coordinated system for the purpose of early fire detection, fast fire suppression, smoke containment and evacuation, and elimination of fuel and oxygen source to protect the occupants and property. Integrated electro-mechanical systems ensure not only safety of occupants but also collaborate for the immediate evacuation of occupants during emergency condition.

3.0 CODES, STANDARDS, AND REGULATIONS

3.1 Building Codes

Every location will have an applicable building code. The building code may be a country code (e.g., Saudi Building Code) that is applicable throughout the entire country; a state or provincial code that is applicable throughout the entire state or province; a regional code that is applicable to a large area that crosses state or provincial borders, or a local city code that is applicable only to a particular city. Each building code is part of a set of codes that includes an Electrical Code, an Energy Conservation Code, a Fire Code, a Mechanical Code, and a Plumbing Code. It is important to identify each of these codes for Mechanical design. The Responsible Engineer should be aware of the fact that a local jurisdiction may not have adopted an entire set of matching codes. This section of the design criteria document needs to clearly identify the codes that are required by the regulatory authorities that have jurisdiction for the review of the project design.

Codes and Standards that related specifically to HVAC, plumbing, or fire protection design are to be included in Sections 4.1, 5.1, and 6.1, respectively.

3.2 Hierarchy of Design Requirements

The hierarchy of design requirements shall be listed to describe which statutory requirements (e.g., codes, standards, and regulations) or other project documents take precedence over one another. The process to resolve any conflicts shall also be described here. The Entity may have requirements that exceed the statutory requirements, but they cannot reduce or waive any statutory requirements.

4.0 HEATING, VENTILATION, AND AIR-CONDITIONING DESIGN

4.1 HVAC Codes and Standards

The specific list of codes and standards to be followed for HVAC design shall be listed here. A separate subsection for each industry group should be used (e.g., ASHRAE, AMCA, SMACNA, NFPA, etc.).

4.2 HVAC Basis of Design

The HVAC design basis needs to establish which areas will have heating systems, which areas will have ventilation with outside air makeup, which areas will have air conditioning, which areas will have dedicated exhaust, and which areas will have humidity control. In general, each specific building area should only have the minimum set of services required to meet statutory and Entity requirements. Use of tables for each building or facility type with rows for rooms/areas and columns to check the areas that will have: heating, ventilation, cooling, exhaust, and/or humidity control are suggested.

4.3 Duct Criteria

4.3.1 Sizing

The basis for duct sizing will be stated here. If there are no special Entity requirements for velocity limits and flow resistance/pressure loss, industry guidelines (e.g., ASHRAE, SMACNA, etc.) shall be listed here and followed.

4.3.2 Materials of Construction

The design basis for duct material selection shall be stated here. Special consideration must be given to ducts that might be exposed to high moisture on either the inside or outside surface. Design guidance for minimum duct thickness shall also be included in this section.

4.3.3 Pressure Class

All ductwork shall be assigned a (SMACNA) pressure class based upon the maximum expected static pressure for the duct system. It is suggested that a table be provided to list the various pressure classes required for the project along with the corresponding system operating pressure ranges. Ductwork will be constructed per the applicable guidelines for each pressure class.

4.3.4 Duct Sealing

Criteria for sealing ductwork shall consider the appropriate guidelines in the Energy Conservation Code portion of the applicable building code. All ductwork shall be assigned a seal class on the design drawings. Joints in duct work will be sealed in accordance with the applicable sealing requirements provided in this section for that pressure class. (A table should be provided in this section to summarize the applicable sealing requirements.)

4.3.5 Duct Insulation

The criteria for applying insulation (e.g., to meet the applicable energy conservation code or meet noise requirements) and the insulation material to be used shall be stated here.

4.4 Noise and Vibration

The noise limits for various building and facility areas shall be provided here. If the noise level requirements are different for Mechanical equipment and HVAC equipment in the same areas, separate subsections or tables shall be used to clearly define the requirements. Use of acoustical enclosures to meet noise requirements shall be described in Section 2.8.

The design basis and method(s) used for vibration control shall also be described here.

4.5 Air Intake and Filtration

The guidance to be followed for locating air intakes shall be stated here. Include a discussion for the use and type of inlet louvers and filters to protect against rain, sand, or other debris (along with associated louver sizing criteria). The filter MERV ratings or particulate removal efficiency shall be provided.

4.6 HVAC Piping

4.6.1 Refrigerant Piping

The design basis for refrigerant piping (e.g., sizing basis and materials of construction) along with insulation requirements and materials to prevent condensation from forming shall be stated here and must be selected to withstand 1.5 times of the service pressure.

4.6.2 Chilled Water Piping

The design basis for chilled water piping (e.g., sizing basis and materials of construction) along with insulation requirements and materials to prevent condensation from forming shall be stated here and must be selected to withstand 1.5 times of the service pressure.

4.7 HVAC System Descriptions

A description of the applicable HVAC subsystems included in the project SOW shall be provided in the following subsections. The design criteria should contain a brief one or two paragraph description that indicates the design intent for the following HVAC systems. The purpose of the description is to obtain the Entity's agreement on the technology to be used and the areas to be covered prior to starting any detailed design. (Only include the subsections that apply to the project. Delete ones that do not apply and renumber the remaining subsections.)

4.7.1 Ventilation

A description of the ventilation system for each building or facility shall indicate how the makeup air will be distributed, what types of equipment (e.g., air handling units or roof fans) are used, whether air will be ducted, and the level of equipment redundancy (if any is provided).

4.7.2 Exhaust

A description of the exhaust system for each building or facility shall indicate which areas have exhaust, whether the discharge is ducted separately to the outside or combined with other exhaust ducts, how fans are controlled (e.g., continuous or intermittent based upon a signal), and the level of equipment redundancy (if any is provided).

4.7.3 Heating

A description of the heating system (if required) shall indicate whether it is a hot air system with air ducts distributing the heat to each room, a local system with unit-type or radiative heaters located in each individual room, or a hydronic or steam system with hot water or steam piping run to fan coil units mounted in each room. It should also indicate the primary heating fuel (typically either electric or natural gas) and the level of equipment redundancy (if any is provided).

4.7.4 Cooling

A description of the cooling system for each building or facility shall indicate whether it is a cold-air system with air ducts distributing the cool air to each room, a local system with a separate direct expansion-type unit in each individual room or area, or a central system with refrigerant or chilled water piping run to fan coil units mounted in each room or area. The description shall explain where the condensate is collected or to where the drains are routed. It should also describe the level of equipment redundancy (if any is provided).

4.7.5 Precision Cooling

A description of the precision cooling system (if one is required) shall include the areas that require the temperature and humidity to be controlled to a narrow band (such as computer and electrical rooms) using computer room area coolers, which can provide heating, cooling, humidification, and dehumidification as needed. (The basis for temperature and humidity ranges shall be included.) It should also describe the location of the precision cooling equipment (e.g., in the same room or an adjacent room to reduce noise) along with the level of equipment and instrumentation redundancy (if any is provided).

4.7.5 Hydronic Cooling

A description of the hydronic cooling system (if one is utilized) shall include the buildings or facilities where this is used. The description shall also state whether secondary or tertiary cooling loops are used. The design basis for ground temperature ranges along with resulting room or area temperatures and humidities shall be summarized. Any special protection for underground piping (e.g., coating and wrapping or cathodic protection) shall be addressed here if not covered in Sections 2.7.1 or 4.6. The location of hydronic cooling pumps and related equipment shall also be included.

5.0 PLUMBING DESIGN

5.1 Plumbing Codes and Standards

The specific list of codes and standards to be followed for plumbing design shall be listed here. A separate subsection for each industry group should be used (e.g., ASPE, ASSE, ASME, AWWA, etc.).

5.2 Plumbing Basis of Design

The basis for plumbing design shall be the applicable local code. It is recommended that a table be used to summarize the fixtures to be provided. It is suggested that the table for each building or facility type have rows for rooms/areas and columns to check the areas that will have: sinks, sanitary connections, floor drains, equipment drains, hose bibs, and/or emergency shower/eyewash stations, etc.

5.3 Piping Criteria

5.3.1 Pipe Sizing

The design basis for pipe sizing shall be described here. Sizing must conform to the applicable plumbing code (which is normally based upon either the flow rate or a fixture count method using the water supply fixture units or drain fixture units as specified in the plumbing code). The Entity may require larger pipe sizes than the minimum sizes defined in the plumbing code. Separate criteria may be required for sizing water supply, drainage, and vent piping.

5.3.2 Materials of Construction

A list of acceptable materials to use for the various types of piping shall be listed here. The materials must conform to the applicable plumbing code and must be selected to withstand 1.5 times of the service or system pressure.

5.3.3 Insulation Requirements

The criteria for applying insulation (e.g., to prevent condensation from forming on cold water lines and for personnel protection on hot water lines) along with the insulation material to be used shall be stated here. The criteria shall also consider the appropriate guidelines from the Energy Conservation Code portion of the applicable building code.

5.4 Backflow Prevention

5.4.1 Building Inlet

The type of backflow preventer (e.g., double check valve or pressure reducing) to be used at the inlet to each building shall be stated to conform with the applicable plumbing code. The location of the backflow preventer shall also be described here. (If there is no plumbing code requirement for specific location, the location should be selected based upon local customary practice.)

5.4.2 Plumbing Fixtures

The method of backflow prevention (e.g., backflow preventer or air gap) shall be stated to conform with the applicable plumbing code.

5.4.3 Fire Water Supply

If fire protection systems are supplied from the same building water supply as the potable water, the type of backflow preventer used in the branch connection to the fire protection system shall be stated.

5.4.4 Hose Bib Connections

The type of vacuum breaker (e.g., pressure type, atmospheric type, or permanently attached hose connection type) installed at all hose bibs, sill cocks, wall hydrants, or any other devices with a hose connection shall be stated.

5.5 Valves and Isolation

5.5.1 Required Locations

The locations that require full-open type isolation valves in the potable water supply pipe shall be listed, which typically include the following:

- *Building entrance*
- *Base of each building riser*
- *Discharge of any water meter*
- *Inlet of each water tank*
- *Inlet of each water heater*

Valves and isolation shall be selected to withstand 1.5 times the working pressure based on its working temperature.

5.5.2 Fixture Isolation

The requirement for a shutoff valve in the potable water supply to each plumbing fixture (with separate valves for the hot and cold water lines to each fixture) shall be stated.

5.5.3 Access Requirements

The locations for shutoff valves and isolation valves located in accessible areas (or with means of access) shall be stated. The location for each sill cock or wall hydrant isolation (which can be separately controlled by a valve located inside the building) shall also be indicated.

5.6 Drain Connection Criteria

5.6.1 Connection Type

The design basis for connecting drains from all plumbing fixtures directly to a building sanitary drain shall be stated. A statement shall also be included to ensure that the drainage or discharge from any device other than a plumbing fixture shall not be directly connected to a sanitary drain, vent, or building drain system.

5.6.2 Indirect Drain Connection Requirements

The criteria shall state the basis for any indirect connections (e.g., use of an air gap and/or a trap). Indirect drain piping shall not be smaller than the nominal size of the outlet on the equipment or device to which it connects. The criteria shall also state whether indirect connections to drain systems are allowed in a toilet room, confined space, concealed space, inaccessible space or an unventilated space.

5.6.3 Air-Conditioning Equipment

The methodology for indirect discharge of condensate or other drainage from air-conditioning or cooling equipment to a trapped and vented drain collection line through an air gap shall be described.

5.6.4 Drain Hub Connections

The minimum distance (e.g., 50 mm) that open hub drains for indirect waste connections shall extend above the surrounding floor shall be stated. The sizing basis for indirect drain connections (e.g., at least one nominal pipe size larger than the indirect drain piping) shall also be indicated.

5.7 Specialty Fixtures

5.7.1 Water Hammer Arrestors

The requirements for where to locate shock absorbing devices shall be stated (e.g., at each pipe riser; on all water distribution piping that contains a quick-closing valve just upstream of the quick-closing valve, such as a solenoid valve, pneumatic valve; on all long supply piping runs, near locations where two or more similar adjacent fixtures are supplied by the same branch, or at faucets of the self-closing or push-pull type). The shock absorbing device shall be located as close as possible to the quick closing valve.

5.7.2 Trap Seal Priming

The methodology for replenishing the seal in a trap that could lose its water seal due to evaporation (because of infrequent use) shall be stated (e.g., having an accessible means to replenish the seal manually if allowed by the applicable plumbing code or with a trap seal priming device).

5.7.3 Temperature Mixing Valves

The design basis (and associated code reference) for a temperature mixing valve that will ensure an appropriate tepid water temperature for the water supply to emergency shower/eyewash stations shall be stated.

5.7.4 Hydro-Pneumatic Tanks

The design basis for any hydro-pneumatic tank in the potable water supply used to maintain system operating pressure shall be provided. The sizing criteria (for capacity), tank type (bladder or diaphragm) code followed, materials of construction, and connection type for on-site charging (e.g., NPT connection for a Schrader valve) shall also be included in this section.

5.8 Potable Water Storage

5.8.1 Water Tanks

The design basis for water storage (if required on site) shall be stated here. The criteria shall include the basis for tank sizing, materials of construction, location of overflow, vent, and drain lines, etc.

5.9 Plumbing Pump Requirements

5.9.1 Booster Pumps

The design basis for potable water booster pumps (if required) shall be provided. Pump type (e.g., usually end-suction when the booster pump is fed directly from a tank or in-line when there is no tank, single-stage, overhung impeller, centrifugal pumps with radially-split casings), sizing criteria, and materials of construction (with all wetted parts meeting the applicable potable water regulations) shall be described.

5.9.2 Sump Pumps

The design basis for sump pumps shall be provided. Pump type (e.g., often submersible, end-suction, single-stage, close-coupled, centrifugal pumps for small sumps used in plumbing applications), sizing criteria, and materials of construction shall be described.

5.9.3 Sewage Pumps

The design basis for sewage pumps shall be provided. Pump type (e.g., submersible, grinder-type, end-suction, single-stage, centrifugal pumps designed to handle sanitary waste with a maximum solid size of 50 mm), sizing criteria, and materials of construction shall be described.

5.9.4 Recirculating Pumps

The design basis for any recirculation pumps shall be provided where required by the applicable plumbing code. Pump type (e.g., in-line, single-stage, centrifugal pumps), sizing criteria, and materials of construction (with all wetted parts meeting the applicable potable water regulations) shall be described.

5.10 Plumbing System Descriptions

A description of the applicable plumbing subsystems included in the project SOW shall be provided in the following subsections. The design criteria should contain a brief one or two paragraph description that indicates the design intent for the following plumbing systems. The purpose of the description is to obtain the Entity's agreement on the design approach that will be followed and areas that will be provided with plumbing services prior to starting any detailed design. (Only include the subsections that apply to the project. Delete ones that do not apply and renumber the remaining subsections.)

5.10.1 Domestic Cold Water

A description shall include the source of potable water for the building, any on-site storage features, whether booster pumps are required/provided, backflow prevention plan, building metering, and the location of water supply and storage equipment within the building. The basic concept for the distribution piping should also be explained.

5.10.2 Domestic Hot Water

A description of how water is heated (central tank or individual on-demand heaters), how stored, how distributed, and where equipment will be located shall be provided. If the plumbing code requires a hot water recirculation system for instances where the length of hot water piping from the source to the fixture exceeds a certain distance (e.g., 30 m), the hot water recirculation system(s) should also be described or an explanation provided as to how the design avoids the need for recirculation.

5.10.3 Sanitary Sewer and Vents

A description of the system for collecting and transporting sanitary waste offsite shall be provided. It should state whether it is gravity-based, pumped, or a combination of the two. The venting and drainage philosophy should be described and include an explanation of how the drains are vented directly outside the building or facility. The location of any necessary specialty equipment should be mentioned along with and the final disposition for the sanitary waste (e.g., sent to a public sewer or a private sewage plant).

5.10.4 Building Drains

The description shall state whether each building has a common drain system for all services or separate drain systems for sanitary and non-sanitary drains. If there is a separate, non-sanitary drain system (for water that has not come into contact with sanitary waste or food particles, such as water from floor drains, equipment drains, HVAC condensate drains, etc. that may be recycled for irrigation or flushing of toilets), it should be described, including the drainage philosophy (gravity or pumped), types of fluids collected, equipment locations, venting provisions, and the final use or disposition for these wastes. If the plumbing code requires treatment or disinfection of the recycled wastewater, such as ozone, chlorine, or UV before this water can be reused for flushing toilets, this should be included in the description.

5.10.5 Storm and Roof Drains

If storm and roof drains are included in the Mechanical SOW, a brief description shall be included here. (Refer to the Civil or Utility design criteria document if this is included in the Civil or Utility SOW for the project.) If storm or roof drain piping is routed inside the building, the design description must meet the applicable plumbing code requirements. If applicable, the methodology to drain these systems should be described as either atmospheric (relying on gravity flow with partially-filled lines and sloped horizontal piping) or siphonic (operating at less than atmospheric pressure with completely full lines and no slope, which is more advantageous for large roof areas that require long runs of horizontal piping or multiple vertical drain risers). The description should also indicate how the drains are collected and where the water ends up (e.g., as irrigation water, with non-sanitary building drains, or the sanitary sewer where allowed).

5.10.6 Grey Water Recycling

If grey water or recycled water is used within the building, then a description shall be provided for this system. It should explain the source of the water, its intended use, the method of disinfection, the type and location of equipment, along with the distribution system.

6.0 FIRE PROTECTION DESIGN

6.1 Fire Protection Codes and Standards

The specific list of codes and standards to be followed for fire protection design shall be listed here. A separate subsection for each industry group should be used (e.g., NFPA, local codes, etc.).

6.2 Fire Protection Basis of Design

The basis for fire protection design shall be the applicable code for the project site. It is recommended that a table be used to summarize the fire protection features provided for each building/facility area/room. It is suggested that the table for each building or facility type have rows for rooms/areas and columns to check the areas that will have: wet pipe sprinklers, dry pipe sprinklers, .standpipe system with hose connections (but no automatic sprinklers), clean agent suppression system (for areas with electrical equipment that should not get wet), fire detection only (without any suppression), and/or fire extinguishers (with extinguisher type stated to distinguish between CO_2 types in electrical rooms and multi-purpose, dry-chemical types in most other areas).

6.3 Fire Protection Piping

6.3.1 Materials

The materials of construction for small bore piping (DN 50 and less), large bore piping (larger than 50 mm), and standpipes shall be listed to comply with applicable codes. The method of construction (e.g., welded or seamless) and connection type (e.g., grooved, threaded, flanged, or welded) shall be included for each piping classification. Piping and all appurtenances shall be selected to withstand 1.5 times the system shut-off pressure with exceptions to those downstream of a pressure reducing valve with relief valve in compliance to NFPA 13.

6.4 Fire Protection Pump Requirements

6.4.1 Fire Booster Pumps

The design basis for booster pumps (if required) shall be provided. Pump type (e.g., usually end-suction when the booster pump is fed directly from a tank or in-line when there is no tank, single-stage, overhung impeller, centrifugal pumps with radially-split casings), sizing criteria, and materials of construction (with all wetted parts meeting the applicable potable water regulations) shall be described. If the pump needs to be UL listed, that should be so stated.

6.4.2 Pressure Maintenance Pumps

The design basis for pressure maintenance ("jockey") pumps (if required) shall be provided. Pump type (e.g., usually close-coupled, single-stage, regenerative-type, centrifugal pumps), sizing criteria, and materials of construction (with all wetted parts meeting the applicable potable water regulations) shall be described. If the pump needs to be UL listed, that should also be stated.

6.5 Fire Protection System Descriptions

A description of the applicable fire protection subsystems included in the project SOW shall be provided in the following subsections. The design criteria should contain a brief one or two paragraph description that indicates the design intent for the following fire protection systems. The purpose of the description is to obtain the Entity's agreement on the design approach that will be followed and areas that will be provided with various types of fire protection features prior to starting any detailed design. (Only include the subsections that apply to the project. Delete ones that do not apply and renumber the remaining subsections.)

6.5.1 Fire Water Supply and Storage

The description shall describe the source of fire-fighting water for the building or facility, the need (and sizing basis) for any on-site storage features, whether booster pumps are needed, if backflow prevention is required and the location of fire-water supply and storage equipment within the building.

6.5.2 Wet Suppression Systems

The description shall list the different types of sprinkler systems required based on the various hazard classes (i.e., light, ordinary, extra) and explain where each type will be used. The basis for sprinkler nozzle selection and sizing shall be included.

6.5.3 Dry Suppression Systems

If required, the description shall state which areas have this coverage and where the dry sprinkler valves will be located. The basis for sprinkler nozzle selection and sizing shall be included.

6.5.4 Standpipe Systems

When standpipes are required (based upon building or facility height), this description shall indicate the type of system (wet or dry, Class II or III), the location of hose stations, and provisions for fire fighter supply connections to put water into the system.

6.5.5 Clean Agent Suppression Systems

If clean agent suppression is required, the description shall state which areas have this coverage, the type of agent, the sizing basis for storage of the clean agent, and the location of storage bottles.

6.5.6 Fire Extinguishers

The type, size, and location rules for manual fire extinguishers shall be described. Electrical areas will typically have different types of extinguishers than other areas (e.g., CO_2 versus dry chemical). Mounting of manual fire extinguishers should be in accordance with applicable local codes, which typically specify height limitations (minimum and maximum) and may require brackets or cabinets to hold the device.

7.0 MISCELLANEOUS UTILITIES

Although not necessarily part of the normal Mechanical design scope for many buildings and facilities, there may be some miscellaneous utilities that interface with the Mechanical scope for some projects. Some typical ones are listed in the subsections below. Sections should be added or deleted (and then renumbered accordingly) to cover the specific utilities that interface with the Mechanical SOW. A brief description of the Mechanical SOW for each utility type shall be included below.

7.1 Utility Codes and Standards

The specific list of codes and standards to be followed for design of the miscellaneous utility systems shall be listed here. A separate subsection for each utility type should be used.

7.2 Compressed Air Systems

A description shall list the areas served (e.g., for operating pneumatic tools in workshop areas or for use in laboratories) and include the sizing basis, supply pressure requirements, along with the number and connection type of air stations. A typical system includes an air compressor, receiver tank, distribution piping, and air stations mounted along the walls in work areas. Each air station should include a filter with a connection for pneumatic tools.

7.3 Fuel Gas Systems

A description shall list the equipment served (e.g., for gas stoves, heaters, or boilers, etc.) and include the sizing basis, and interface pressure requirements (along with pressure reduction and safety relief capability if required). If fuel gas clean-up equipment is required to meet manufacturer's requirements for downstream components, a description and sizing basis shall be provided for this equipment also.

7.4 Fuel Oil Systems

A description shall list the equipment served (e.g., for oil stoves, heaters, or boilers, etc.) and include the sizing basis, storage needs, and interface pressure requirements (along with pressure reduction and safety relief capability if required). If fuel oil clean-up equipment is required to meet manufacturer's requirements for downstream components, a description and sizing basis shall be provided for this equipment also.

7.5 Cranes and Hoists

A list of any cranes and hoists (with lift capacity ratings) shall be provided if needed to lift heavy equipment for maintenance or replacement.

8.0 EQUIPMENT AND MATERIAL SELECTION

The technical criteria for equipment and material selection shall be included in the appropriate sections above. However, any additional, non-technical criteria for selection (e.g., country of origin or commercial considerations for lead-times, availability of repair and spare parts, etc.) can be included here.

8.1 Selection Criteria

This section might include a discussion of the Entity's requirements for selecting from a list of pre-approved suppliers, the preference for country of origin, or other commercial considerations, such as availability of spare parts and the ability to retain onsite service technicians for maintenance. All equipment and components must meet the minimum requirements as stated in the contract documents for the project.

8.2 Energy Savings Criteria

The criteria for selecting high-efficiency equipment shall be explained here. This could include direction from the Entity for the project, LEED requirements, or from the appropriate sections of the Energy Conservation Code portion of the applicable building code.

8.3 Life Cycle Cost Analysis

The Entity's requirements for the commercial evaluation to support selection of equipment and components shall be described. The analytical methodology to be followed that incorporates not only the initial capital cost, but also includes the anticipated operation and maintenance costs over the useful life of the component shall be summarized here.

8.4 Safety Considerations

This section shall include any additional safety requirements that the Entity may impose for worker safety (during construction) and operator/occupant safety (for the life of building, facility, or equipment) beyond the mandatory statutory safety requirements (i.e., codes, standards, and regulations. The steps to incorporate human factor ergonomic principles shall be discussed along with accident mitigation and reduction plans.

8.5 Standardization and Redundancy

The Entity's requirements for standardization and redundancy of Mechanical equipment and components shall be described here.

9.0 PHYSICAL REQUIREMENTS

The criteria for physical layout and arrangement of Mechanical equipment and associated components shall be described here.

9.1 Piping Layout

The criteria for layout of piping (including associated valves and inline specialty components or instruments) shall be described here. The requirements shall address access to piping and components for normal operation, maintenance, or replacement. Additional layout criteria to address requirement for safety (e.g., locating pipes carrying hot fluids out of reach) should be mentioned if not already described in Section 8.4. Requirements for sloping pipe runs (e.g., to meet an applicable code or to facilitate gravity drainage) should also be discussed if not mentioned elsewhere in this document.

9.2 Duct Layout

The criteria for layout of HVAC ducts (including associated dampers and inline specialty components or instruments) shall be described here. The requirements shall address access to ductwork and components for normal operation, maintenance, or replacement. Additional layout criteria to address requirement for safety (e.g., locating ducts with hot air or flue gas out of reach) should be mentioned if not already described in Section 8.4.

9.3 Mechanical Equipment Arrangement

The criteria for arrangement of Mechanical equipment and components shall be described here. The requirements shall address aisle spacing and access to equipment and components for normal operation, maintenance, or replacement along with any other special Entity requirements, such as consistent orientation of similar or identical equipment for human factor considerations.

10.0 Building Management System and Integration Requirements

If a separate design criteria document, diagrams, and specification exists for the control and monitoring of mechanical and electrical systems inclusive of all equipment for this project, it can be mentioned here (and included as a reference in Section 11.0 below) without any further detailed explanation. Otherwise, include the relevant design criteria for instrumentation and controls of mechanical systems and equipment in this section. Include as many subsections as deemed necessary to describe the functional control requirements for individual pieces of equipment along with complete system integration, including any interfacing to the electrical systems and Fire Detection and Alarm System.

Reference document that can be mentioned in this document shall include data point schedule, sequence of operation, and PID (Process and Instrumentation Diagram) to clearly describe the required field devices, controllers, and functions of the BMS.

11.0 REFERENCES

A list of references and supporting documents shall be included in this section. The document title along with the document number and revision or other unique identifier (such as published version or date) shall be shown. References made throughout this document may simply mention the appropriate reference section number (i.e., Reference 11.1, 11.2, 11.3, etc.) without repeating the entire reference document title throughout the body of this design criteria document.

Attachment 12 - EPM-KEM-TP-000015 - Template - MED Desalination System Data Sheet

PROJECT NAME:			JOB No.	
ATTACHMENT:			MR No.	
DETAILS				
1	**Influent Seawater Supply**		**Minimum**	**Maximum**
2	Influent Seawater Volumetric Flowrate	(l/s)	*	*
3	Influent Seawater Operational Pressure at Interface	(Barg)	*	
4	Influent Seawater Shut-off Pressure	(Barg)	n/a	
5	Max. Operational Rate of Change of Seawater Flowrate	[(l/s)/min]	n/a	*
6	Max. Emergency Rate of Change of Seawater Flowrate	[(l/s)/min]	n/a	*
7	**Influent Seawater Quality**		**Minimum**	**Maximum**
8	Sodium	(mg Na/l)		
9	Potassium	(mg K/l)		
10	Calcium	(mg Ca/l)		
11	Magnesium	(mg Mg/l)		
12	Strontium	(mg Sr/l)		
13	Barium	(mg Ba/l)		
14	Total Boron	(mg B/l)		
15	Total Iron	(mg Fe/l)		
16	Total Aluminium	(mg Al/l)		
17	Total Manganese	(mg Mn/l)		
18	Chloride	(mg Cl/l)		
19	Sulfate	(mg SO4/l)		
20	Bromide	(mg Br/l)		
21	Fluoride	(mg F/l)		
22	Total Inorganic Nitrogen	(mg N/l)		
23	Bicarbonate	(mg HCO3/l)		
24	Carbon Dioxide	(mg CO2/l)		
25	pH			
26	Total Dissolved Solids	(mg tds/l)		
27	Suspended Solids	(mg ss/l)		
28	Total Organic Carbon	(mg C/l)		
29	Temperature	(°C)		
30	Assimilable Organic Carbon	(mg C/l)		
31	Total Coliforms (Prior to Chlorine Addition)	(mpn/100 ml)		
32	Normal Free Chlorine Concentration	(mg Cl2/l)		
33	Shock Chlorination Free Chlorine Concentration	(mg Cl2/l)		
34	Shock Chlorination Duration	(mins)		
35	Interval Between Shock Chlorination Events	(hrs)		n/a
36	Screening Size	(mm)	n/a	
37	Number of Seawater Supply Mains			
38	**Seawater Supply Termination Point Details**			
39	Type of Termination to be Supplied by Seller			
40	Connection at Termination Point to be Made by			
41	Nominal Pipe Size at Termination Point	(mm)		

Attachment 13 - EPM-KEM-TP-000016 - Template - Miscellaneous Chemical Feed System Data Sheet

PROJECT NAME:			JOB No.		
ATTACHMENT:			MR No.		
DETAILS					
1	TREATMENT SERVICE				
2	CHEMICAL SERVICE				
3	EQUIPMENT NUMBER(S)				
4	QUANTITY OF SKIDS				
5	LOCATION	☐ Indoors	☐ Outdoors		
6	SUNSHADE	☐ Yes	☐ No	☐ N/A	
7	MAXIMUM ALLOWABLE NOISE LEVEL (__ dBA at __ m)				
8	CHEMICAL FEED PUMPS				
9	QUANTITY (per skid)				
10	MANUFACTURER / MODEL NUMBER	*	*		
11	TYPE				
12	DESIGN CAPACITY (lph)				
13	DESIGN DISCHARGE PRESSURE (barg)				
14	TURNDOWN	☐ 10:1	☐ 20:1	☐ 40:1	☐ Other (specify)
15	MINIMUM CAPACITY (lph)	*			
16	MAXIMUM CAPACITY (lph)	*			
17	MAXIMUM DISCHARGE PRESSURE (barg)	*			
18	FLOW CONTROL	☐ Manual	☐ Automatic		
19	TYPE OF AUTOMATIC CONTROL	☐ N/A	☐ Stroke	☐ Speed	
20	CHEMICAL FEED PUMP MOTORS				
21	MANUFACTURER / MODEL NUMBER	*	*		
22	HORSEPOWER (kW)	*			
23	VOLT / PHASE / CYCLE (V / phase / Hz)	*	*	*	
24	ENCLOSURE	*			
25	INSULATION CLASS	*			
26	SERVICE FACTOR	*			
27	RPM (RPM)	*			
28	INTERCONNECTING PIPING - SIZE (mm)	*			
29	SCHEDULE (SUCTION / DISCHARGE)	☐ 40	☐ 80	☐ 40	☐ 80
30	INSTRUMENTATION LOCATION				
31	PULSATION DAMPENER ☐ N/A	☐ Suction	☐ Disch.	☐ Common	☐ Individual
32	CALIBRATION COLUMN	☐ Suction	☐ Disch.	☐ Common	☐ Individual
33	PRESSURE GAUGE	☐ Suction	☐ Disch.	☐ Common	☐ Individual
34	STRAINER	☐ Suction	☐ Disch.	☐ Common	☐ Individual
35	DRAIN VALVE	☐ Suction	☐ Disch.	☐ Common	☐ Individual
36	BACKPRESSURE VALVE (by Seller)	☐ Suction	☐ Disch.	☐ Common	☐ Individual
37	INJECTION QUILLS	☐ Yes	☐ No		
38	FLOW RATE / DIAMETER (of line being injected into) (lpm / mm)				
39	QUANTITY / MAKE / MODEL		*	*	
40	CONNECTION (SIZE / TYPE) (mm)				
41	CHEMICAL TANKS				

Attachment 14 - EPM-KEM-TP-000017 - Template - Atmospheric Bulk Chemical Feed System Data Sheet

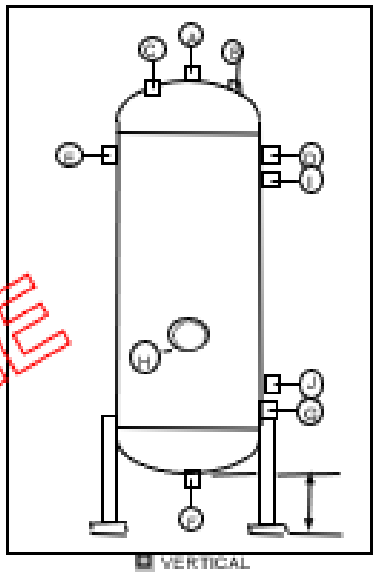
PROJECT NAME:	JOB No.
ATTACHMENT:	ME No.

DETAILS

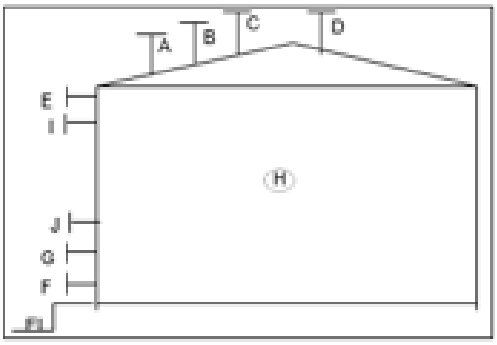
NOZZLE SCHEDULE

Mark	Size, mm	Type	Qty	Function
A	"	"	1	VENT
B	"	"	1	LEVEL INSTRUMENTATION
C	"	"	1	TRUCK FILL CONNECTION
D	"	"	1	CALIBRATION COLUMN RETURN
E	"	"	1	OVERFLOW
F	"	"	1	DRAIN
G	"	"	1	OUTLET
H	"	"	1	MANHOLE
I & J	"	"	1	LEVEL GAUGE CONNECTIONS

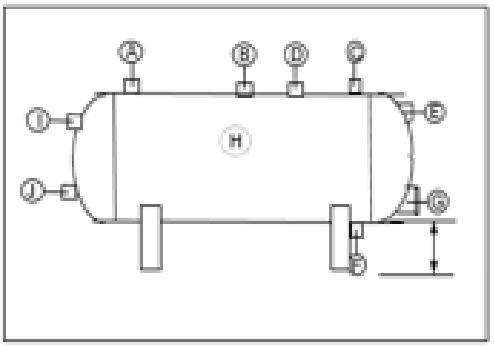
NOTES:
1. Manhole shall be a minimum of __ mm in diameter and shaped to facilitate removal.
2. The drain shall facilitate complete drainage of the tank.
3. The tank overflow and valved drain shall be piped to a location flanged terminal point.
4. The truck fill connection shall be piped to grade level.
5. The vessel orientation is denoted by an 'X' in the appropriate box.



☐ VERTICAL



☐ FLAT BOTTOM



☐ HORIZONTAL

CHEMICAL				DESIGN / OPER PRESSURE (barg)		
SHELL (MTL/THICKNESS) (mm)			"	DESIGN / OPER TEMP (°C)		
HEAD (MTL/THICKNESS) (mm)			"	CORROSION ALLOWANCE		
INSULATION CLIPS / THICKNESS	☐ YES	☐ NO		FLANGE (RATING / FACING)		
INSTALLATION LOCATION	☐ Indoors	☐ Outdoors		FITTINGS RATINGS		
SUNSHADE	☐ YES	☐ NO		PIPING AND VALVES - MATERIAL OF CONSTRUCTION (MOC)		
COATINGS: INTERIOR						
EXTERIOR				OVERFLOW & DRAIN PIPING - MOC		
ACCESSORIES	☐ Grounding Lugs			WIND LOADING		
	☐ Ladder and Platform			SEISMIC DESIGN		
MANUFACTURER				APPLICABLE CODES/STANDARDS		

Attachment 15 - EPM-KEM-TP-000018 - Template - Horizontal Centrifugal Pump Data Sheet

PROJECT NAME:				JOB No.			
ATTACHMENT:				MR No.			
DETAILS							
1	SERVICE / P&ID NUMBER						
2	MANUFACTURER / MODEL / TYPE OF PUMP	*		*		*	
3	QUANTITY						
4	TAG NUMBERS						
5	LIQUID PUMPED						
6	FLUID						
7	TEMPERATURE: RATED / MINIMUM / MAXIMUM (°C)						
8	SPEC. GRAVITY/VISCOSITY/VAPOR PRESS.: @ DESIGN TEMP (-- /cst/bara)						
9	PUMP PERFORMANCE						
10	NPSHR / NPSHA (m)	*					
11	FLOW: RATED / MINIMUM / MAXIMUM (m3/hr)			*		*	
12	RATED PRESSURE: SUCTION / DISCHARGE AT FLANGE (barg)					*	
13	DIFFERENTIAL HEAD: RATED / SHUTOFF (m)					*	
14	RPM/ROTATION (VIEW FROM MOTOR FACING PUMP)/SPECIFIED SPEED			*		*	
15	EFFICIENCY: @ RATED (%)			*			
16	BRAKE HORSEPOWER: RATED CONDITIONS / MAX CONDITIONS (kW)	*				*	
17	MAXIMUM ALLOWABLE NOISE LEVEL (IN BUILDING/OUTSIDE) (dBA @ m)	@					
18	PUMP CONSTRUCTION						
19	IMPELLER DIAMETER: RATED / MINIMUM / MAXIMUM (mm)	*		*		*	
20	IMPELLER EYE AREA/SUCTION EYE PERIPHERAL VELOCITY (mm²/in/sec)	*				*	
21	NUMBER OF STAGES	*					
22	MAXIMUM WORKING PRESSURE / HYDROTEST PRESSURE (barg)	*				*	
23	CLEARANCE: WEAR RING / BEARING / IMPELLER (SEMI-OPEN) (mm)	*		*		*	
24	SHAFT DIAMETER (mm)	*					
25	CASING TYPE	☐ Radially Split				☐ Horizontally Split	
26	CASING SUPPORT	☐ Center Line Mounted				☐ Foot Mounted	
27	IMPELLER SUPPORT	☐ Overhung				☐ Between bearings	
28	SUCTION: SIZE/FLANGE RATING/FLANGE FACING/POSITION (mm/--/--/--)	*	*			*	*
29	DISCHARGE: SIZE/FLANGE RATING/FACING/POSITION (mm / -- / -- / --)	*	*			*	*
30	BASEPLATE REQUIRED / SOLEPLATE REQUIRED	☐ YES	☐ NO			☐ YES	☐ NO
31	BEARING TYPE / LIFE	*				*	
32	BEARING LUBE: TYPE / FLOW / PRESSURE (-- / m³/hr / barg)	*		*		*	
33	SHAFT SEAL: TYPE / CONNECTION / COOLING FLOW (-- / -- / m³/hr)	*		*		*	
34	ROTOR FIRST CRITICAL SPEED (rpm)	*					
35	MATERIAL						
36	CASING / DIFFUSER	*				*	
37	IMPELLER / SHAFT	*				*	
38	WEAR RINGS: CASE / IMPELLER	*				*	
39	SHAFT SLEEVE: BRG / STUFF BOX	*				*	
40	COUPLING						
41	FURNISHED BY / MANUFACTURER	☐ By Buyer	☐ By Seller			*	

Attachment 16 - EPM-KEM-TP-000019 - Template - Sump Pump Data Sheet

PROJECT NAME:			JOB No.		
ATTACHMENT:			MR No.		
DETAILS					
1	SERVICE / P&ID NUMBER				
2	MANUFACTURER / MODEL		*		*
3	QUANTITY / PUMP LOCATION				☐ Indoors ☐ Outdoors
4	EQUIPMENT TAG NUMBER(S)				
5	LIQUID PUMPED / SUMP INFORMATION				
6	FLUID				
7	FLUID TEMPERATURE: RATED / MINIMUM / MAXIMUM (°C)				
8	SPECIFIC GRAVITY @ RATED TEMPERATURE				
9	VISCOSITY / VAPOR PRESSURE @ RATED TEMPERATURE (cSt / bara)				
10	SUMP DEPTH BELOW BOTTOM OF PUMP SUPPORT PLATE (m)				
11	PUMP PERFORMANCE				
12	RATED CAPACITY (m^3/hr)				
13	DIFFERENTIAL HEAD / TOTAL DIFFERENTIAL HEAD (Note 2) (m)				*
14	NPSHA / NPSHR / MINIMUM SUBMERGENCE (m / m / mm)		*		*
15	EFFICIENCY / BRAKE HORSEPOWER AT RATED CONDITIONS (% / kW)		*		*
16	PUMP SPEED (rpm)		*		
17	MAXIMUM ALLOWABLE NOISE LEVEL (PUMP AND MOTOR) (dBA @ m)		@		
18	PUMP CONSTRUCTION				
19	TYPE	☐ Vertical ☐ Vertical Cantilever ☐ Submersible ☐ Commercial			
20	CONFIGURATION	☐ Simplex	☐ Duplex		
21	IMPELLER TYPE	☐ Open	☐ Semi-Open	☐ Recessed	
22	SHAFT SEAL TYPE		*		
23	BEARING TYPE - FRAME / LINESHAFT		*		*
24	BEARING LUBE - TYPE	☐ Grease Packed		☐ External Flush	
25	FLUSHING WATER: FLOW / PRESSURE (m^3/hr / barg)		*		*
26	DISCHARGE SIZE / FLANGE RATING / FLANGE FACING (mm / -- / --)		*		
27	SUPPORT PLATES	☐ Required		☐ Not Required	
28	CIRCULAR - DIAMETER / THICKNESS (mm)				*
29	SQUARE - LENGTH / WIDTH / THICKNESS (mm)				*
30	RECTANGULAR - LENGTH / WIDTH / THICKNESS (mm)				*
31	PIT COVER	☐ Not Required	☐ By Buyer	☐ By Seller	
32	SQUARE - LENGTH / WIDTH / THICKNESS (mm)				*
33	RECTANGULAR - LENGTH / WIDTH / THICKNESS (mm)				*
34	MATERIALS		DESCRIPTION		ASTM NUMBER
35	SUSPENSION COLUMN		*		*
36	CASE		*		*
37	IMPELLER		*		*
38	SHAFT		*		*
39	DISCHARGE PIPE		*		*
40	SUPPORT PLATE		*		*
41	PIT COVER		*		*
42	CONTROLS				

Attachment 17 - EPM-KEM-TP-000020 - Template - Roof Mounted Vent Fan Assembly Data Sheet

PROJECT NAME:			JOB No.			
ATTACHMENT:			MR No.			
DETAILS						
1	SERVICE					
2	BUILDING					
3	EQUIPMENT NUMBER(S)					
4	QUANTITY					
5	MANUFACTURER		*			
6	MODEL NUMBER		*			
7	SERVICE CONDITIONS:					
8	AMBIENT TEMPERATURE:					
9	INDOOR (SUMMER / WINTER)	(°C)				
10	OUTDOOR (SUMMER / WINTER)	(°C)				
11	DESIGN WIND SPEED	(m/sec)				
12	SITE ELEVATION	(___m above MSL)				
13	BUILDING PRESSURE (RELATIVE TO ATMOSPHERE)	(± kPa)				
14	DUST TYPE / DUST LOADING					
15	CORROSIVE ATMOSPHERE / CONTAMINANTS		☐ Yes	☐ No		
16	SMOKE REMOVAL		☐ Yes		☐ No	
17	CONFIGURATION					
18	STANDARD OR REVERSE MOUNT		☐ Standard		☐ Reverse	
19	HOODED INTAKE / MINIMUM HOOD OPENING	(m^2)	☐ Yes	☐ No	*	
20	TYPE OF DRIVE		☐ Direct		☐ Belt	
21	INTAKE FILTERS		☐ Yes	☐ No	☐ Permanent	☐ Disposable
22	BIRD SCREEN / INTERIOR GUARD		☐ Yes	☐ No	☐ Yes	☐ No
23	DAMPER		☐ Yes	☐ No	☐ Gravity	☐ Motorized
24	PERFORMANCE:					
25	EXHAUST MODE					
26	CAPACITY	(m^3/hr)				
27	FAN STATIC PRESSURE	(kPa)	*			
28	DISCHARGE STATIC PRESSURE LOSS	(kPa)				
29	INLET STATIC PRESSURE LOSS, BUYER / TOTAL	(kPa)			*	
30	DESIGN TEMPERATURES:					
31	WINTER (DRY BULB / WET BULB)	(°C)				
32	SUMMER (DRY BULB / WET BULB)	(°C)				
33	STATIC EFFICIENCY	(%)	*			
34	DISCHARGE VELOCITY	(m/sec)	*			
35	FAN SPEED	(RPM)	*			
36	NOISE LEVEL (REQUIRED / EXPECTED)	(___dBA @ 1 m)			*	
37	VIBRATION PEAK VELOCITY	(mm/sec)	*			
38	SUPPLY MODE					
39	CAPACITY	(m^3/hr)				
40	FAN STATIC PRESSURE	(kPa)	*			
41	DISCHARGE STATIC PRESSURE LOSS	(kPa)				

Attachment 18 - EPM-KEM-TP-000021 - Template - Sewage Lift Station Data Sheet

PROJECT NAME:				JOB No.		
ATTACHMENT:				MR No.		
DETAILS						
1	EQUIPMENT NUMBER(S)					
2	QUANTITY OF LIFT STATIONS					
3	**RATINGS AND CONDITIONS OF SERVICE**					
4	LIQUID PUMPED / LIQUID TEMPERATURE: MIN / MAX (/ °C / °C)					
5	DESIGN FLOW RATE INTO SUMP / CAPACITY (EACH PUMP) (m³/hr / m³/hr)					
6	TOTAL DISCHARGE HEAD (ft)					
7	**CONSTRUCTION**					
8	TYPE OF PUMP / ASSEMBLY			☐ Simplex ☐ Duplex		
9	PUMP (MODEL NUMBER / MANUFACTURER):	*		*		
10	SOLIDS HANDLING / NON-CLOGGING / MAX SOLID SIZE (/ / mm)	☐ Yes ☐ No	☐ Yes ☐ No	*		
11	IMPELLER / SHAFT SEAL TYPE	☐ Recessed	☐ Semi-enclosed	*		
12	SHAFT COUPLING TYPE	*				
13	BEARING LUBRICATION	☐ Sealed Lubricated	☐ Grease Packed	☐ Other		
14	BEARING TYPE (THRUST / INTERMEDIATE)	*		*		
15	WET WELL (FURNISHED BY)	☐ Buyer		☐ Seller		
16	MATERIAL OF CONSTRUCTION/USEABLE VOLUME (BETWEEN LEVELS) (Litres)					
17	TOP/BOTTOM OF WET WELL ABOVE/BELOW GRADE ELEVATION (m / m)					
18	CONNECTION DISTANCE BELOW ELEVATION (INLET / OUTLET) (mm / mm)					
19	GROSS CAPACITY / WET WELL DIAMETER (litres / m)	*		*		
20	**WET WELL COVER**	☐ Solid Cover	☐ Hinged Access Door			
21		☐ Partial Grating	☐ Full Grating	☐ Gas Tight		
22	WET WELL INLET CONNECTION (SIZE/TYPE/RATING)					
23	WET WELL OUTLET CONNECTION (SIZE/TYPE/RATING)					
24	MANHOLE OR DOOR SIZE (mm x mm)	*				
25	PUMP DISCHARGE (SIZE / RATING) (mm / lb std)	*		*		
26	VENT (SIZE / RATING) (mm / lb std)	*		*		
27	EQUIPMENT WEIGHT (EMPTY / FLOODED) (kg / kg)	*		*		
28	**INSTRUMENTATION AND CONTROLS:**	☐ Thermal Overload Protection		☐ HOA Switches		
29		☐ Disconnect Switches		☐ Motor Starters		
30	TYPE OF ALTERNATOR	☐ Mechanical		☐ Electrical		
31	NUMBER OF MECHANICAL FLOAT CONTROLS					
32	ENCLOSURE NEMA RATING (CONTROL PANEL/JUNCTION BOX)					
33	**MATERIALS**					
34	WET WELL COVER/WET WELL COVER FRAME/WET WELL COVER GASKET	*	*	*		
35	CASE / IMPELLER / SHAFT	*	*	*		
36	BEARINGS (THRUST / INTERMEDIATE)	*		*		
37	**DRIVER**					
38	RATED HORSEPOWER / RPM	*		*		
39	VOLTAGE / PHASE / FREQUENCY	*	*	*		
40	ENCLOSURE	☐ ODP		☐ WP II		
41		☐ TOTALLY ENCLOSED		☐ EXPLOSION PROOF		

Attachment 19 - EPM-KEM-TP-000022 - Template - Hydropneumatics Tank System Data Sheet

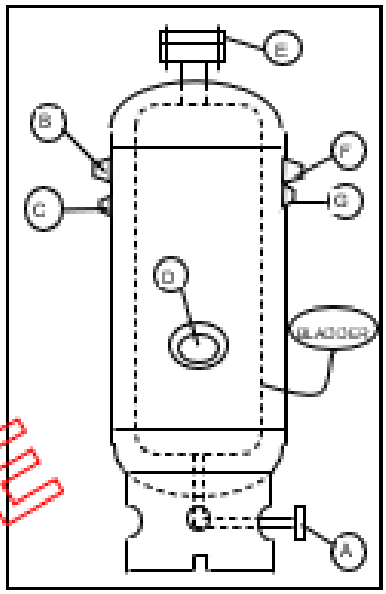
PROJECT NAME:	JOB No.
ATTACHMENT:	MR No.

DETAILS

NOZZLE SCHEDULE

Mark	Size, mm	Type	Qty	Function
A	*	*	1	POTABLE WATER INLET/OUTLET
B	*	*	1	PRESSURE GAUGE
C	*	*	1	PRESSURE SWITCH
D	*	*	1	HANDWAY
E	*	*	1	BLADDER ACCESS
F	*	*	1	AIR INLET
G	*	*	1	PRESSURE RELIEF VALVE

NOTES:
1. Skillar to add additional nozzles as necessary.
2. The pressure gauge (Nozzle B) shall include an isolation valve.
3. Provide a pressure relief valve in accordance with the applicable code.
4. Vessel shall include process, vent, and drain connections for safe operation, and maintenance, as required.
5. Nozzle A shall be extended horizontally outside the insulation by 150 mm for ease in system connection.

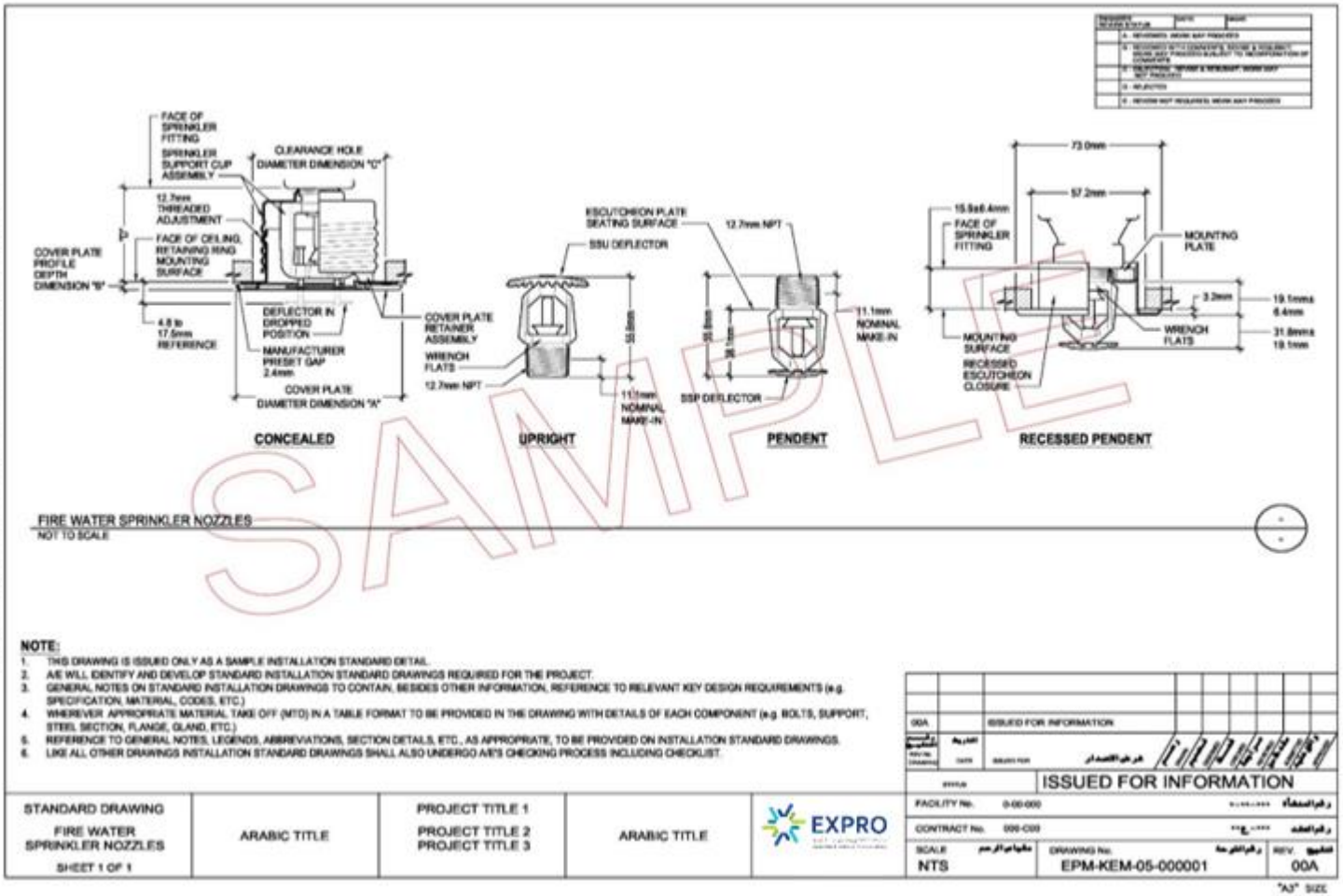


HYDROPNEUMATIC TANK:			DESIGN / MAX OPER PRESS (barg)	
SERVICE			DESIGN / MAX OPER TEMP (°C)	
FILL / DISCHARGE RATE (lpm)			COATING	
DESIRED RUNNING TIME (min)			NUMBER OF SKIDS	
EFFECTIVE SYSTEM PROTECTION (ESP)			EQUIPMENT TAG NUMBERS	
VOLUME (liters)			INSTALLATION LOCATION	
MAX SYSTEM PRESS (barg)			FREEZE PROTECTION	*
MIN SYSTEM PRESS (barg)			FOOTPRINT (HEIGHT) (mm)	*
MANUFACTURER	*		(LENGTH / WIDTH) (mm)	* / *
VESSEL TOTAL VOLUME (liters)	*		WEIGHT (kg)	*
OVERALL HEIGHT (mm)			CONTROL PANEL NEMA RATING	
SHELL (MTL / THICKNESS) (mm)		*	POWER SOURCE (VOLTAGE)	
HEAD (MTL / THICKNESS) (mm)		*	(CYCLE / PHASE)	
INSULATION CLIPS	☐ YES ☐ NO		INTERCONNECTING PIPING (SCH)	*
HYDRO PRESSURE (barg)	*		(MATERIAL / SIZE) (mm)	* / *
CORROSION ALLOWANCE (mm)			WELDING SPECIFICATION	
FLANGE (RATING / FACING)			WIND LOADING DESIGN REQS.	
FITTINGS RATINGS			SEISMIC DESIGN REQUIREMENTS	
JOINT EFFICIENCY (%)			MAX ALLOWABLE NOISE LEVEL dBA at m	
ASME CODE STAMPED	☐ YES ☐ NO		APPLICABLE CODES/STANDARDS	
			P&IDS	

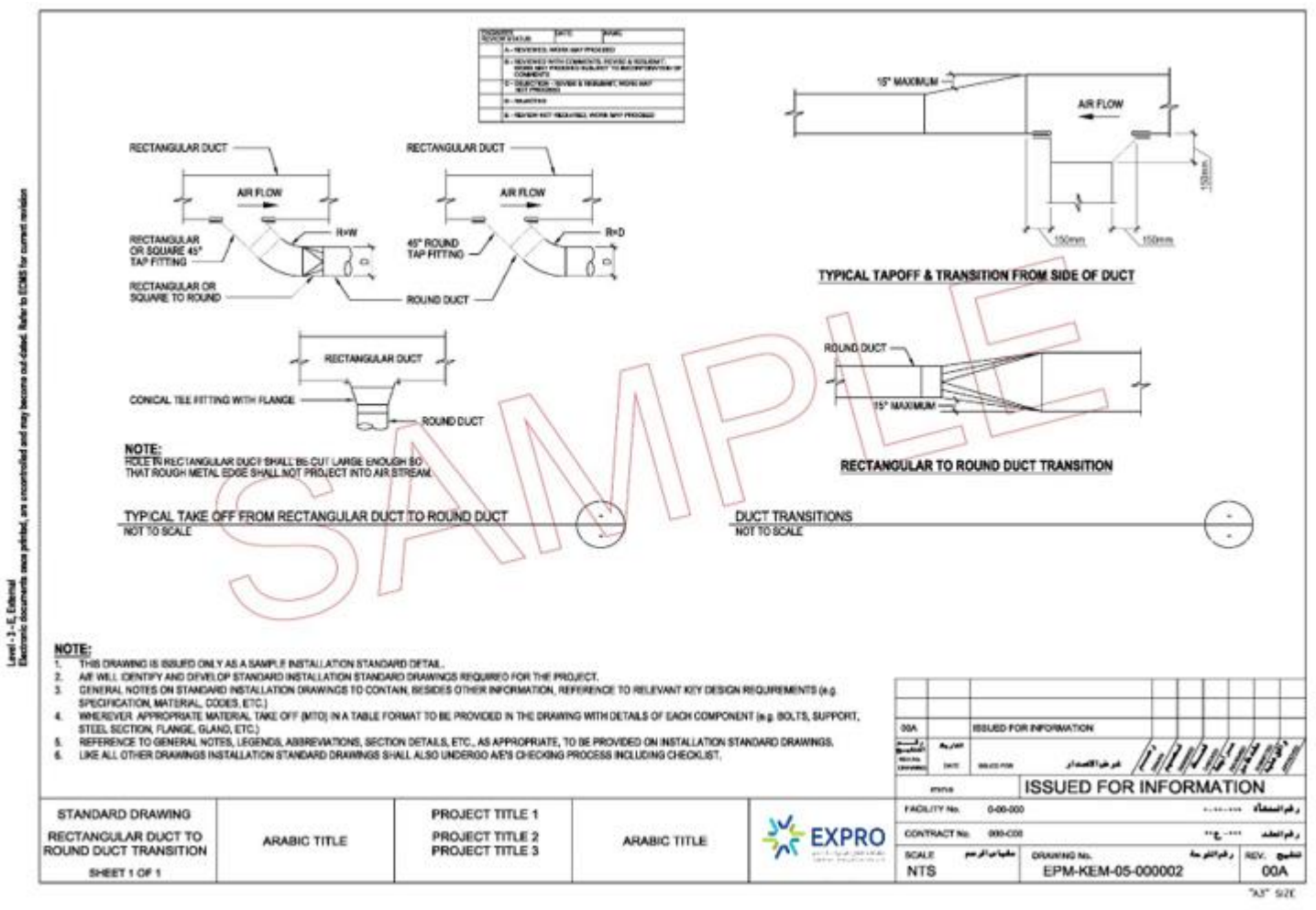
Attachment 20 - EPM-KEM-RG-000001 - List of Mechanical Deliverables

SN	Deliverable	Tool	Deliverable Contents	Developed During -	Deliverable/Data required for				Comments
					Procurement	Construction	Start-Up & Commissioning	Project Controls	
1	Load Calculation (HVAC Software Output), Psychrometric Analysis, Fresh Air Calculation, and HVAC Equipment Load Calculation.	Hevacomp, HAP, TRACE, MS Excel, MS Word	Load Calculation is a compilation of HVAC software output prints showing cooling and heating requirements for the building based on fenestration, occupants, and meteorological data. Psychrometric Analysis is a diagram which shows the air process for a given system (mostly complex) to attain the room temperature and %RH requirements based on outdoor condition (single or dual season). The Psychrometry is the basis for humidification, dehumidification, total heating and cooling requirements, as well as the capacity of HVAC equipment. For healthcare and other cleanroom application where minimum air change is required, tabulation showing the minimum ACH airflow and load calculation must be provided as basis for equipment cooling and heating requirements. The minimum ACH will be the basis for BMS programming especially for Centralized VAV application. Fresh/Outdoor Air and Exhsut Air calculation based on the latest ASHRAE 62.1 version must be included in the deliverables for verification of OA-AHU and Exhaust Fan capacity. Other calculations shall include, (1) AHU, OA-AHU, and FCU cooling and heating capacity with Energy Recovery Equipment, (2) AHU air flowrate, pressure head, and consumed power, (3) Fan and Pump flowrates, pressure head, and power consumption, (4) Cooling Tower and Fan rating, (4) Chiller Nominal Capacity and considered de-rating factor, (5) Steam Boiler Capacity calculation including make-up water and condensate water return system.	D					Refer to Document EPM-KEM-TP-000026 for the check list for Standard Mechanical Deliverables during design stage.
2	Mechanical Fire and Life Safety System Calculation	CFD Analysis Software, MS Excel, MS Word	For Prescriptive Based Approach, calculation includes (1) airflow rates, number of open doors considered, pressure differential and air velocity, and air leakages required for pressurization of staircase or areas between smoke zones; (2) Fire Load and Heat Release Rates, smoke reservoir details, sprinklered or non-sprinklered building for smoke extraction strategy; (3) Fire Load and Heat Release Rates, smoke reservoir details, pressure differential across doors between smoke zones, sprinklered or non-sprinklered building for engineered smoke extraction strategy. For Performance Based Approach (such as Parking Ventilation and Smoke Control), CFD Analysis shall be submitted. Calculation shall include capacity (air flow, head loss, and power consumption) and fire rating of fans and appurtenances based on resulting plume temperature.	D					Refer to Document EPM-KEM-TP-000026 for the check list for Standard Mechanical Deliverables during design stage.
3	Fire Hose and Sprinkler System Calculation	Hydraulic Calculation Software, MS Excel, MS Word	A/E shall specify type of hazard considered (light, ordinary, or extra hazard) for Pipe Schedule Method pipe sizing. The Contractor approved Civil Defense Fire Sprinkler Specialist can use Hydraulic Calculation complying with NFPA 13 to reduce required pipe size resulting from Pipe Schedule Method. The document shall include fire water storage requirements and capacity (flow, head loss, and power consumption) for Fire Pump and Jockey Pump.	D					Refer to Document EPM-KEM-TP-000026 for the check list for Standard Mechanical Deliverables during design stage.
4	Plumbing System Calculation	MS Excel, MS Word	Calculation includes cold and hot water system storage requirements based on reputable Standards. Fixture Units (water and drainage) calculation and summation as appearing in the Single Line Diagram shall be presented base on nodes. The document shall include fire water storage requirements and capacity (flow, head loss, and power consumption) for Fire Pump and Booster Pump.	D					Refer to Document EPM-KEM-TP-000026 for the check list for Standard Mechanical Deliverables during design stage.
5	Clean Agent System Calculation	AgentCalcs, Janus Design Suite, Kidde Fenwall, and other software	Software output shall include all parameters required by the Code such as discharge time, room volume, temperature consideration, and clean agent concentrations.	D					Refer to Document EPM-KEM-TP-000026 for the check list for Standard Mechanical Deliverables during design stage.
6	Riser Diagrams	2D	Riser Diagrams are a schematic representation of the functional relationship among equipment, piping or ducts, in-line components, major instrumentation, and process control for a given system. They provide the quantities of equipment and components, supply/return flow rates, and general sizing criteria. Riser Diagrams shall be created for all HVAC, Fire Protection, and Plumbing systems.	D		Y	Y		Refer to Document EPM-KEM-TP-000002 for the check list for an HVAC Riser Diagram.
7	Process Instrumentation Diagrams (P&IDs) for Air and Water Distribution System	2D	P&IDs define the flow of the process, indicate the quantities of equipment and components, characterize the control and instrumentation, and identify components furnished by others for a given system. Each component on a P&ID is uniquely identified in accordance with the Entity or A/E numbering system as required by the contract documents. P&IDs may not be required for all systems when sufficient detail is shown on the corresponding Riser Diagrams and Equipment Schedules. P&IDs are critical requirements for the programming of the BMS controllers.	D		Y	Y		Refer to Document EPM-KEM-TP-000004 for the check list for a P&ID.

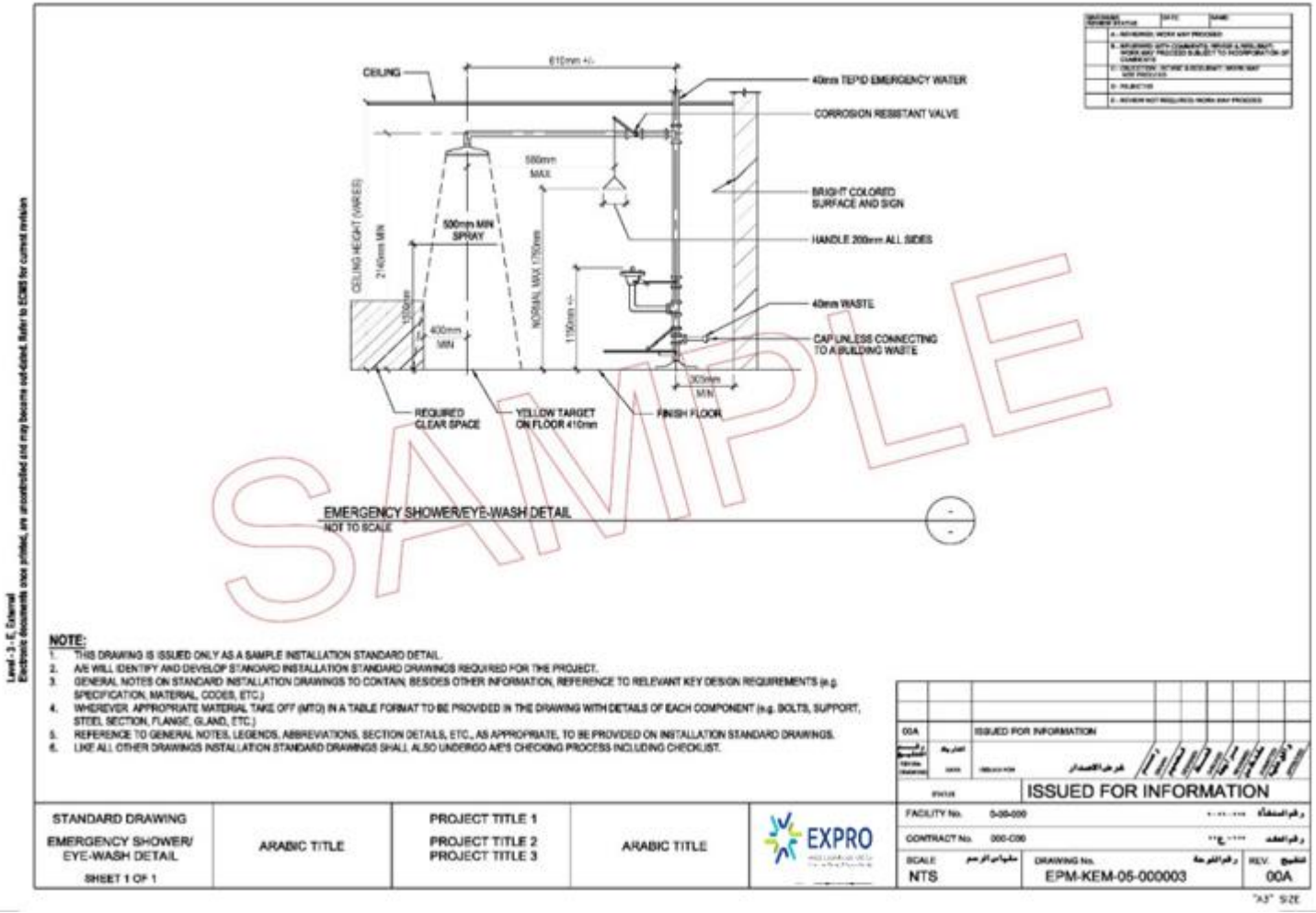
Attachment 21 - EPM-KEM-05-000001 - Fire Water Sprinkler Nozzles



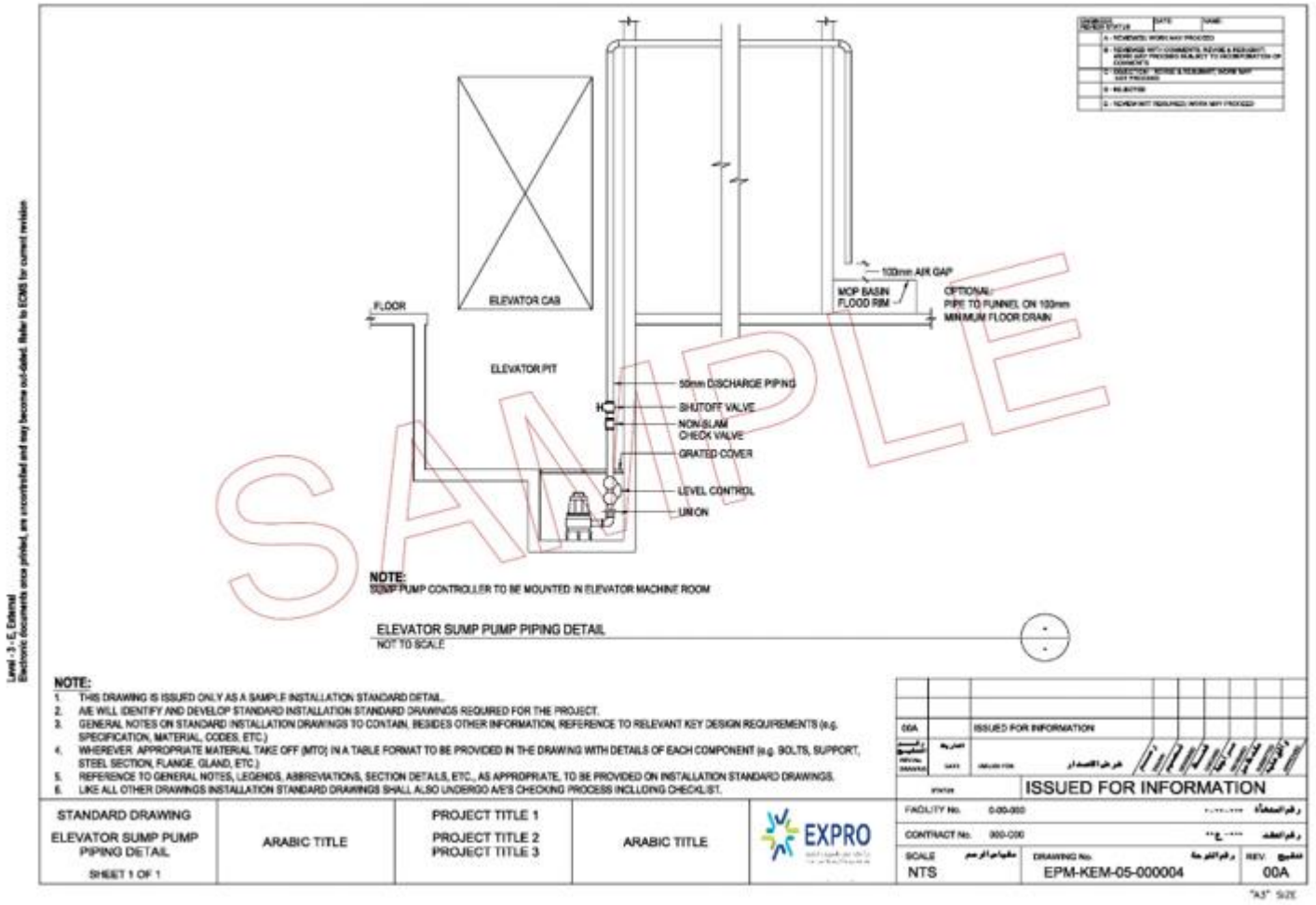
Attachment 22 - EPM-KEM-05-000002 - Typical Take Off from Rectangular Duct to Round Duct - Duct Transitions



Attachment 23 - EPM-KEM-05-000003 - Emergency Shower/Eye-Wash Detail



Attachment 24 - EPM-KEM-05-000004 - Elevator Sump Pump Piping Detail



Attachment 25 - EPM-KEM-05-000005 - Installation Detail of Fire Hydrant (Wet-Barrel)