Basic and Detail Engineering
Index

1. Basic Engineering .................................................................................................................. 3
   1.1. Process Description, Design Basis and Equipment List .................................................. 3
   1.2. Process Flow Diagram (PFD) and Material Balances ..................................................... 3
   1.3. P&IDs ............................................................................................................................ 3
   1.4. Pipe Index and Specification ......................................................................................... 4
   1.5. Mechanical Equipment and Vessel Specifications ....................................................... 4
   1.6. Gas Duct Study ............................................................................................................ 5
   1.7. Instrumentation ............................................................................................................. 6
   1.8. Philosophies .................................................................................................................. 6
   1.9. HSSE and Quality plan .............................................................................................. 7

2. Detail Engineering .................................................................................................................. 8
   2.1. Equipment Summary and Process Data Sheets ............................................................... 8
   2.2. PI-Diagrams (P&ID’s) .................................................................................................. 8
   2.3. Plot Plan and Foundation Layout .................................................................................. 8
   2.4. Mechanical Drawings ................................................................................................... 9
   2.5. Structural Steel work .................................................................................................. 9
   2.6. Pipe Systems Design ................................................................................................... 9
   2.7. Electrical ...................................................................................................................... 10
   2.8. Instrumentation .......................................................................................................... 11
   2.9. Process Control & Safety Systems ............................................................................. 11
   2.10. Specifications ............................................................................................................. 12
   2.11. Manufacturer Record Book ..................................................................................... 12
   2.12. Instructions for Installation, Operation and Maintenance ........................................ 13
   2.13. QA/QC and HSSE Philosophy ................................................................................. 14

Appendix ....................................................................................................................................... 15
1. Basic Engineering

The Basic Engineering package includes:

1.1. Process Description, Design Basis and Equipment List

- Process Description
  Based on the client’s requirements the process description is a document containing a general process description, general flow sequence and reactions, products and effluents.
- Design Basis
  Design Basis including capacity, raw materials, products, utilities, exports, effluents, and specific site criteria as given by the client.
- Equipment list
  The process Equipment List includes names and tag number, duty or size, design temperature and pressure and materials.

1.2. Process Flow Diagram (PFD) and Material Balances

Process Flow Diagram; result of a process development design includes:

- Main Process flows streams, numbered referring to the mass balance
- Flow directions
- Major equipment with symbols, names and identification numbers
- Dimension/duty of main equipment apparatus
- Major subsystems
- Control loops
- Control, ESD and safety relief valves
- Interfaces connection to the linked system with battery limits indicated

- Mass & Heat Balance
  Calculations for the design case and minimum case, including flow rate, temperatures, pressures and transport properties for each stream as well as heat calculations for all relevant heat exchangers.

1.3. P&IDs

These are a representation of the process equipment for the plant by symbols for all equipment and instruments installed in the plant (apparatus, machinery, pipelines, etc.), including installed standby units.

Information includes:
- Item number and designation of the parts of equipment.
Diagrammatic pipeline routing with piping service code, line number, line specification number, and nominal diameter.

− Valves essential for the process.
− Duct sizes and materials of construction.
− General instrumentation requirements to control the process.
− KVT standard insulation thicknesses and requirement for paint on pipelines, duct and equipment.
− Plant air and instrument air users.
− Battery limit tie-in points for all process and utility lines.
− Interlock notes showing the safe start, trip and interlock functions of the instrumentation and motors.
− Electrical controls such as the start/stop, local/panel, manual/automatic controls required for electrical equipment, including locations of running lights, alarms and ammeters.

1.4. Pipe Index and Specification

1.4.1. Piping Index

List of all piping services installed in the battery limits and represented in the P&ID’s. Services are classified according to fluid code and service with indication of piping material, nominal operating temperatures and pressures, and recommended KVT pipe specifications.

− Piping & Valve Specifications

All pipe specifications referenced in the piping index are provided. Valve specifications appropriate to the project and referenced by the pipe specifications are also provided.

1.4.2. Plant Layout Drawings

This document contains the physical plant configuration considering the available area, material handling, structural form and utilities.

The drawing includes the following information:
− Preliminary arrangement of equipment with north arrow, if known, and Plant battery limits.
− List of the equipment to be installed within the Plant battery limits.

1.5. Mechanical Equipment and Vessel Specifications

For all equipment, including proprietary equipment, specifications suitable for obtaining vendor bids shall be prepared. These specifications shall include the following information, or part of as applicable or found necessary by KVT for the specification:

− Operating data (pressure, temperature, material flow, heat flow, fluid compositions and characteristics such as thermal properties, density, viscosity, vapour pressure etc.).
− Design operating conditions (temperatures, pressures, flows etc.).
− Allowable pressure drop
− Duty, minimum fouling factor or excess area recommended for coolers and heat exchangers
• Estimated available NPSH and TDH requirements for pumps (preliminary). E&C Contractor is responsible for the final available NPSH and pump head check after detailed engineering design of the piping system is done.
• General pump seal requirements.
• Recommended machine and driver type and noise requirements for rotating equipment
• Special requirements for the execution of design and fabrication.
• Materials recommended for the main parts and corrosion allowances.
• References to KVT standard testing and inspection requirements when applicable.
• Insulation requirements
• For vessels/tanks:
  o Outline sketches providing sufficient detail to allow a vendor or engineering firm to complete the design and fabricate the vessels. The sketches are for basic engineering only and will not be updated to match detailed shop fabrication drawings, or to match any KVT approved changes requested by the vessel fabricator.
  o Diameter x height (recommended).
  o Storage volume and type.
  o Fluid storage conditions.
  o Materials and corrosion allowance recommended.
  o Nozzle schedule
  o Packing height
  o Packing specification
  o Liquid distributor types

1.5.1. Other Specifications
  o Specifications for catalyst and heat transfer salt will be provided.
  o Insulation specifications: Insulation thickness requirements are shown on the P&IDs. Insulation material and installation specifications will be provided.
  o Safety Shower Specification: A datasheet listing recommended locations of safety showers and utility stations within the Plant will be provided. A safety shower specification will be provided.
  o Material Selection Guide: Specification for the recommended materials of construction will be provided.

1.6. Gas Duct Study
A preliminary duct study showing equipment location and duct routing information shall be provided. The preliminary duct study will be based on the plant layout and equipment from a similar sized plant. The study will include a duct between KVT-designed equipment, and is completed up to
a “reasonable” location where it is connected to a purchased piece of equipment (e.g. main gas blower).

The duct study as described above will include:

- Duct layout drawings to scale, plan and elevations
- Preliminary location of fixed and supporting points
- Preliminary location of expansion joints
- Preliminary location of duct valves

1.7. Instrumentation

1.7.1. Instrument Design Basis

General guidelines for designing instruments in services that are specific for each plant type. The guidelines will include the selection of materials of construction and special considerations for specifications and installations of such instruments.

1.7.2. Instrument List

The instrument list contains the following information:

- Instrument Tag Number
- Service Description
- P&ID number
- Location
- Instrument Type
- DCS I/O Type

1.7.3. Process Control and Safety Systems

Process Control System description; Interlock and emergency shutdown system.

1.7.4. Complex Loop Functional Descriptions

For complex loops where the P&ID’s cannot adequately describe the control algorithms, additional programming information is supplied to facilitate correct implementation of the control in a Digital Control System.

1.8. Philosophies

1.8.1. Operating philosophy

The aim of the operating philosophy is to provide general information on the operating requirements of the plant as well as operator requirements and qualifications.
1.8.2. Reliability and Maintenance Philosophy
The aim of the reliability & maintenance philosophy is to provide a general overview about the reliability of the key components of the Plant including the information on recommended maintenance procedures, frequencies and turnaround requirements.

1.9. HSSE and Quality plan

1.9.1. Quality plan
Quality Plan reports how the contract work is conducted meeting the agreed quality requirements and time schedule.

1.9.2. HSSE Plan
The document describes the plan for the management of Health, Safety, Security and Environment through the Basic Engineering Design of the project.
2. Detail Engineering

Based on the Basic Engineering Package, KVT will perform detail engineering and provide the following Detail Engineering Package.

2.1. Equipment Summary and Process Data Sheets

The equipment summary and process data sheets will be updated based on the basic engineering data.

- Summary of process equipment with final duty or size
- Final design data such as temperature and pressure
- Materials
- Process data sheets including principle mechanical drawings

2.2. PI-Diagrams (P&ID’s)

The P&ID’s will be updated based on the basic engineering data and further detail engineering work. If a HAZOP or SIL Analysis is performed, KVT will input the relevant actions into the P&ID’s.

2.3. Plot Plan and Foundation Layout

2.3.1. Plot Plan

A detailed plot plan will be issued based on the plant layout issued during basic engineering. The drawing shall include the following information:

- Arrangement of equipment with north arrow
- Plant battery limits
- List of the equipment to be installed within the Plant battery limits
- Exhaust point location plan
- Sketch for electrical equipment room and control room

2.3.2. Foundation Layout and Loads Calculation

KVT will produce a basic specification for the civil work to be designed by others, including the following information:

- General layout of foundations, basins, sumps and sewers
- Anchorage drawings (typical only) with sizes and grades and locations relative to equipment centre lines in all three planes, also recommended lengths and pre-tensioning.
- Foundation loads including all static and dynamic forces or movements acting on foundations or other load bearing supports during start-up, shut down, normal and maximum operating conditions and test conditions
2.4. Mechanical Drawings

2.4.1. Arrangement Drawings
KVT will issue a 3-D model (AutoCAD) of the plant including the following details:
- Steel structure
- Major Equipment
- Ducts
- Major pipe work

A “Naviswork” NWD file will be issued to the client. Free viewers for this format are available from the software provider.

2.4.2. Detail Design Drawings
KVT shall issue detailed drawings of all supplied equipment.

2.5. Structural Steel work

Detail Design Drawings for the required steel structure and platforms shall be provided in sufficient detail to serve as basis for fabrication by others. The fabricator is responsible for preparation of shop fabrication drawings, bills of material, etc.

2.6. Pipe Systems Design

Based on the basic engineering data and the Mechanical and Piping Design Criteria as issued by the client, KVT shall prepare the following documents related to piping:

2.6.1. Pipe Schedule
The pipe schedule as prepared during basic engineering shall be updated, providing all necessary information such as listed below:
- Pipe line number and pipe classes
- Materials of Construction
- Nominal Sizes and Pressures
- Operating, Design and Test Pressures and Temperatures
- Insulation and heat tracing requirements

2.6.2. Piping Layout Drawings
Piping drawings shall be issued with the following detail
- Duct work arrangement and detail drawings
- Pipe Isometrics for all main pipes systems such as Sulphuric Acid, Molten Salt, Fuel Gas, Cooling Water
- Pipe Isometric drawings for utility pipe work ≥ DN 50
- System Sketches for all utility pipe work < DN 50
Drawings will include all relevant data for work shop and/or site fabrication.

- Arrangement Drawings to show the arrangement of the duct within the Sulphuric Acid Plant with all required information regarding lifting and installation.
- Detail Drawings to include all details for manufacturing at a work shop.
- Isometric drawings to include Bill of Materials, Spool Identification, Support Location and other information required for manufacturing.
- System Sketches to include approximately Bill of Material, Support location and other information required for site fabrication.

2.6.3. Valve Data Sheets

Data sheets for all types of control, automated and relief valves with the following minimum information shall be provided:

- Valve Type
- Valve Design information such as Operation Mode; Size; Connection type; Flange Rating; Full or reduced bore; Operating, Design and Testing Pressure and Temperature; Materials
- Details for Actuator, Controls and Accessories

For all non operated valves, valve specification data sheets shall be issued.

2.6.4. Relief Valve and Burst Disc Calculation

Relief valve calculation to DIN EN ISO 4126-1, with all potential sizing cases considered, including maximum relieving temperature and a Burst disc calculations to manufacturer’s formula shall be prepared.

2.7. Electrical

Based on the “Electrical and Instrumentation Design Criteria” KVT shall issue all relevant electrical documents required for the installation and safe operation of the plant.

2.7.1. Electrical Schedules

- Single Line Diagrams
- Electrical Consumers location drawing
- Cable Schedule
- Cable Routing Plans
- Schematic diagrams of special control and interlocking systems
- Electrical Termination and Hook-up Details

2.7.2. Panel Cabinet Layout

Internal layout of panel showing overall size and layout, lighting, cable entries and terminations strip locations, wiring trays, segregation of voltage level, IS and non-IS equipment.
2.7.3. Electrical Utility Requirement Schedule
List of all electrical utility requirements together with the service requirement and loads.

2.7.4. Load / Motor List
Each load (static and motor) shall be listed with description, name plate rating and absorbed rating stated.

2.8. Instrumentation
Based on the “Electrical and Instrumentation Design Criteria” KVT shall issue all instrument relevant documents required for the installation and safe operation of the plant.

2.8.1. Instrument Schedules/Diagrams
- Instrument Index to be updated if required
- Instrument Data Sheets for all types of instruments indicated on P&IDs
- Instrument Connection Details
- Instrument Loop Diagrams

2.8.2. Instrument Hook-ups
A drawing shall be provided for each tagged instrument, which will contain the following information where appropriate:
- Seller/ Manufacturer
- Tag number
- Process connection size(s) and ratings
- Inlet and outlet configuration
- Face-to-face dimensions
- Overall height, width and depth
- Electrical connection size(s)
- Instrument mounting details
- Instrument accessories (positioner, handwheel, airset, etc.)
- Weight

2.9. Process Control & Safety Systems

2.9.1. Process Control System Description (FDS)
KVT shall prepare a Functional Design Specification (FDS) in order to allow programming of the PCS System for the Sulphuric Acid Plant.
Results of a HAZOP or SIL study (which is organized by client or general contractor) shall be integrated in the control system.

2.9.2. DCS System
- Specification of the DCS functions
- I/O List
- Design features of signal exchange with MCC
- DCS graphic display information

2.9.3. Alarm & Trip Settings
List of alarm and trip settings of all instrumentation installed within the plant.

2.9.4. Cause and Effect diagrams
These shall indicate clearly and precisely the shut-down requirements on the standard format sheet with defined conventions. All auto-start, change-over, etc of pumps, etc. are to be clearly defined with the location of field devices.

2.10. Specifications

2.10.1. Insulation
KVT shall prepare an insulation specification based on the design criteria from the buyer including the following information:
- List of equipment, ducts and pipes which have to be insulated
- Specification for insulation of ducts, piping and equipment

2.10.2. Painting Specifications
KVT shall prepare a surface preparation and painting specification based on the design criteria from the buyer.

2.10.3. Packing, Preservation and Lifting Specification
KVT shall prepare specification for packing, unpacking, offloading, preservation and lifting of the supplied equipment.

2.11. Manufacturer Record Book
KVT shall prepare a Manufacturing Record Book (MRB) incorporating all quality records for the main delivery items of the plant. The MRB shall include the following information:
- Inspection Certificates, Statement of Compliance
- Bill of Material
- Non Destructive Test Records, Pressure Test Records
• Welding Procedures, Qualification Records, Specifications
• Dimensional Records
• Inspection and Test Plan
• Statutory Authority Approval
• As Built drawings

2.12. Instructions for Installation, Operation and Maintenance

2.12.1. Reliability and Maintenance
• Data on reliability of key components (input to separate availability study)
• Information on recommended maintenance procedures, frequencies and turnaround requirements

The operating instructions are prepared based on the basic engineering work specified in this document. The operating instructions typically include:
• A description of the process.
• Instructions for normal and turndown operation of the Plant and equipment (as applicable).
• Instructions for starting and stopping the Plant, including emergency shutdown.
• Routine plant operating tests.
• Health and safety information, including MSDS’s.
• Operating details for the vendor supplied equipment
• General maintenance of the equipment.

2.12.3. Schedule of Commissioning and Operational Spares
This shall include separate recommendations for commissioning spares, spare parts & consumables for one year’s operation.

2.12.4. Construction and Commissioning Philosophy
Based upon the generated basic design a high level Construction and Commissioning Philosophy will be prepared. This will take into consideration the local environment and conditions prevalent to this project. It will consider alternative strategies and make a justified recommend highlighting any inherent execution risks of the preferred methodology.

2.12.5. Lifting Equipment Test Certificates
KVT shall provide test certificates for all lifting equipment supplied to the client.
2.13. QA/QC and HSSE Philosophy

A Specific QA/QC and HSSE Philosophy for the project shall be issued by KVT
APPENDIX